ANNUAL REPORT 2012 Yoshikawa Lab., IMR, Tohoku Univ.

ANNUAL REPORT 2012

April 2012 - March 2013

Yoshikawa Lab.

Since 2007

IMR, Tohoku University

Contents

1 Preface	5
2 Research Digest	7
3 Message from Foreign Participants	23
4 Members	27
5 Research Life	33
6 Prizes and Awards	39
7 List of Collaborative Research	43
8 Research Funds	47
9 List of Patents	53
10 Committees of academic societies and conferences	54
11 List of Presentations	55
12 List of Publications	75
13 Copies of Selected Papers	85
14 TV, Journals and Newspaper Items	145
15 List of Events	151
16 Events and Memorieas	153

Preface

The report in your hands is intended to give a general impression about research activity of the *Yoshikawa Laboratory* in the Institute for Materials Research (IMR), Tohoku University. This is the first report of my laboratory as an official Research Division in IMR (originally established in April, 2007 as *Yoshikawa Group* at IMRAM). It contains a summary of our various activities and copies of our selected publications in FY2012.

We hope that you will find it interesting and informative.

Current issue covers our activities within academic year from April 2012 to March 2013. Within this period we put our efforts to develop our key technologies and understand the science behind them. Highlights of this year are three following items. The first one is the further progress in studies of GAGG for gamma-ray scintillator. Food survey monitoring system and gamma camera for environment survey are under development. The second one is the improvement of ^{6}LiCAF growth yield. LiCAF is being investigated for neutron detection as an alternative to ^{3}He. The third one is the establishment of crystal growth technology of halide materials. Eu:SrI_2 was grown by the micro-pulling down method. One inch bulk Eu:SrI_2 was also successfully grown. The fourth one is related to starting the development of shaped crystal growth of langasite type CNGG-Al and CTGS-Al for combustion pressure sensor.

When we try to develop novel scintillator crystals, there are plenty of topics, which we have to study, such as design of host lattice from both solid state chemistry point of view and physical point of view. In the multicomponent garnet study, we found that the relative position between band gap and position of dopant level are the key issues. Moreover, the single crystal growth technology, optical characterization, understanding of luminescence processes, searching for the suitable photodetector, reflector, light guide and so on are also very important.

This year, we attempted to apply this concept to other topics such as piezoelectric materials and got positive results.

These activities are always supported by our colleagues from all over the world through the fruitful collaboration.

The details of these studies can be found in the photos and papers published within the above period and included in this report.

All the laboratory members took part in preparation of this report. I appreciate their efforts very much. I wish also to thank to all of our colleagues from Japan and overseas that had participated in our research and significantly contributed to the progress of our projects.

Akira YOSHIKAWA

Professor,
Institute for Materials Research (IMR),
New Industry Creation Hatchery Center (NICHe),
Tohoku University

March, 2013

Research Digest

Research Activities in 2012

Development of
Scintillator, Laser, Piezoelectric crystals
Crystal growth technology and device application

Int'l collaboration

Inst. Phys. (Czech), Milan-Bicocca Univ. (Italy), Tennessee Univ.(USA)
Univ. Lyon1 (France), General Physics Inst. (Russia), IMS (Russia)
Soltan Institute for Nuclear Studies (Poland), Delft Univ. (The Netherlands)

Fluoride Scintillators

Oxide Scintillator

Neutron imager, VUV scintillators

PEM
PET/MRI
Dosimeter
Food inspection

Halide Scintillators

Survey meter

Multidisciplinary Research for "Characterization" and "Device application"

Transparent Ceramics Scintillators

Combustion sensor, SAW filter, …

Compton camera, APD, MPPC,MSGC, …

Piezoelectric Crystals

Development of new photodetectors

Univ., National Inst.

Univ. of Tokyo (Kamiokande, Takahashi Lab.), Kyoto Univ.(Tanimori Lab),
Osaka Univ.(Sarukura Lab), Nagoya Univ. (Iijima Lab, Uritani Lab, Iguchi Lab),
Hiroshima Univ.(Fukazawa Lab), Kyushu Univ.(Ishibashi Lab), Waseda Univ. (Kataoka Lab)

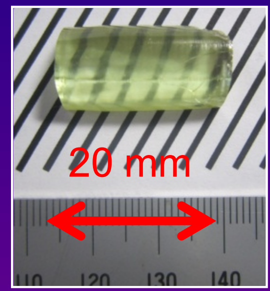
Company

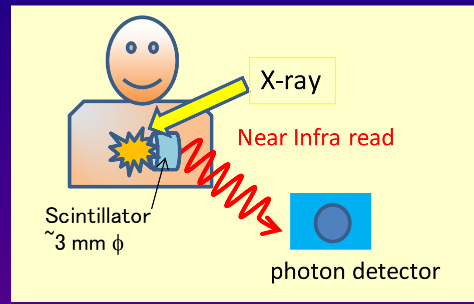
Tokuyama, Furukawa, TDK, Koike, Murata Manufacturing, Canon,
Chiyoda Technol, Nihon Kessho Kogaku, Hitachi-Aloka Medical , Oxide, Tanaka Kikinzoku Kogyo,
Furuya, Star seiki, TEP, Toei Scientific Industrial, Aoyama Seiko, Akira Seiko

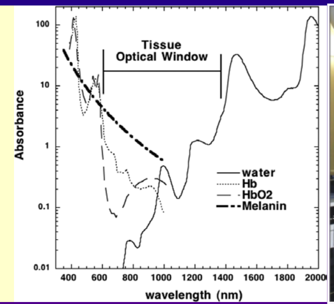
Oxide scintillators

Infrafed photon emitting scintillator

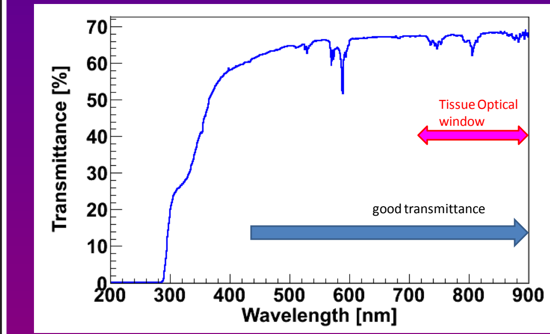
Nd-doped $Ca_3(Nb,Ga)_5O_{12}$

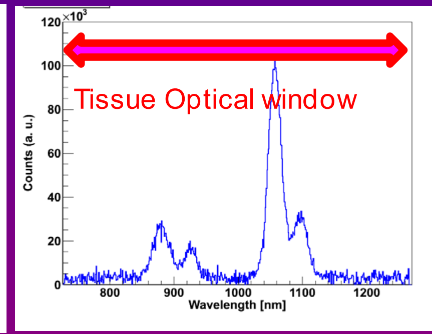






Novel radiation in-situ real-time monitor for radiation therapy and diagnostics





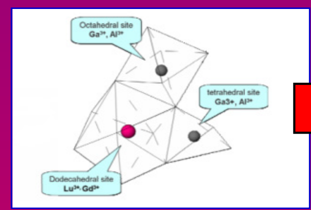
Nd^{3+} infrared emission
– matches tissue transparency window

A. Yoshikawa et al., IEEE/NSS (2012)

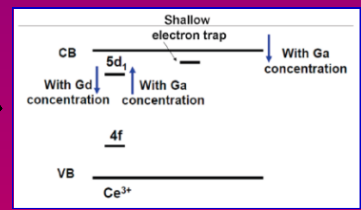
Support Industry by "The Cabinet Office"

Materials for gamma-ray detection

Multicomponent Ce-doped garnet scintillators - GAGG



Balanced composition - band gap engineering and energy-level positioning



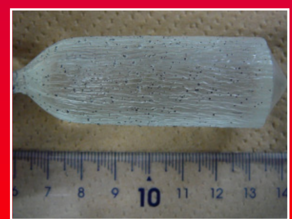
After composition screening by Micro-pulling down

High light yield
42000 photons/MeV
Found for
$Gd_3Ga_3Al_2O_{12}$:Ce!!
90ns decay time

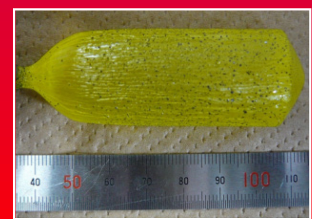
Application:

GammaSpotter detector by Furukawa Co.

Further studies of high-quality crystals with optimized composition grown by Czochralski method:



$Gd_3Al_2Ga_3O_{12}$ undoped

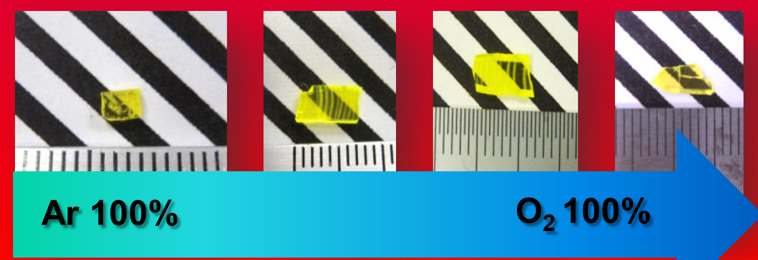


$Gd_3Al_2Ga_3O_{12}$:Ce 2%

Growth of GAGG by floating-zone method
(inverted composition $Gd_3Al_3Ga_2O_{12}$:Ce)

Oxygen

2 vol% 20 vol% 40 vol% 100 vol%



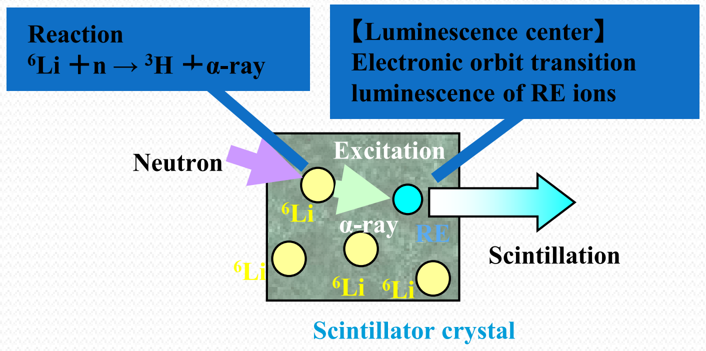
M. Seki et al., IEEE/NSS (2012)

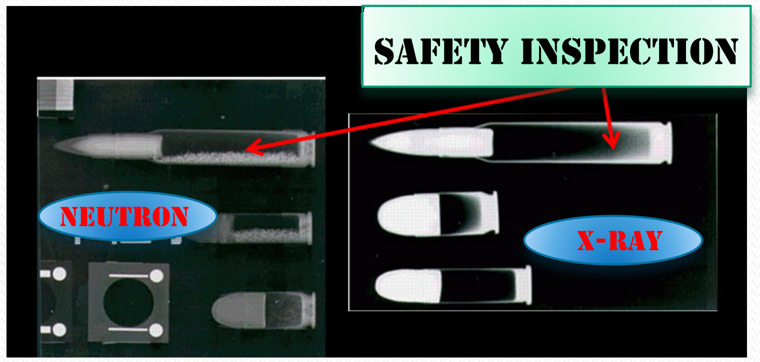
Support Industry by "Japan Science ant Tecnology Agncy (JST)" with Furukawa Co.Ltd.

Fluoride scintillators

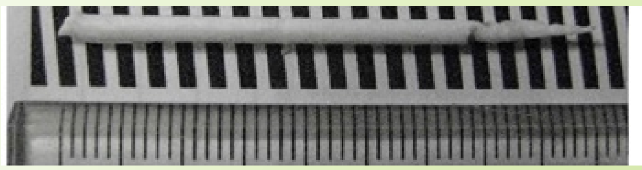
Neutron scintillators alternatives to ^{3}He

Luminescence mechanism of neutron scintillator.

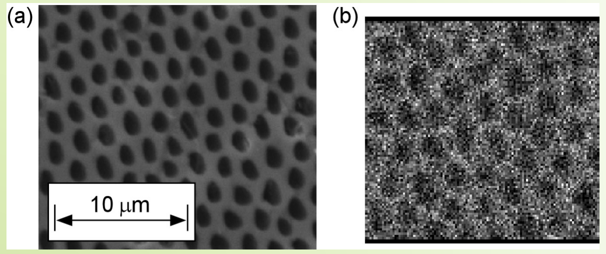




Eutectic composite scintillators



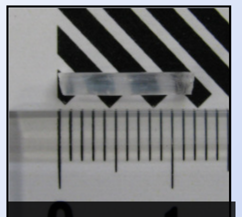
As grown LiF/LiLuF$_4$ eutectic crystal.



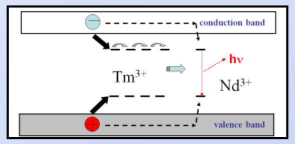
a) Image of SEM and (b) mapping image of Lu by EDX for the LiF/LiLuF$_4$ eutectic crystal.

Y. Yokota, et al., Presentation at 4th international conference on Directionally Solidified Eutectic Ceramics (2012).

VUV fluoride crystals

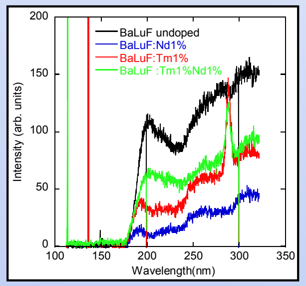


Grown crystal of BaLu$_2$F$_8$:Nd1%



➢Possibility of energy transfer improvement in Nd-doped scintillator by Tm^{3+} codoping

➢Overlap of the Tm^{3+} 5d-4f emission with Nd^{3+} 4f-5d absorption – condition for efficient energy transfer

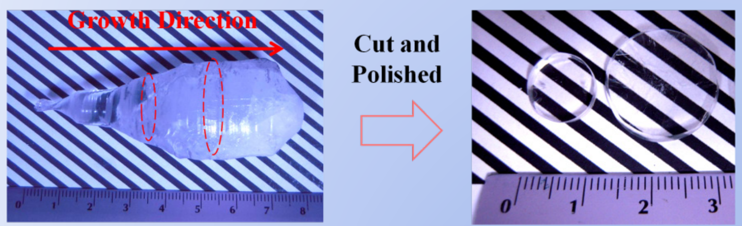


▪Radioluminescence in the VUV/UV region

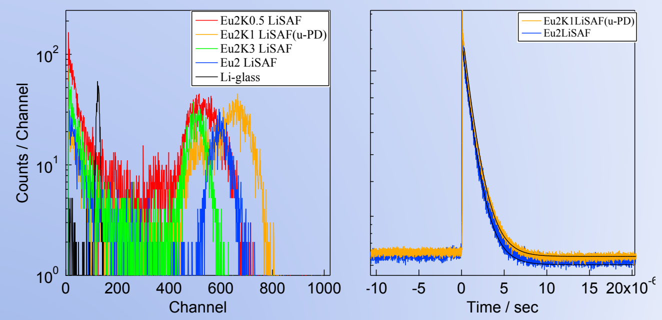
▪No 5d-4f luminescence features of Nd^{3+} or Tm^{3+} observed (poor transmittance in VUV region is not the cause)

▪Tm^{3+} 4f-4f peaks observed in the Tm-doped samples

J. Pejchal, et al., Presentation at 第23回 光物性研究会 (2012).



As grown (left) and polished (right) Eu2%-K1% co-doped crystals.



Pulse height spectra and decay time of our grown crystals compared with Li-glass.

S. Wakahara, et al., Presentation at EEE 2012 Nuclear Science Symposium (2012).

Support Industry by "Japan Science an d Technology Agency (JST)" with Tokuyama Co.

Halide scintillators

This page presents halide materials for radiation detectors and their optical properties. In the last year, single crystals of Eu:SrI$_2$, LaBr$_3$, RbPb$_2$Cl$_5$, Nd:RbPb$_2$Cl$_5$ and Yb:RbPb$_2$Cl$_5$ were prepared by the micro-pulling-down (m-PD) method and by the vertical Bridgman method. In this year, we especially focused on the characteristics of the single crystals of Eu doped SrI$_2$. They are displayed below.

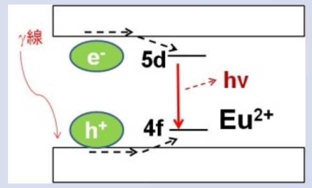
Gamma-ray Survey meter

Usual Scintillators

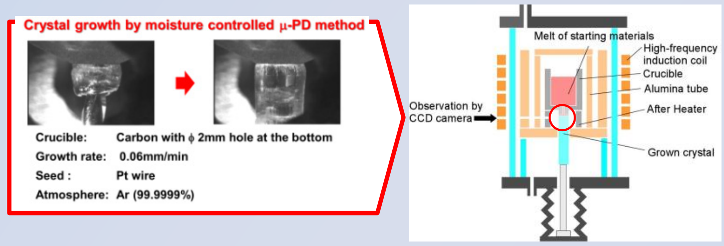
Tl:NaI, Ce:LaBr$_3$, Bi$_4$Ge$_3$O$_{12}$

Eu:SrI2 Scintillator

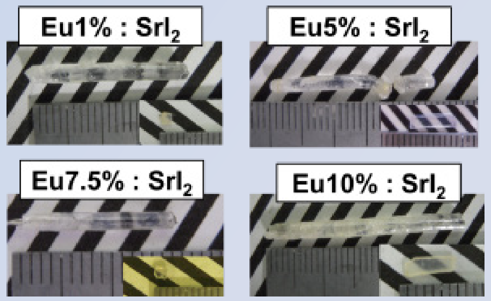
High performance of the survey meter is expected when using Eu:SrI$_2$.



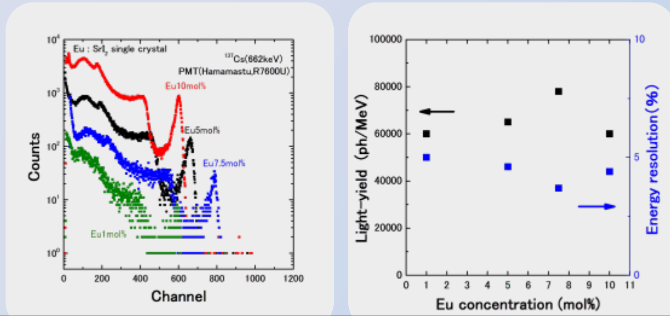
Crystal growth



Grown Eu : SrI$_2$ crystals



Light yeild and energy resolution

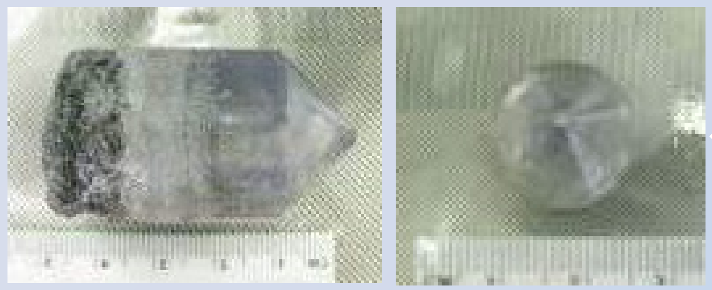


	Eu1mol%	Eu5mol%	Eu7.5mol%	Eu10mol%
Light - yield (ph/MeV)	~60,000	~65,000	~78,000	~60,000
Energy resolution (%)	~5	~4.6	~3.7	~4.4

SrI$_2$ crystals were studied by **X-ray diffraction** (XRD) that confirmed presence of pure SrI$_2$ crystal phase, **radioluminescence** measurements showed Eu^{2+} emission peak around 430 nm, under ^{137}Cs **γ-ray irradiation** light yields were determined to be 60,000 ~ 78,000 ph/MeV, energy resolution was between 3.7~ 5.0%.

西本ら、第73回応用物理学会学術講演会

Challenge to increase the crystal size up to 1 inch × 1 inch



Large size crystal successfully prepared

Support Industry by "Kanto Bureau of Economy, Trade and Industry" with Chiyoda technol, Oxide, Hitachi Aloka Medical

Transparent ceramic scintillators

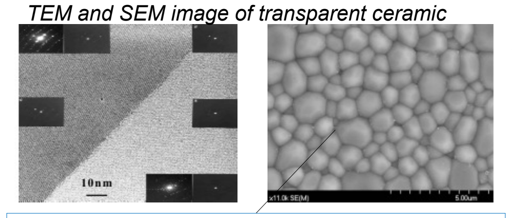
Introduction

Favorable properties of ceramics

- Better chemical uniformity with respect to single crystals.
- Possibility of reaching high dopant concentration.
- Possibility of sintering materials with high-melting point.

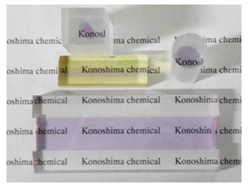
Ceramics are cluster single crystals

TEM and SEM image of transparent ceramic



Single crystalline particles with micro particles

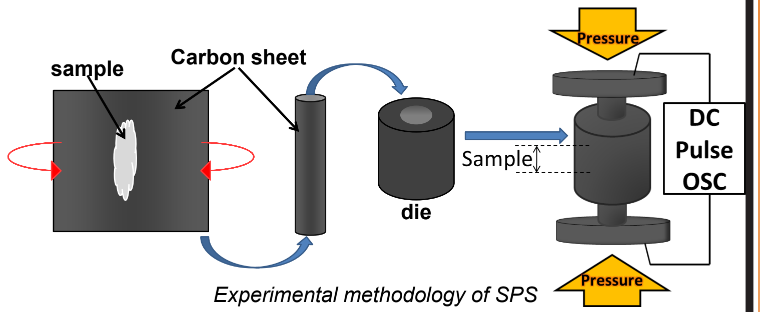
Transparent ceramics by Konoshima chemical Co., Ltd.



Spark plasma sintering(SPS)

Advantages of SPS

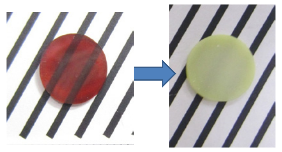
- A rapid sintering rate suitable for densification of variety of ceramics.
- Strongly reductive conditions due to carbon die and punch.
- Easy high-density solidification.



Experimental methodology of SPS

RE:$SrHfO_3$ (RE=Ce)

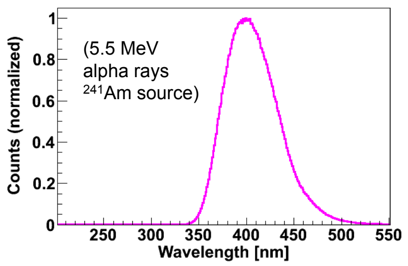
Hf : High Z, but high melting point.
→ Using SPS method.



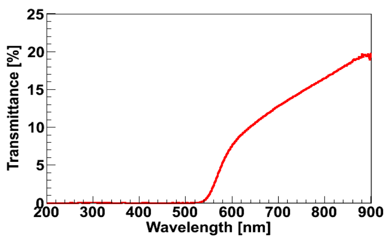
Al,Ce:$SrHfO_3$ exhibited high transparency!

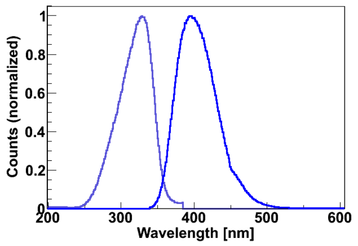
Annealing and co-dopant

Radioluminescence(Al,Ce:$SrHfO_3$)

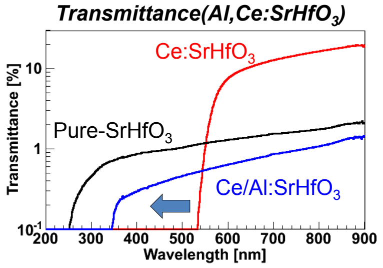


Transmittance and photoluminescence of Ce:$SrHfO_3$

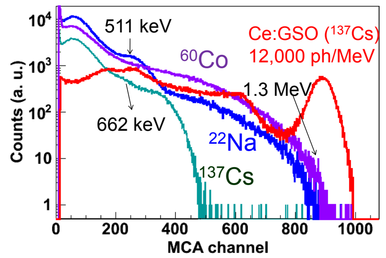




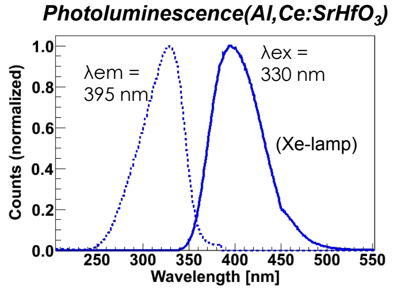
Transmittance(Al,Ce:$SrHfO_3$)



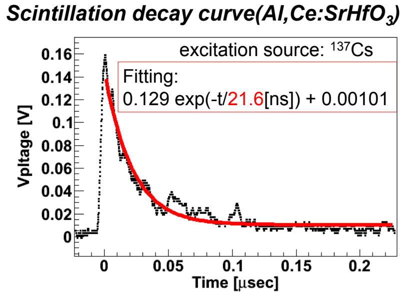
Pulse height(Al,Ce:$SrHfO_3$)



Photoluminescence(Al,Ce:$SrHfO_3$)



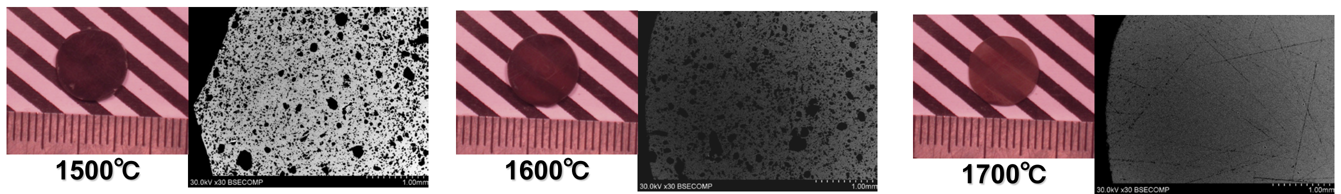
Scintillation decay curve(Al,Ce:$SrHfO_3$)



S. Kurosawa et al., LUMDETR 2012

$Lu_3Al_5O_{12}$ (LuAG)

Optimization of sintering temperature

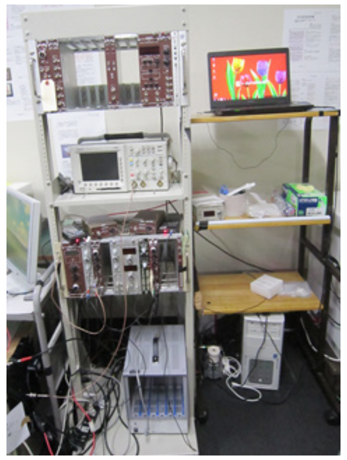


1700℃ is the best sintering temperature!

Photodetectors

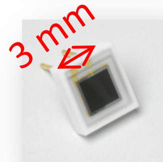
We investigate radiation response of our scintillators using photomultiplier tubes and semi-conductor detectors, also under different temperature conditions.

1, New Pulse-height Measurement System

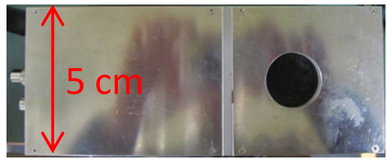


New setup

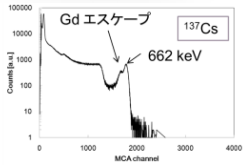
Ultra Bialkali (UBA) R7600U

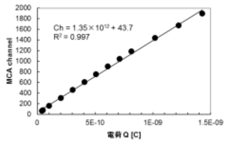


APD



New APD measurement system





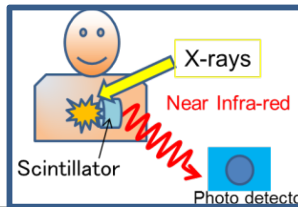
We use several photodetectors for pulse height measurement.

- PMT (Photo multiplier tubes)
  - ✓ Ultra and super –bialkali (UBA and SBA)
- APD (avalanche photodiode)
  - ✓ High quantum efficiency (up to ~80%)
  - ✓ Wide sensitivity range (ex: 320 -1000 nm for S8664 HPK)
- MPPC (Multi-Pixel Photon Counter)
  - ✓ Suitable for photon counting

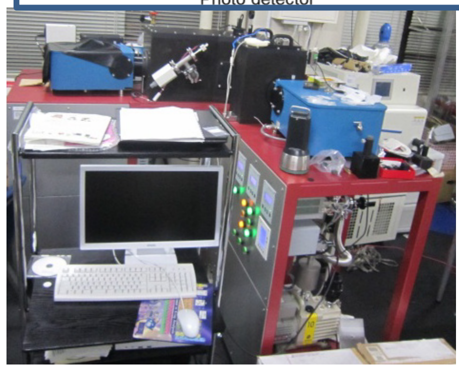
Possibility of temperature control, Estimation of the temperature dependence of the scintillation properties

2, New Spectrometer

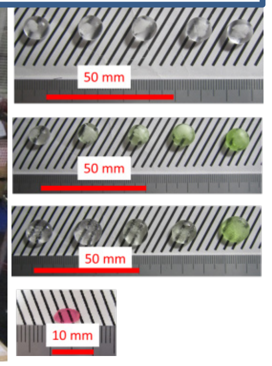
In the "Next Program", we investigate the Near Infra-red (NIR) scintillators using new luminescence apparatus



We apply NIR scintillator to dosimeter in radiation therapy



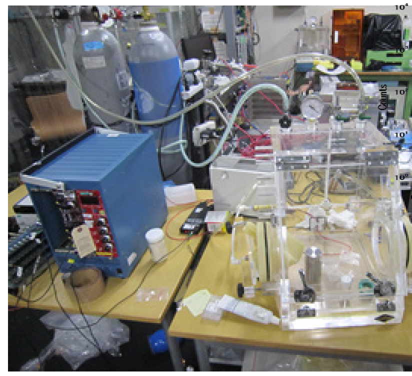
New spectrometer for NIR



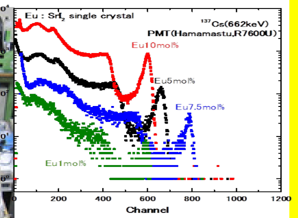
NIR crystals

3, Halide Scintillator Measurement

Pulse height spectra or scintillation decay curves under gamma ray excitation can be measured even for Eu:SrI_2 and other hygroscopic halides!



New setup

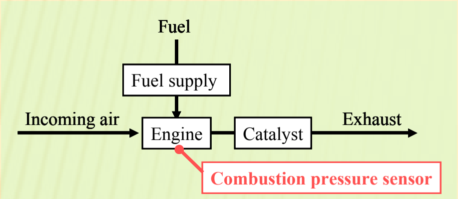


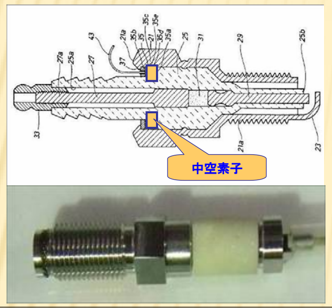
80,000 photons/MeV !

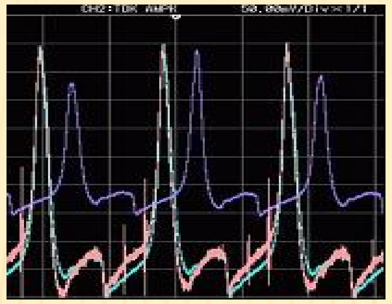
Development of Piezoelectric single crystals

Piezoelectric crystals

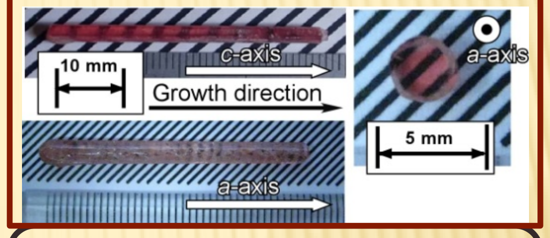
Langasite-type crystal
・The Curie point above 1,000 degrees.
・The piezoelectric constant is 2 times higher than of the quartz.
⇒ Suitable for materials for "The combustion pressure sensor"



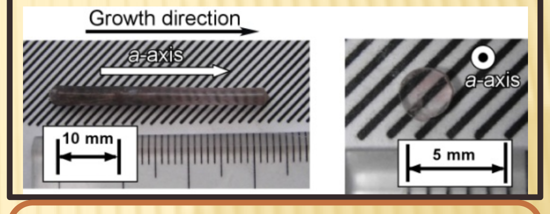




SNGS

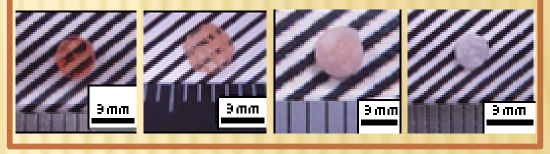


STGS



$Ca_3Nb(Ga_{1-x}Al_x)_3Si_2O_{14}$

x=0.0 x=0.2 x=0.8 x=1.0



Support Industry by "The Smoll and Medium Enterprise Agency" with TDK, Furuya Metal, Akita Seiko, Aoyama Seiko

Investigation of the crystals properties

Measurement of the piezoelectric modules

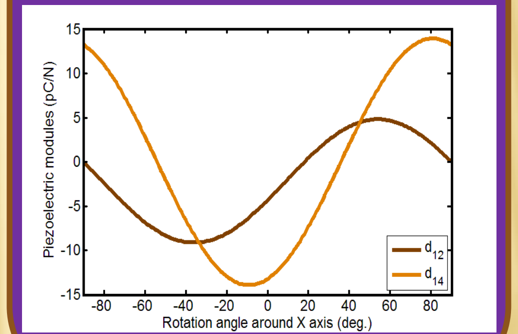
Calculation of rotated piezoelectric modules

$$d'_{12}=-d_{11}\cos 2(\theta)+d_{14}\sin(\theta)\cos(\theta)$$
$$d'_{14}=d_{11}\sin(2\theta)+d_{14}\cos(2\theta)$$

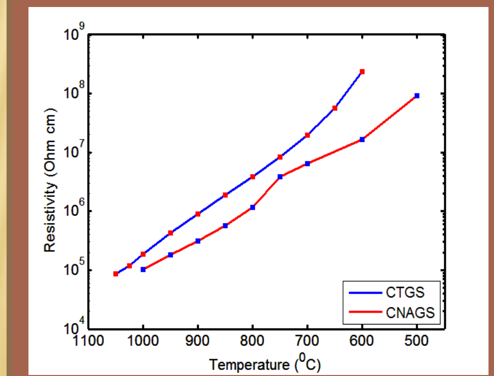
Characterization of rotated cuts

Resistance measurements up to 1000 ° C

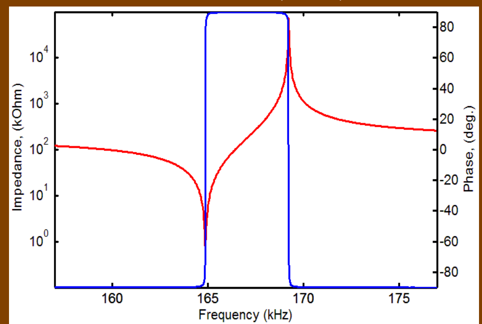
Rotated Piezoelectric modules of CTGS



Resistivity of CTGS & CNAGS

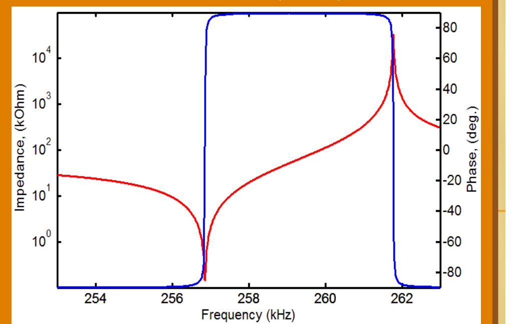


Extensional mode (XYt)-35°- cut



Piezo modulus d'_{12} - 9.03 pC/N
Coupling Factor - 24.9%
Q-factor - 13 000

Face Shear mode (XYt)-15°- cut



Piezo modulus d'_{14} - 13.9 pC/N
Coupling Factor - 21.3%
Q-factor - 10 000

Development of shape control growth

Development of dosimeter using shape-controlled scintillation crystal

as-grown crystal

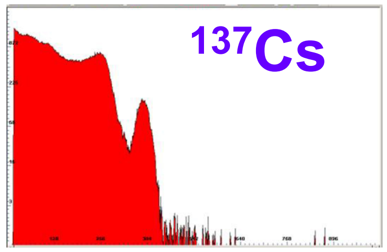
Ce:YAG

cutting

element for dosimeter

No polishing

Pulse-height spectrum of as-grown crystal

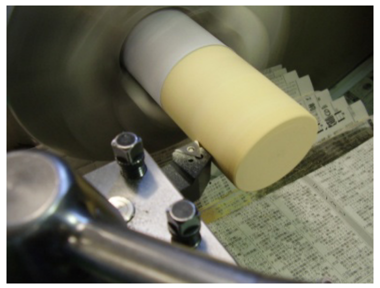


Pocket dosimeter

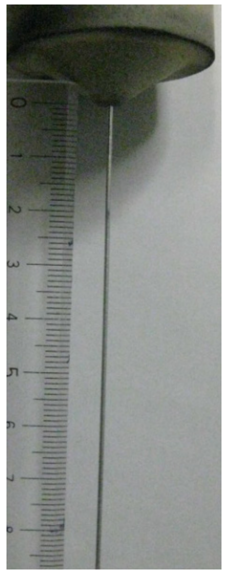
- Fast response
- Geiger mode APD
- Temperature compensation circuit

Collaborated with TDK

Development of functional metallic products by shape-controlled growth techniques



Development of ceramics crucible



Growth of Ir alloy fiber crystal could be achieved.

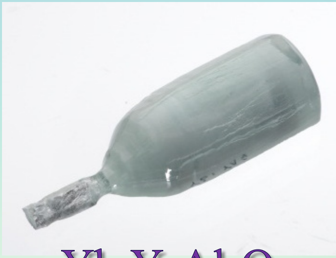
Support Industry by "Ministry of Economy, Trade and Industry" with Tanka Kikinzoku Kogyo, Star Seiki ,TEP, Toei kagaku sangyo

CRYSTAL GALLERY

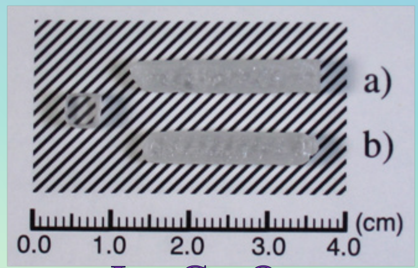
OXIDE

< Garnet type >

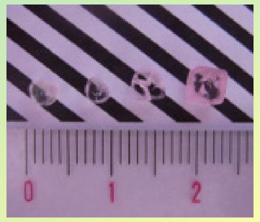
$Y_3Al_5O_{12}$



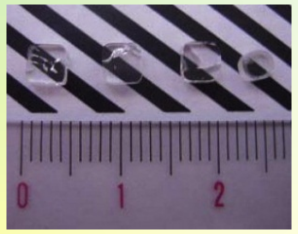
$Yb:Y_3Al_5O_{12}$



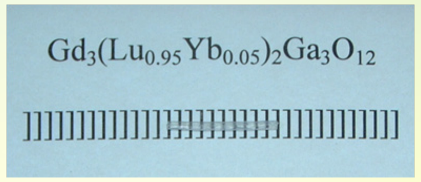
$Lu_3Ga_5O_{12}$



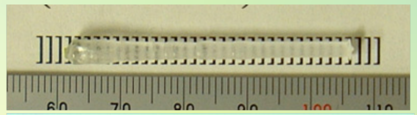
$Ho:Lu_3Al_5O_{12}$



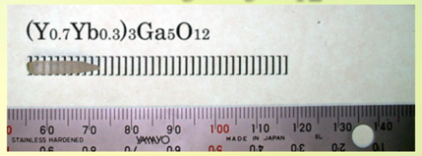
$Tm:Lu_3Al_5O_{12}$



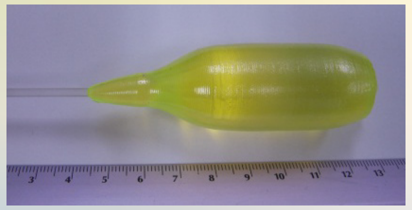
$Gd_3Lu_2Ga_3O_{12}$



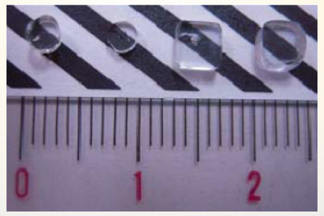
$Lu_3Al_5O_{12}$



$Y_3Ga_5O_{12}$



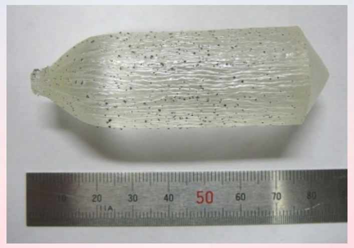
$Ce:Lu_3Al_5O_{12}$



$Nd:Lu_3Al_5O_{12}$

$Pr:Lu_3Al_5O_{12}$

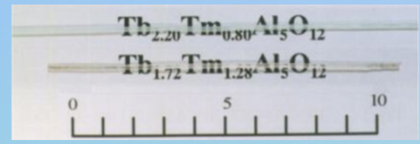
$Gd_3Ga_5O_{12}$



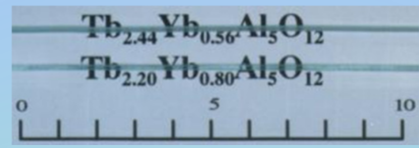
$Gd_3Al_2Ga_3O_{12}$

$Ce:Gd_3Al_2Ga_3O_{12}$

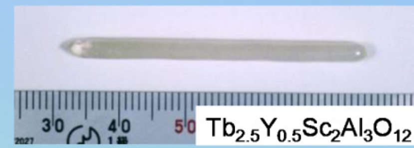
< Garnet type >



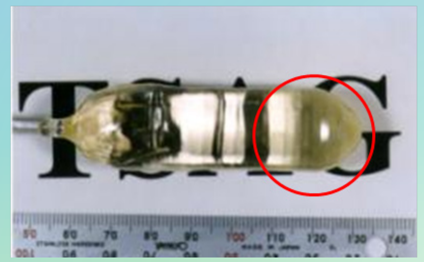
$Tb_{3-x}Tm_xAl_5O_{12}$



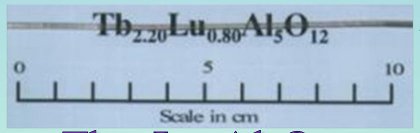
$Tb_{3-x}Yb_xAl_5O_{12}$



$Tb_{2.5}Yb_{0.5}Sc_2Al_3O_{12}$



$Tb_{2.2}Sc_{2.8}Al_3O_{12}$



$Tb_{3-x}Lu_xAl_5O_{12}$

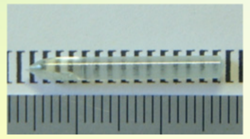
$Tb_{3-x}Sc_{2+x}Al_3O_{12}$

< Ilmenite type >

$LiNbO_3$

< Perovskite type >

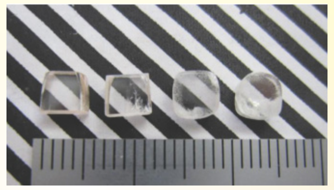
$YAlO_3$



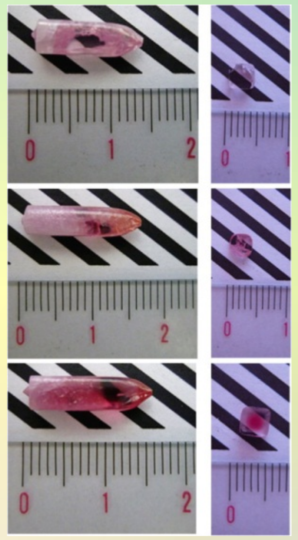
$(Lu, Y)AlO_3$

$KNbO_3$

$TbAlO_3$

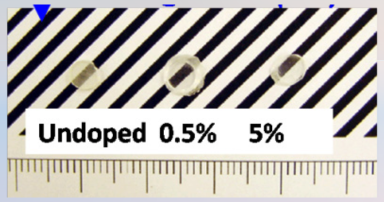


$Tm:YAlO_3$

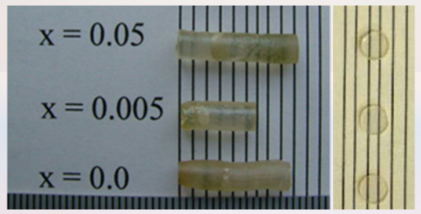


$Cr:YAlO_3$

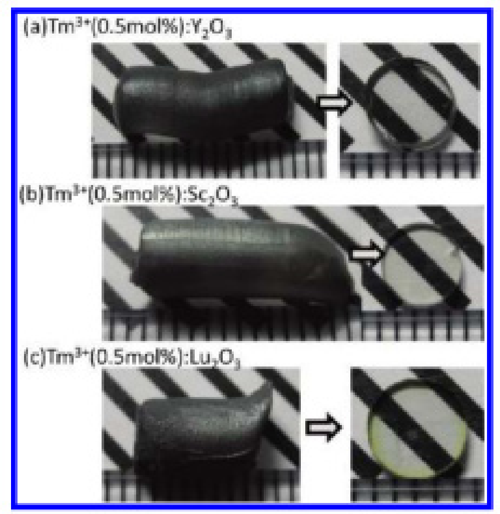
< Sesquioxide type >

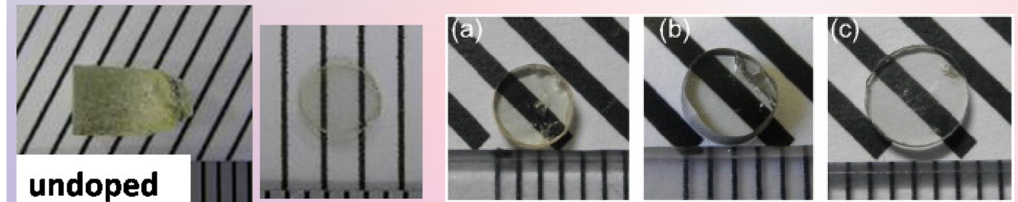


Sc_2O_3



Y_2O_3



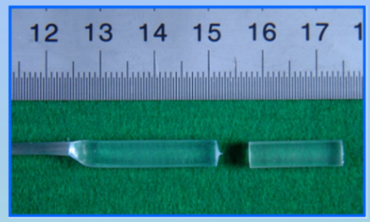


Lu_2O_3

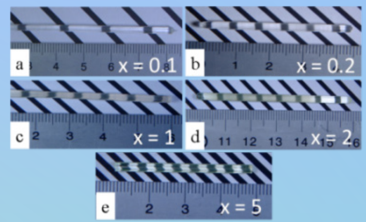
< Apatite type >

$Ca_8La_2(PO_4)_6O_2$

< Spinel type >

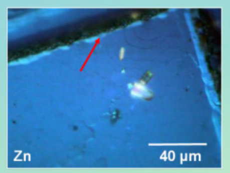


$Ti:MgAl_2O_4$

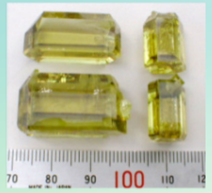


$Mn:MgAl_2O_4$

< ZnO type >

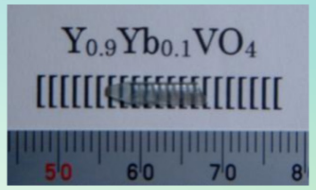


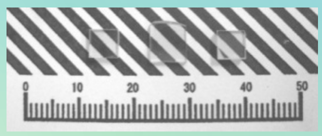
LPE ZnO Single Crystalline film



ZnO Single Crystal

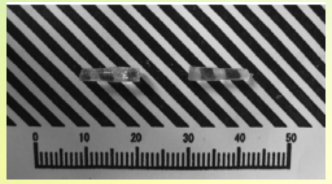
< Vanadate type >





YVO_4, $(Y,Lu)Vo_4$, $LuVO_4$

< Aluminate type >



$LiAlO_2$

< Corundum type >

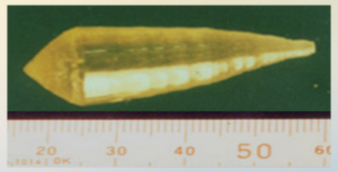
Al_2O_3

$Cr:Al_2O_3$

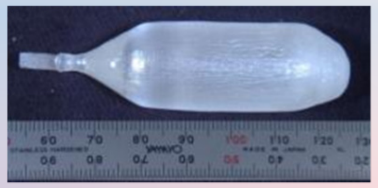
< Langasite type >

$La_3Nb_{0.5}Ga_{5.3}Al_{0.2}O_{14}$

$La_{2.95}Ca_{0.05}Ta_{0.525}Ga_{5.475}O_{14}$



$Sr_3TaGa_3Si_2O_{14}$

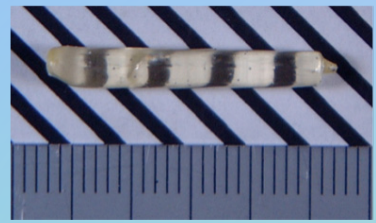


$La_3Ga_{5.3}Al_{0.2}SiO_{14}$

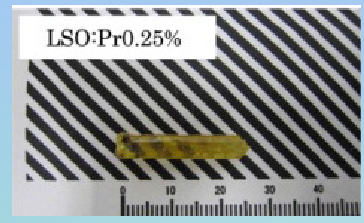
$La_{2.95}Ba_{0.05}Ta_{0.525}Ga_{5.475}O_{14}$

$La_3Ta_{0.5}Ga_{5.3}Al_{0.2}O_{14}$

< Silicate type >



Lu_2SiO_5

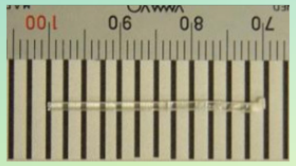


$Pr:Lu_2SiO_5$

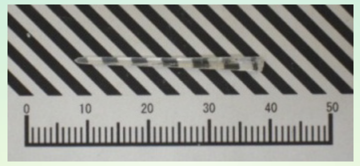
$Pr:Y_2SiO_5$

$Ce:Gd_2SiO_5$

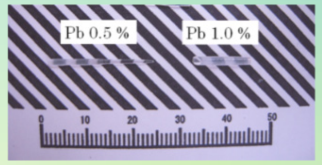
< Borate type >



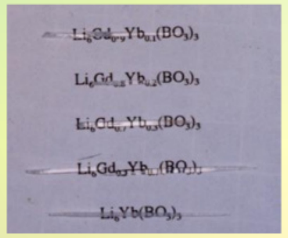
$Li_6Y(BO_3)_3$



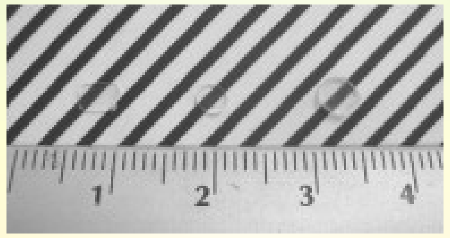
$YCa_4O(BO_3)_3$,



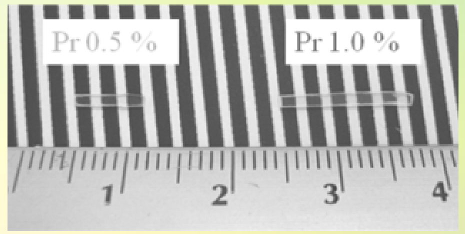
$Pb:YCa_4O(BO_3)_3$



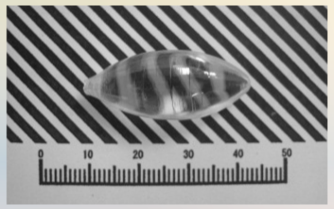
$Li_6Yb(BO_3)_3$, $Li_6Gd(BO_3)_3$



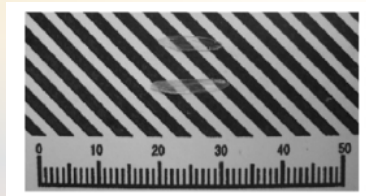
$Tm:Ca_3(BO_3)_2$



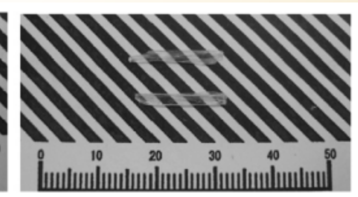
$Pr:Ca_3(BO_3)_2$



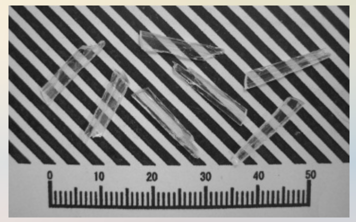
$Ce:Ca_3(BO_3)_2$



SrB_2O_4

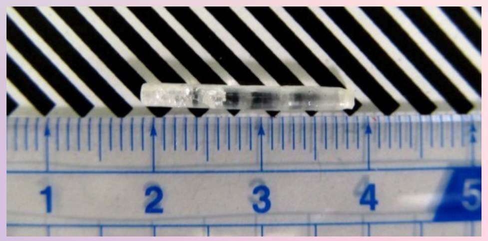


$Ce:SrB_2O_4$



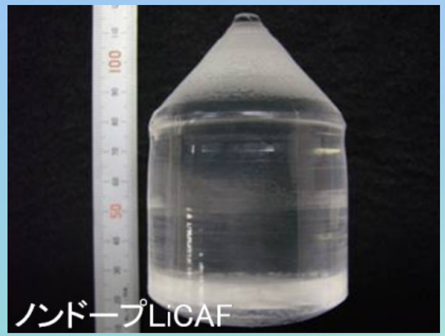
CaB_2O_4

Halide



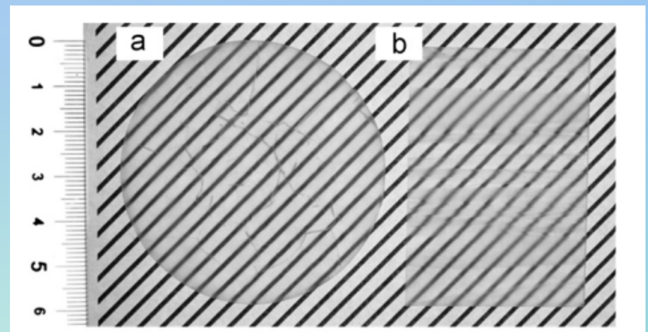
$Yb:RbPdCl_5$

Fluoride

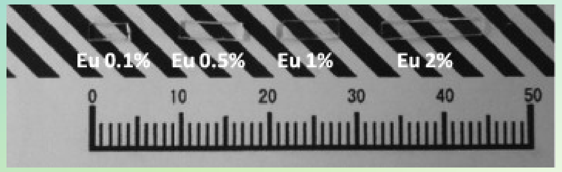


$LiCaAlF_6$

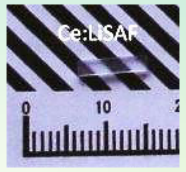
$Ce:LiCaAlF_6$



$Eu:LiF/CaF_2$

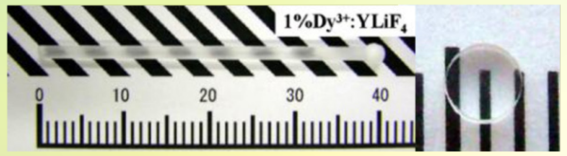


$Eu:LiCaAlF_6$

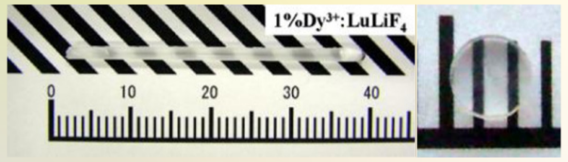


$Ce:LiSrAlF_6$

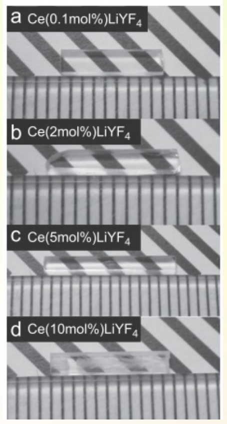
$Eu:LiSrAlF_6$



$Dy:LiYF_4$



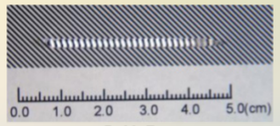
$Dy:LuYF_4$



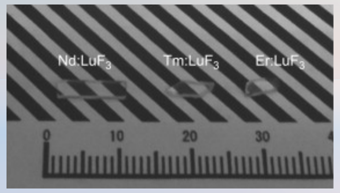
$Ce:LiYF_4$

$SrMgF_4$

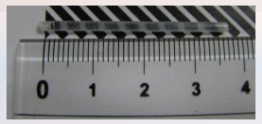
$Ba_{0.2}Sr_{0.8}MgF_4$



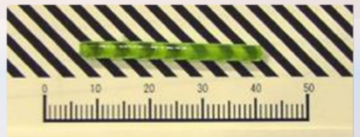
$BaMgF_4$



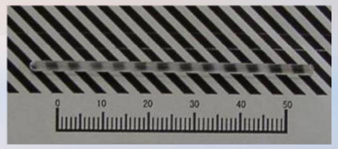
$Nd:Tm:Er:LuF_3$



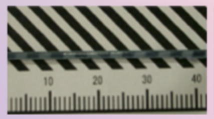
$Tm:Nd:BaYLuF_8$



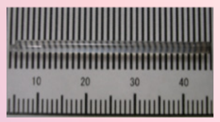
$Ce:PrF_3$



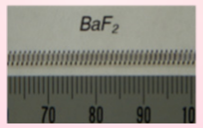
$K(Y_{0.99}Pr_{0.01})_3F_{10}$



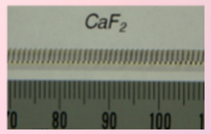
NdF_3



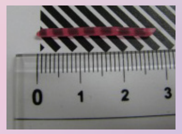
CeF_3



BaF_2

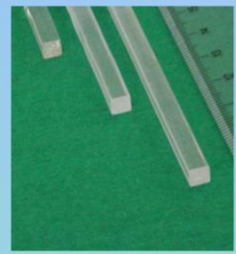


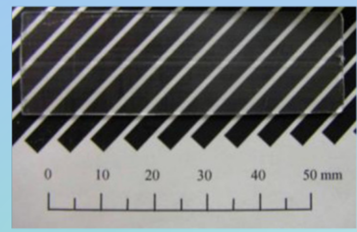
CaF_2

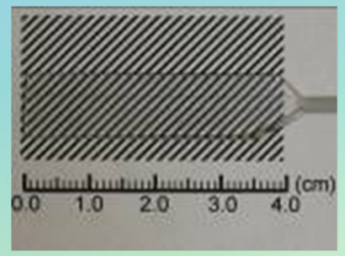


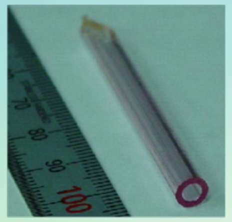
ErF_3

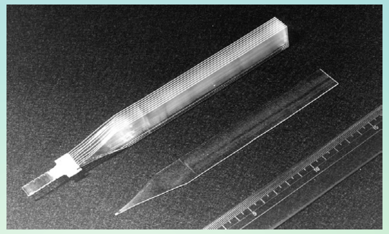
Shaped Crystal

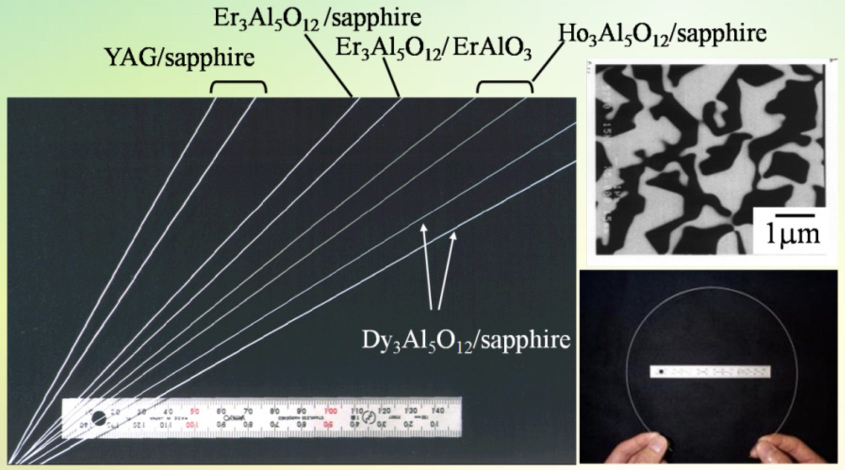


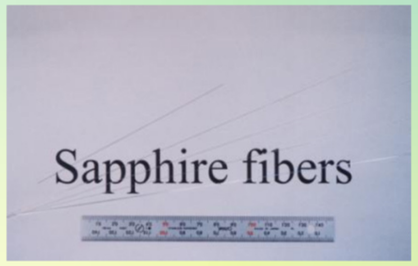




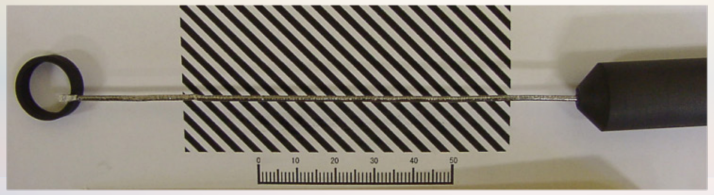




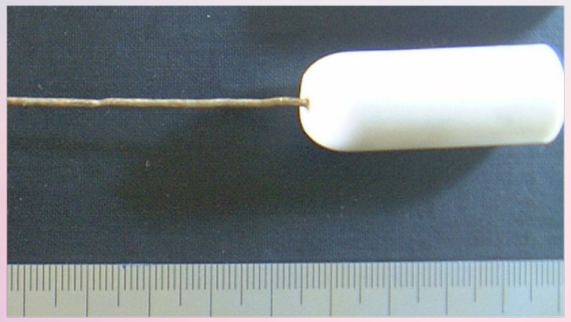




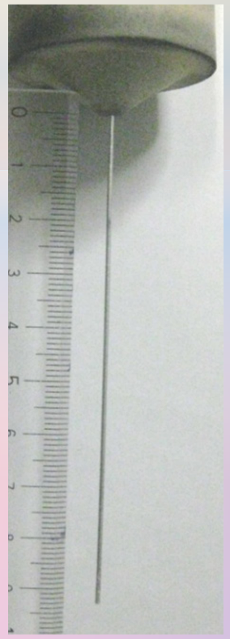
Others



Fe-Ni-Ga alloy fiber produced from carbon crucible (right) with conically shaped bottom (Scale in mm)



$Cu_{72}Al_{17}Mn_{11}$ alloy fiber produced from Al_2O_3 ceramic crucible (right) with spherically shaped bottom (Scale in mm)



Message from Foreign Participants

I have been invited by Prof. A.Yoshikawa to visit his lab and to attend the conference Summit of Material that occurred between November 25th and December 2nd at the Institute of Materials research at the Tohoku University in Sendai. I knew, of course Prof A.Yoshikawa and his team since a long time in the field of scintillating materials, through the conferences and publications, but it was my first time in the Institute and even in Japan.

I have been really impressed by the high level of research in the field of material preparation and related characterizations. I also have been extremely impressed by the speed of activity recovery, at the scale of the whole University, after the 2011 dramatic events in Japan.

I found here a very good, pleasant and efficient atmosphere for working. I really appreciated the conference Summit of Materials which allowed me to get a good overview of the activities in material sciences. The parallel workshop about electron microscopy and related techniques of single ions characterizations was also of high interest.

As the Luminescence group leader of the new Institute Light and Matter (ILM) at the University Lyon 1 and at the CNRS, but also as the Chairman of the International Conference Series SCINT on the inorganic scintillating materials, I really consider the Prof. A.Yoshikawa's group as a key research lab in the international community of materials for Optical purposes in general and for scintillation in particular.

I frankly hope that we'll develop in the near future cooperation in scintillating materials fields, may be in the frame of the joined Eu-Japan project which has been recently submitted.

I would like to thank all the actors which contributed to my invitation and Prof. A.Yoshikawa in particular for this pleasant and fruitful first time in Japan.

Prof. Christophe Dujardin
Institute Light and Matter
University Lyon 1 and CNRS

OAO «FOMOS-MATERIALS»
16, Buzheninova st.,
Russia, Moscow, 107023
Tel: +7(495)-963-0013
Fax:+7(495)-964-2266
E-mail: mail@newpiezo.com

Message for 2012 annual report from Andrey Medvedev

Dr. Kochurikhin introduced Prof. Yoshikawa and me in Moscow in the spring 2012. Prof. Yoshikawa told about their research plans a study of piezoelectric properties of the single crystals for high-temperature applications in the sensors of physical quantities. Since I have some experience in research, development, and devices manufacture on different piezoelectric materials Prof. Yoshikawa invited me to work in IMR for a few months.

In June 2012, I visited Prof. Yoshikawa laboratory for the first time. This was my first visit to Japan after the great earthquake and the second visit to the Tohoku University. During my stay I was familiarized with the equipment and measuring devices available in the lab. We drew a purchase plan of new equipments and fixtures for investigation piezoelectric and electrophysical properties of the different kind piezoelectric materials. Also I made a small report, which has told about the company "Fomos-Materials" and its products as well as about the properties of langasite family single crystals.

In mid-September 2012, I came to Tohoku University again and began to work in the laboratory of Prof. Yoshikawa. One of the directions of our research was a study of the possibility using micro crystals grown by the Micro-Pulling-Down technique for measuring piezoelectric constants of the different materials. It was shown that with the right choice of the plate orientation the measurements results at small and large samples are practically the same. We have also developed and produced original fixture for the high-temperature measurements of the different properties of the piezoelectric materials.

Also I would like to share my impressions about educational activities in Prof. Yoshikawa lab. All students have the opportunity to work on the growth and research equipment, to participate in international conferences. Especially, I think it is very useful to hold weekly seminars where all team members report about their research results.

Finally, I would like to thank Professor Yoshikawa for the invitation to work in his laboratory, Mr. Uemura for their help in solving many of the problems encountered during my stay in Japan, and to wish all members of Prof. Yoshikawa team great success in the crystals growth and investigation of their properties.

Sincerely Yours,

Andrey Medvedev

Members

Members of Yoshikawa Lab

Professor
A. Yoshikawa

Associate Professor
(2012.9月まで)
T. Yanagida

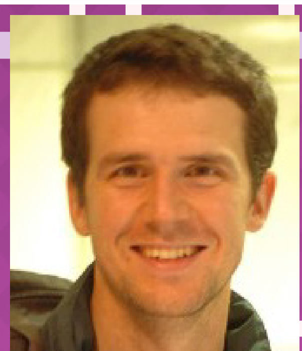
Research Assistant Professor
Y. Yokota

Research Assistant Professor
(2012.6月から)
S. Kurosawa

TechnicalCounsellor
H. Uemura

Post Doctoral Fellow
Y. Fujimoto

Post Doctoral Fellow
Y. Futami



Post Doctoral Fellow
J. Peichal

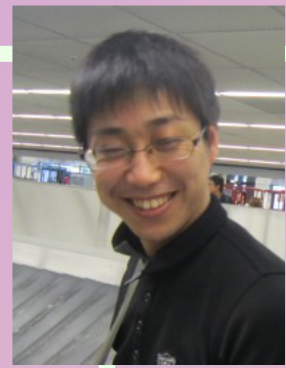
Researcher
Y. Shoji

Secretary
(2012.9月まで)
A. Imai

Secretary
K. Toguchi

Secretary
(2012.7月から)
M. Sasaki

Secretary
(2013.1月から)
Y. Saijo



First grade
Doctoral course student
A. Yamaji

Second grade
Master course student
S. Wakahara

First grade
Master course student
S. Suzuki

First grade
Master course student
K. Nishimoto

First grade
Master course student
M. Kitahara

First grade
Master course student
M. Seki

First grade
Master course student
A. Suzuki

Researcher
K. Kamada

FURUKAWA

Researcher
M.Sato

TDK

Researcher
D. Totsuka

NK&K

Researcher
A. Medvedev

FOMOS-Materials

2012年度 吉川研究室
Members (2012 academic year)

4. 1. 2012

Professor		**教授**	
Dr.	Akira Yoshikawa	吉川 彰	NICHe兼任
Associate Professor		**准教授**	
Dr.	Takayuki Yanagida	柳田 健之	2012.9.30月まで
Research Assistant Professor		**助教**	
Dr.	Yuui Yokota	横田 有為	
Dr.	Shunsuke Kurosawa	黒澤 俊介	2012.6月から
Adviser		**顧問**	
Prof	Masae Kikuchi	菊地 昌枝	
Prof	Touetsu Shishido	宍戸 統悦	
Post Doctoral Fellow		**博士研究員**	
Dr.	Jan Pejchal	ヤン ペジャール	Czech
Dr	Yutaka Fujimoto	藤本 裕	
Dr.	Yoshisuke Futami	二見 能資	
Dr	Andrey Medvedev	アンドレイ メドベーゼフ	Russia 2012.9月から
Technical Counsellor		**技術参事**	
	Hiroshi Uemura	上村 博	
Researcher		**研究員**	
	Yasuhiro Shoji	庄子 育宏	2012.10月から

Secretaries		**秘書**	
	Akiko Imai	今井 亜希子	2012.9.30まで
	Keiko Toguchi	戸口 景子	
	Megumi Sasaki	佐々木 愛美	2012.7月から
	Yumiko Saijo	西條 由美子	2013.1月から
Graduate Students		**大学院生**	
	Akihiro Yamaj	山路 晃広	D1
	Shingo Wakahara	若原 慎吾	M2
	Masanori Kitahara	北原 正典	M1
	Kei Nishimoto	西本 けい	M1
	Mafuyu Seki	関 真冬	M1
	Akira Suzuki	鈴木 彬	M1
	Shotaro Suzuki	鈴木 祥太朗	M1
Researchers		**民間等共同研究員**	
	Ko Onodera	小野寺 晃	TDK株式会社／ TDK Co., Ltd.
	Masato Sato	佐藤 真人	TDK株式会社／ TDK Co., Ltd.
	Ryota Ohashi	大橋 良太	キャノン株式会社／ Canon Inc., Ltd.
Dr.	Kentaro Fukuda	福田 健太郎	株式会社トクヤマ／ Tokuyama Co., Ltd.
	Noriaki Kawaguchi	河口 範明	株式会社トクヤマ／ Tokuyama Co., Ltd.
Dr.	Kei Kamada	鎌田 圭	古河機械金属株式会社／ Furukawa Co., Ltd.
	Daisuke Totsuka	戸塚 大輔	日本結晶光学株式会社／ Nihon kesshokougaku Co., Ltd.
Visiting Professors/Researchers		**客員教授**	
Prof.	Georges Boulon	ジョージ ブーロン	France
Prof.	Martin Nikl	マーチン ニクル	Czech Republic
Dr.	Vladimir V.Kochurikhin	ヴラディミール カチューリッヒン	Russia

Research Life

My first challenging year has passed. I enjoyed laboratory life and tried to focus on my two topics which were halide material for the gamma ray detectors and the eutectic materials for the neutron scintillators.

Laboratory life was very exciting due to variety of research activities from scintillation study and crystal growth to evaluation using a lot of sophisticated experimental equipment. I tried to make single crystals of rare-earth doped SrI2 by Micro-Pulling-Down Method and evaluate its scintillation properties. In the beginning, I had repeated some failures in my experimental work. Recently, however, I have made progress and I am able to make good crystals. Now when I think about it, the failures made me strong enough to solve complicated problems. My most impressive memory is the international conference at Washington.D.C. There, I had oral presentation for the first time and I felt great accomplishment. I also enjoyed some events such as cherry-blossom, beer party in IMR, summer trip for Miyagi Zao and so on.

All laboratory members are very kind with a sense of humor. I really appreciate their assistance and my delightful days.

I'll do my best in studies and work for this laboratory until my graduation.

Kei Nishimoto
(M1)

Akira Suzuki
(M1)

Hello! I am Akira Suzuki, a graduate student in the Yoshikawa laboratory. I joined this laboratory last year, and I was very impressed by its research activities. I always enjoyed my laboratory life with many research activities such as experiments, conference attendances and paper publications.

My major is material engineering with crystal growth dynamics. Now I have been studying a novel scintillator material, especially an oxide scintillator crystal. In Yoshikawa laboratory, we can do all the experiments from synthesis of new materials to evaluation of their properties, and I have developed various types of new oxide scintillators using our micro-pulling down method.

In this academic year, I attended many domestic and international conferences. I learned latest achievements of science and engineering and communicated with other researchers in these meetings. In additions, I also published many peer-reviewed scientific papers and obtained some patents. The experience to write and publish a paper is one of the most exciting events in my student life.

I thank all the colleagues for their kindness, and I have decided to do my best on my research and enjoy this life in my next year.

In Yoshikawa laboratory many single crystals are being designed, grown by micro-pulling-down method and their scintillation properties such as a light yield, decay time, energy resolution, and so on are studied. My research theme is the improvement of scintillation properties, especially of the Ce doped GAGG crystal. I measured a lot of data, wrote some papers and grew several Ce:GAGG crystals with a lot of help of my gentlemen colleagues. I could attend five meetings included two international conferences in this year as. And then, we went Mt. Zao in this summer to hold a meeting and I remember the astonishing beautiful mountain view.

Mafuyu Seki (M1)

Masanori Kitahara (M1)

This year I researched piezoelectric materials. There were few people dealing with this topic so there were many things to do in the lab from the beginning. Some time it was hard to try and struggle with some measurements. But it was a good opportunity to find out something myself. I want to harness this experience also the next year. I want to thanks to all the members in Yoshikawa lab for the advice in research, office work, and many other things we talked and did.

Shotaro Suzuki (M1)

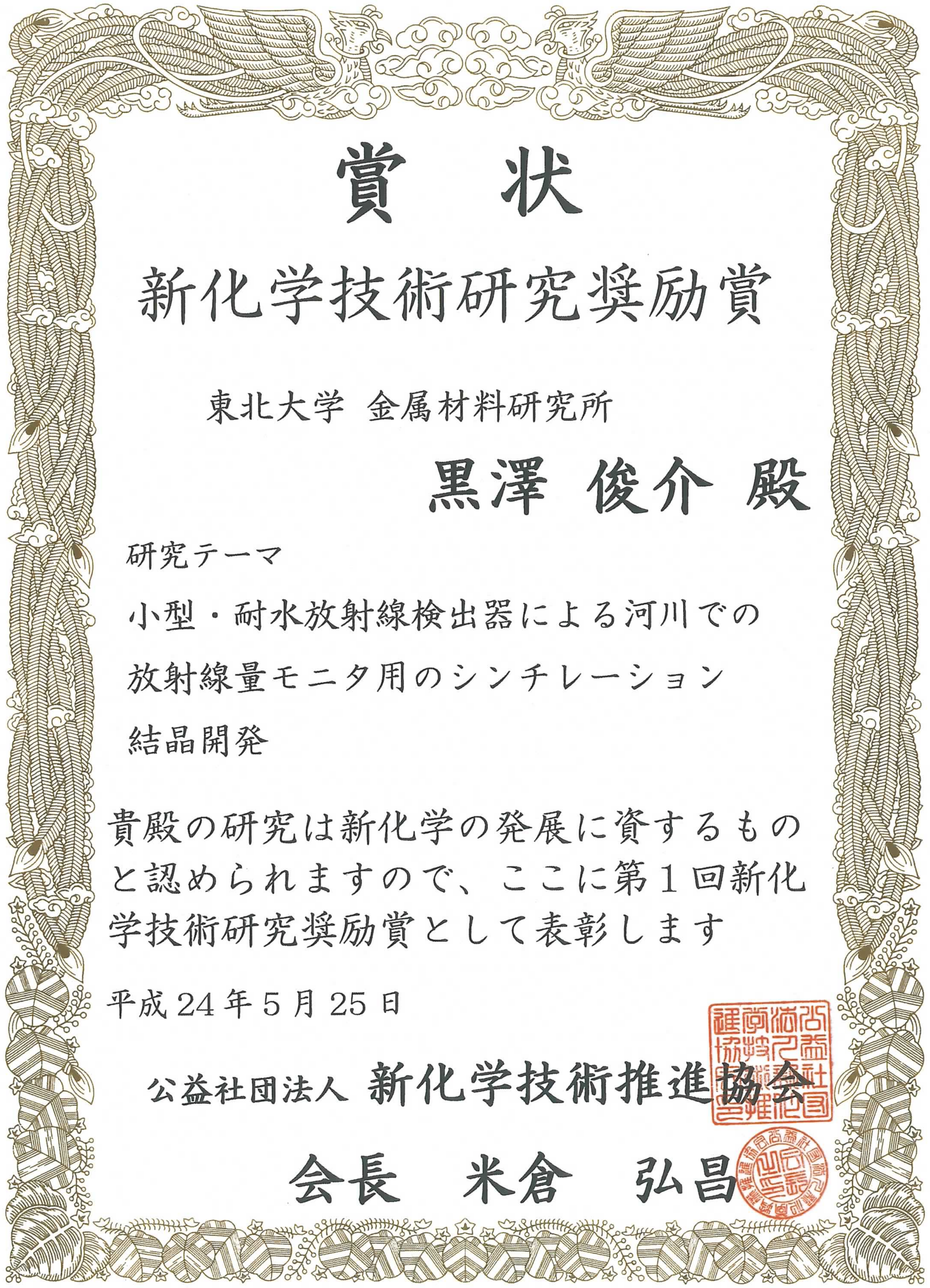
One year has passed since I joined Yoshikawa laboratory. I am researching thermal neutron scintillation materials. When I joined laboratory the first day, I did not know many things about the research. All of the members in this laboratory are very kind and guide me in a responsible way. Now, I gained a bit of knowledge for research. I am enjoying my research life with laugh and studying. There were a lot of events. For example, cherry blossom viewing party, beer and imoni party, futsal and basketball cup in IMR, etc. In this year, we are the champions at the basketball cup in IMR by grace of me (and some student and post-doctoral)!! Next year, I will pass over the last research life at full power!!

Prizes and Awards

受賞等
Prizes and Awards

1. 黒澤 俊介
   『新化学技術研究奨励賞』(2012 年 5 月 25 日)
   公益社団法人新化学技術推進協会

2. BOMS(吉川研究室)
   『優勝』(2012 年 11 月 13 日)
   平成24年度 金属材料研究所共融会 バスケットボウル大会



賞　状

新化学技術研究奨励賞

東北大学 金属材料研究所

黒澤 俊介 殿

研究テーマ

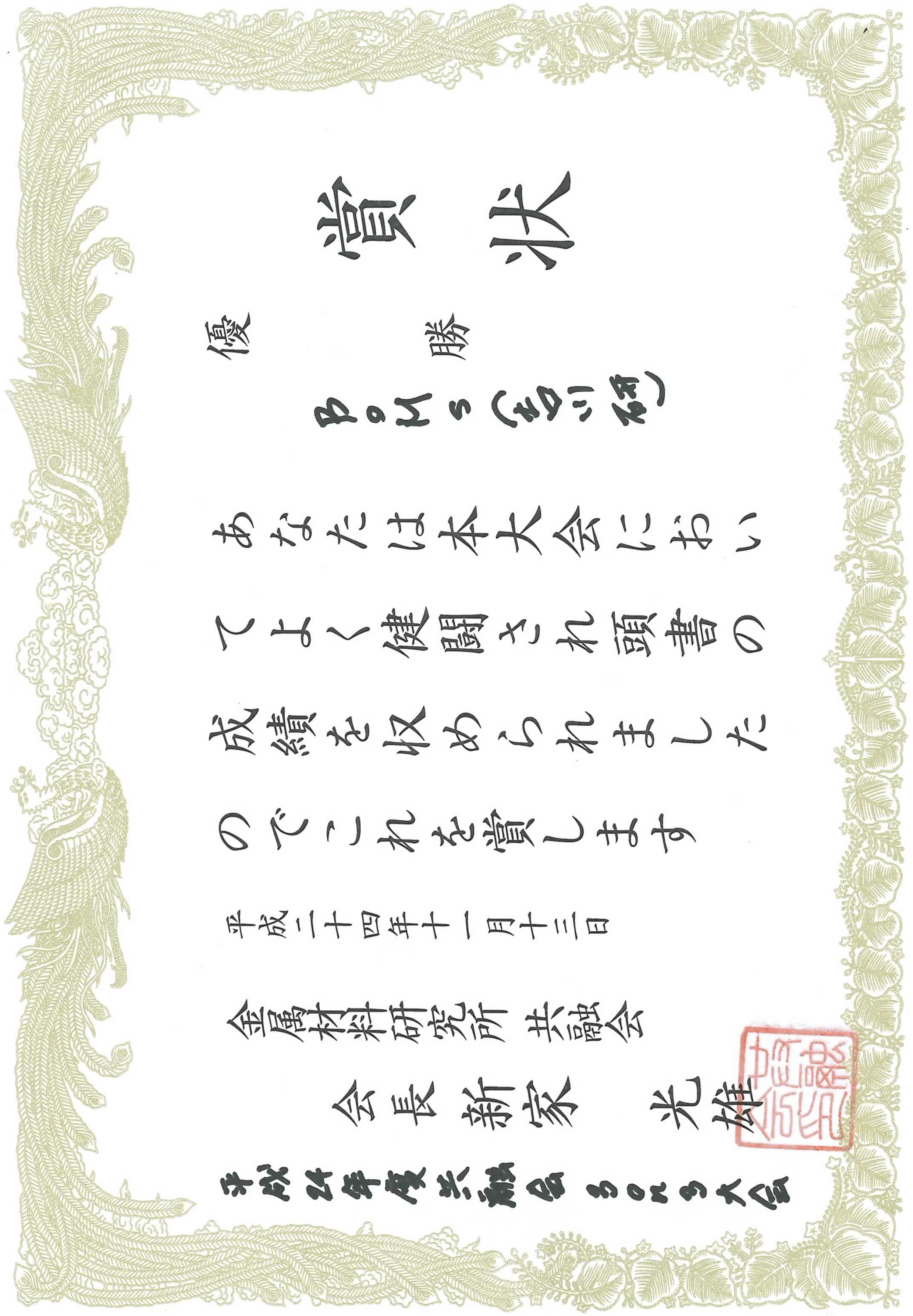
小型・耐水放射線検出器による河川での
放射線量モニタ用のシンチレーション
結晶開発

貴殿の研究は新化学の発展に資するもの
と認められますので、ここに第１回新化
学技術研究奨励賞として表彰します

平成 24 年 5 月 25 日

公益社団法人 新化学技術推進協会

会長　米倉　弘昌



List of Collaborative Research

Visits by International Collaborator 2012

Affiliation	Researcher	Research Theme
General Physics Institute (Russia)	Dr. V. Kochurikhin	Growth of bulk single crystals and automatic diameter control of Czochralski growth
Fomos Materials (Russia)	Dr. A. Medvedev	Langasite-type piezoelectric single crystals and their piezoelectric properties
General Physics Institute (Russia)	Dr. M. Borik	Growth of bulk single crystals
LPCML, CB Lyon1 Univ. (France)	Pr. G. Boulon	TEM Analysis of Rare Earth Dopant Distribution in YAG Optical Ceramics
LPCML, CB Lyon1 Univ. (France)	Pr. G. Boulon	Ceramic laser materials with a nonpress vacuum sintering method
LPCML, CB Lyon1 Univ. (France)	Pr. C.Dujardin	Luminescence in various scintillator
Institute of Physics ASCR (Czech Republic)	Dr. M. Nikl Dr. P. Prusa	Characterization of various scintillator materials
Scintillation Materials RC University of Tennessee、(USA)	Pr. C. Melcher	LSO scintillator
Institute for Scintillation Materials (Ukraine)	Pr. O.Gektin	Large size bulk halide crystals growth and industrial applications

Seminar at Yoshikawa Laboratory 2012

Date	Affiliation	Speaker	Title of speech
Nov. 27	Institute of Physics ASCR (Czech Republic)	Dr. M. Nikl	Inorganic scintillation nanopowders and nanocomposites
Nov. 27	LPCML, CB Lyon1 Univ. (France)	Pr. C.Dujardin	Spacial distribution of luminescence in various systems

Visits to International Collaborator 2012

Affiliation	Researcher	Period of stay
North –Caucasus State Technical Univ. (Russia)	Pr. Yoshikawa	April 22 - 24
The National Institute of Solar Energy (France)	Pr. Yoshikawa,	June 4 - 5
TPS corporation (Korea)	Pr. Yoshikawa	September 25 - 26
General Physics Institute (Russia)	Pr. Yoshikawa Assist. Pr. Yokota Assist. Pr. Kurosawa	October 5-6
Fomos Materials (Russia)	Pr. Yoshikawa Assist. Pr. Yokota Assist. Pr. Kurosawa	October 6
The University of Adelaide (Australia)	Pr. Yoshikawa	November 13-14
Institute of Physics ASCR (Czech Republic)	Dr. Pejchal	March 1-19

Research Funds

平成 24 年度　研究資金
Research funds (2012 fiscal year)

【内閣府（研究管理機関:日本学術振興会）】
The Cabinet Office (In charge: Japan Society for the Promotion of Science)

1. 最先端・次世代研究開発支援プログラム
Funding Program for Next Generation World-Leading Researchers (NEXT Program)

「次世代癌治療用近赤外線発光シンチレータの系統的研究開発」
"Systematic study of infrared photon emitting scintillators for cancer therapy"
研究代表者:吉川　彰　　Research Leader: A. Yoshikawa
メンバー:黒澤　俊介、Jan Pejchal、山路　晃広、若原　慎吾、鈴木　彬、北原　正典、関　真冬
Member: S. Kurosawa, J. Pejchal, A. Yamaji, S. Wakahara, A. Suzuki, M. Kitahara, M. Seki
Total: 150,080,000 yen/3years, 2011.2 - 2013.3 (26,950,000 yen in 2012FY)

【経済産業省－東北経済産業局】
Tohoku Bureau of Economy, Trade and Industry
-The Ministry of Economy, Trade and Industry

1. 戦略的基盤技術高度化支援事業(サポイン)
Funding Program for Strategic Support Industry

「難加工性機能性合金の形状制御結晶育成技術の開発」
"Developments of f unctional metallic products by shape-controlled growth techniques"
プロジェクト副代表者:吉川　彰　　Project Sub Leader: A. Yoshikawa (NICHe)
メンバー:横田　有為、二見　能資、上村　博
Member: Y. Yokota, Y. Futami, H. Uemura
Total: 34,880,000 yen, 2012.4 - 2013.3 (10,650,000 yen for our team)

【経済産業省－関東経済産業局】
Kanto Bureau of Economy, Trade and Industry
-The Ministry of Economy, Trade and Industry

1. 平成23年度地域イノベーション協創プログラム補助金
（震災復興技術イノベーション創出実証検出事業）
Funding Program for Innovative technology in reconstruction after disaster

株式会社千代田テクノル、株式会社オキサイド、日立アロカメディカル株式会社からの再委託研究
Truster: Chiyoda Technol Corporation, Oxide Corporation, Hitachi Aloka Medical, Ltd
「新規シンチレータを用いた高感度シンチレーション検出器の開発」
"Development of high sensitive dosimeter with new scintillator"
研究代表者:湯蓋　邦夫　　Research Leader: K. Yubuta
メンバー:吉川　彰、横田　有為、黒澤　俊介
Member: A. Yoshikawa, Y. Yokota, S. Kurosawa
Total: 12,920,000 yen for our team, 2012.4 -2013.3

【経済産業省－中小企業庁】
The Small and Medium Enterprise Agency
-The Ministry of Economy, Trade and Industry

1. 平成23年度グローバル技術連携・創業支援補助金一般枠
Funding Program for the small and medium enterprise in developing global operation

株式会社フルヤ金属、秋田精工株式会社、株式会社青山精工からの再委託研究
Truster: Furuya Metal Co.Ltd, Akita Seiko Co.Ltd, Aoyama Seiko Co.Ltd

「燃焼圧センサー用形状制御圧電結晶作製を可能にする特殊合金坩堝の鋳造技術と連続原料供給システムの開発」
"Developments of alloy crucibles and growth furnace system on shape-controlled piezoelectric crystals"
研究代表者:横田　有為　　Research Leader: Y. Yokota
メンバー:吉川　彰、Andrey Medvedev, Valery Tchani
Member: A. Yoshikawa, A. Medvedev, V. Tchani
Total: 25,000,000 yen for our team, 2012.5 - 2012.12

【JSTプロジェクト】
Japan Science and Technology Agency

1. JST研究成果展開事業【先端計測分析技術・機器開発】
   Development of Systems and Technology for Advanced Measurement and Analysis Technology

   「無人ヘリ搭載用散乱エネルギー認識型高位置分解能ガンマカメラの実用化開発」
   "Research and development of scattered energy recognition type and high positional resolution gamma camera for unmanned helicopter survey"

   古河機械金属株式会社からの再委託研究
   Truster: Furukawa Co. Ltd.
   研究代表者:黒澤 俊介　Research Leader: S. Kurosawa
   メンバー:藤本 裕、鈴木 彬、鈴木 祥太朗、北原 正典、関 真冬
   Member: Y. Fujimoto, A. Suzuki, S. Suzuki, M. Kitahara, M. Seki
   Total: 23,750,000 yen for our team, 2012.4 - 2013.3

2. JST研究成果最適展開支援プログラム（A-STEP）シーズ育成タイプ
   Adaptable and seamless technology transfer program through targetdrive R&D

   「核物質セキュリティ用3He 代替中性子計測装置の開発」
   "Development of neutron scanning apparatus for homeland security using scintillator instead of 3He gas detector."
   研究代表者:横田 有為　Research Leader: Y. Yokota
   Total: 7,250,000 yen for our team, 2012.10 - 2013.3

3. JST研究成果最適展開支援プログラム（A-STEP）【FS】探索タイプ
   Adaptable and seamless technology transfer program through targetdrive R&D

   「非破壊検査や核セキュリティー等への応用を目指した中性子イメージング用数十マイクロメートル高分解能シンチレータカメラの開発」
   "Development of high resolution neutron scintillation camera for homeland security and nondestructive testing"
   研究代表者:二見 能資　Research Leader: Y. Futami
   1,300,000 yen, 2012.10 -2012.3

【復興庁】
Reconstruction Agency

1. 平成24年度地域イノベーション戦略支援プログラム
   Funding Program for "Invest Japan" promotion for reconstruction

   宮城県インテリジェントコスモス研究機構からの再委託プログラム
   Truster: Intelligent Cosmos Research Institute, Miyagi pref.
   「次世代自動車のための人材育成プログラム」
   "Manpower training program for innovation in automotive industry"
   メンバー:横田 有為、吉川 彰、上村 博、二見 能資、
   Member: Y. Yokota, A. Yoshikawa, H. Uemura, Y. Futami
   Total:　3,500,000 yen, 2012.10 - 2013.3

【文部科学省科学研究費補助金】
Ministry of Education, Culture, Sports, Science and Technology

日本学術振興会
Japan Society for the Promotion of Science
科学研究費助成
Grants-in-Aid for Scientific Research

1. 若手研究（B）
   Grants-in-Aid for young scientists (B)
   研究代表者: 横田 有為　Research Leader: Y. Yokota
   1,300,000 yen, 2012.4-2013.3

2. 特別研究員奨励費
   Postdoctoral Fellowship
   研究代表者: 藤本 裕　Research Leader: Y. Fujimoto
   700,000 yen, 2012.4-2013.3
   研究代表者: 黒澤 俊介　Research Leader: S. Kurosawa
   800,000 yen, 2012.4-2013.3

【企業･財団･個人からの受託･共同研究，寄付金および小型プロジェクト】
Funds from industry, Foundations, personal donation and small project

1. 株式会社トクヤマ
   Tokuyama Corporation

2. 古河機械金属株式会社
   Furukawa Co. Ltd.

3. TDK 株式会社
   TDK Corporation

4. 日本結晶光学株式会社
   Nihon Kessho Kogaku Co.Ltd

5. キヤノン株式会社
   Canon Inc.

6. 株式会社ジー･イー･エス
   GES Co. Ltd.

7. 七十七銀行
   The 77 Bank

8. 大阪大学レーザーエネルギー学研究センター　共同研究
   Collaboration program with Institute of Laser Engineering, Osaka Univ.
   「真空紫外域に発光する新規発光結晶の開発」

平成 24 年度申請特許

List of patents

1. フッ化物単結晶、発光素子及びシンチレーター

   吉川　彰、柳田　健之、横田　有為、藤本　裕、石津　澄人、福田　健太郎、河口　範明
   (Akira Yoshikawa, Takayuki Yanagida, Yuui Yokota, Yutaka Fujimoto, Sumito Ishizu, Kentaro Fukuda, Noriaki Kawaguchi)

2. シンチレーター用材料、シンチレーター及び放射線検出器

   吉川　彰、黒澤　俊介、横田　有為、鈴木　彬、古川　保典
   (Akira Yoshikawa, Shunsuke Kurosawa, Yuui Yokota, Akira Suzuki, Yasunori Furukawa)

3. 結晶材料

   吉川　彰、横田　有為、黒澤　俊介
   (Akira Yoshikawa, Yuui Yokota, Shunsuke Kurosawa)

4. 結晶材料及び放射線検出器

   吉川　彰、黒澤　俊介、横田　有為、庄子　育宏、鈴木　彬、宍戸　統悦
   (Akira Yoshikawa, Shunsuke Kurosawa, Yuui Yokota, Yasuhiro Shoji, Akira Suzuki, Toetsu Shishido)

他　外国出願　２　件

学会、学内における役員・委員等
Committees of academic societies and conferences

吉川　彰
Dr. Akira YOSHIKAWA, Professor

日本結晶成長学会 Japanese Association for Crystal Growth Cooperation	理事（新技術・新材料分科会担当） Trustee (responsible for new technology and new materials branch)
	編集委員 Member of the editorial staff
日本学術振興会第 161 委員会 No. 161 committee, Japan Society for the Promotion of Science	運営委員 Manager
日本学術振興会第 186 委員会 No. 186 committee, Japan Society for the Promotion of Science	代表幹事 Chief secretary
第 7 回発光・受光及び放射線変換素子に関する国際学会 The 7th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation (LUMDETR 2009)	科学諮問委員 Scientific Advisory Committee
Europhysical Conference of Defects in Insulating Materials (EURODIM 2010)	国際諮問委員 International Advisory Committee
International Conference on Defects in Insulating Materials (ICDIM 2012)	国際諮問委員 International Advisory Committee

List of Presentations

A. International conference and symposia
国際学会

1. Y. Yokota, Y. Futami, M. Sato, K. Tota, T. Yanagida, K. Onodera and A. Yoshikawa
"Growth of columnar and plate-shaped langasite-type piezoelectric single crystals and their piezoelectric properties"
The International Workshop on Piezoelectric Materials and Applications (IWPMA) 2012/4/22-25 Hirosaki, Japan (2012)

2. A. Yoshikawa, Y. Yokota, S. Kurosawa, Y. Fujimoto, M. Nikl, V. V.Kochurikhin
"Development of Novel Scintillator Crystals and their applications"
International conference on Solid State Chemistry
2012/4/22-27 Stavropol, Russia (2012)

3. A.Yamaji, Y. Fujimoto, T. Yanagida, N. Kawaguchi, Y. Yokota, A. Yoshikawa
"Crystal Growth and Scintillation Properties of Ce-Doped K2NaLuF6"
IEEE 2012 Symposium on Radiation Measurements and Applications (SORMA west 2012) 2012/5/14-17 Oakland, CA, US (2012)

4. S. Kurosawa, V. V. Kochurikhin, M. A.?Borik, Y. Yokota, T. Yanagida, A. Yoshikawa
"Scintillation Properties of High-Melting Temperature Single Crystals Using Skull Melting Method "
SORMA west 2012/5/14-17 Oakland, CA, US (2012)

5. J. Iwanowska, L. Swiderski, T. Szczesniak, P. Sibczynski, M. Moszynski, K. Kamada, K. Tsutsumi, Y. Usuki, T. Yanagida, A. Yoshikawa
"Performance of Ce:Gd3Ga3Al2O12 (GGG) Scintillator in Gamma-Ray Spectrometry"
SORMA west 2012/5/14-17 Oakland, CA, US (2012)

6. K. Watanabe, T. Kodo, A. Yamazaki, A. Uritani, T. Iguchi, N. Kawaguchi, T. Yanagida, Y. Fujimoto, K. Fukuda, T. Suyama, A. Yoshikawa
"Temperature Dependence of Neutron-Gamma Discrimination Based on Pulse Shape Discrimination Technique in a Ce:LiCaAlF6 Scintillator"
SORMA west 2012/5/14-17 Oakland, CA, US (2012)

7. S. Kurosawa, H. Kubo, S. Kabuki, K. Ueno, S. Iwaki, M. Takahashi, K. Taniue, N. Higashi, K. Miuchi, D.G. Kim, M.J. Kim, T. Tanimori, J.W. Kim
"2D Dose-Verification in Proton Therapy Using an Electron-Tracking Compton Camera"
Particle Therapy Co-Operative Group (PTCOG51) 2012/5/14-19 Seoul, Korea (2012)

8. M. Nikl, K. Kamada, A. Yoshikawa, P. Bohacek
"New Material Concepts in Complex Oxide Phosphors and Scintillators"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

9. A. Yoshikawa, S. Kurosawa, A. Yamaji, S. Wakahara, Y. Fujimoto, K. Watanabe, A. Yamazaki, A. Uritani, T. Iguchi, T. Yanagida, M. Nikl
"Crystal Growth and Scintillation Properties of Colquiriite (6LiCaAlF6, 6LiSrAlF6) Single Crystal, as a Candidate for Neutron Scintillator Alternatives to 3He"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

10. S. Wakahara, T. Yanagida, Y. Yokota, A. Yamaji, J. Pejchal, Y. Fujimoto, M. Sugiyama
"Crystal Growth and Evaluation of Scintillation Properties of Eu-M (M=Na, K, Rb and Cs) Co-doped LiSrAlF6 Complex Fluoride Single Crystals for Thermal Neutron Detector"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

11. J. Pejchal, M. Nikl, T. Yanagida, Y.Yokota, A.Yoshikawa
"Luminescence and Scintillation Properties of Rare-earth-doped BaLu2F8 Single Crystals Grown by Micropulling-down Method"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

12. A. Suzuki, S. Kurosawa, J. Pejchal, V. Babin, A. Yamaji, M. Seki, Y. Futami, Y. Yokota, K.Yubuta, T. "Shishido, M. Kikuchi, M. Nikl, A. Yoshikawa"
Scintillation Properties of Ce-doped Gd3Al2Ga3O12 Crystal Grown by Floating Zone Method
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

13. M. Seki, V. V. Kochurikhin, S. Kurosawa, A. Suzuki, A. Yamaji, Y. Fujimoto, S. Wakahara, Y. Yokota, A. Yoshikawa
"Optical and Scintillation Properties of Y3Al5O12 Crystals Doped with Rare Earth"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

14. Y. Fujimoto, T. Yanagida, S. Kurosawa, A. Yoshikawa
"Growth and Scintillation Properties of Ce3+-doped (Yx-1Gdx)AlO3 Crystals"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

15. K. Kamada, T. Yanagida, T. Yanagida, T. Endo, K. Tsutumi, Y. Usuki, A. Yoshikawa
"Crystal Growth and Scintillation Properties of Ce doped (Gd,Y)3Al5O12 Single Crystal"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

16. A.Yamaji, V. V Kochurikhin, Y. Fujimoto, T. Yanagida, S. Kurosawa, Y. Yokota, A. Yoshikawa
"Optical Properties and Radiation Response of Ce3+-doped GdScO3 Crystals"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

17. S. Kurosawa, Y. Yokota, T. Yanagida, A. Yoshikawa
"Eu-Concentration Dependence of Optical and Scintillation Properties for Eu-doped SrF2 Single Crystals"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

18. Y.Yokota, A. Yamaji, S. Kurosawa, A. Yoshikawa
"Growth of Ce Doped LiYF4 Bulk Crystal with High Ce Concentration by Cz Method and the Scintillation Properties"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

19. T. Yanagida, Y. Fujimoto, K. Yamanoi, M. Kano, A. Wakamiya, S. Kurosawa, Y. Yokota, A. Yoshikawa, N. Sarukura
"Optical and Scintillation Properties of Bulk ZnO Crystal"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

20. A.Yamaji, Y. Yokota, Y. Fujimot, S. Kurosawa, A. Yoshikawa
"Crystal Growth and Scintillation Properties of Ce : Li(Ca,Sr)AlF6"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

21. K. Kamada, T. Yanagida, T. Endo, K. Tsutumi, A. Yoshikawa
"Crystal Growth and Scintillation Properties of Ce, Pr and Eu doped La2:75Lu2:25Ga3O12 Single Crystal"
5th International Conference on Optical and Optoelectronic Properties of Materials and Applications (ICOOPMA12) 2012/6/3-7 Nara,Japan (2012)

22. Y. Yokota, Y. Futami, M. Sato, K. Tota, Y. Fujimoto, S. Kurosawa, K. Onodera and A. Yoshikawa
"Crystal growth of plate- and tube-shaped langasite-type piezoelectric single crystals and their physical properties"
International Symposium on Integrated Functionalities (ISIF2012) 2012/6/18-21 Hong Kong, China (2012)

23. S. Kurosawa, T. Yanagida, Y. Yokota, A. Yoshikawa
"Scintillation Property of Nddoped BaY2F8"
The 10th International Conference on Excitonic Processes in Condensed Matter, Nanostructured and Molecular Materials (EXCON2012) 2012/7/2-6 Groningen, The Netherlands (2012)

24. Y. Yokota, Y. Fujimoto, S. Kurosawa, N. Kawaguchi, K. Fukuda, and A. Yoshikawa
"Optical and Scintillation properties of Lu co-doped Ce:LiYF4 single crystals"
The 10th International Conference on Excitonic Processes in Condensed Matter, Nanostructured and Molecular Materials (EXCON2012) 2012/7/2-6 Groningen, The Netherlands (2012)

25. Y. Yokota, M. Sato, Y. Futami, K. Tota, Y. Fujimoto, S. Kurosawa, K. Onodera and A. Yoshikawa
“Crystal growth and piezoelectric properties of Ca3NdGa3Si2O14 single crystals grown under various atmosphere”
International Symposium on Applications of Ferroelectrics (ISAF) 2012/7/9-13 Aveiro, Portugal (2012)

26. M. Nikl, J. Pejchal, K. Kamada, A. Yoshikawa (Lu,Y,Gd)3(Ga,Al)5O12 single crystal scintillators
“Luminescence and scintillation mechanism in Cerium doped (Lu,Y,Gd)3(Ga,Al)5O12 single crystal scintillators”
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

27. P. Prusa, K. Kamada, J. A. Mares, A. Yoshikawa, M. Nikl
“Light yield of (Lu, Y, Gd)3Al2Ga3O12:Ce garnets”
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

28. W. Drozdowski, K. Brylew, M. E. Witkowski, A. J. Wojtowicz, K. Kamada, T. Yanagida, A. Yoshikawa
“Effect of Thermal Annealing on Light Yield, Time Profiles, and Low Temperature Thermoluminescence of LuAG:Pr Scintillator Crystals”
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

29. S. Wakahara, T. Yanagida, Y. Fujimoto, Y. Yokota, A.Yamaji, J. Pejchal, S. Kurosawa, N. Kawaguchi, K. Fukuda and A.Yoshikawa
“Evaluation of Ce3+ and Alkali Metal Ions Co-doped LiSrAlF6 Crystalline Scintillators”
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

30. Y. Fujimoto, K. Kamada, T. Yanagida, S. Kurosawa,A. Yoshikawa
“Photo- and Radio- Excited Luminescence Properties of La2O3-Al2O3 Based Eutectics”
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

31. J. Pejchal, V. Babin, M. Nikl, A. Yoshikawa, A. Beitlerova
“Luminescence processes in Ti-doped LiAlO2 single crystals for neutron scintillators”
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

32. A.Yamaji, H. Ogino, Y. Fujimoto, T. Yanagida, Y. Yokota, S. Kurosawa, A. Yoshikawa
“Scintillation Properties of Er-doped Y3Al5O12 single crystals”
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

33. A.Yoshikawa, K. Kamada, Y. Fujimoto, S. Kurosawa, Y. Yokota, J. Pejchal, Y. Futami, M. Nikl
“Crystal chemistry of Cerium doped multicomponent {Gd,RE}3[Ga,Al,M’]2 (Ga,Al,M”)3O12 single crystalline scintillators and their performance”
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

34. Y. Ohashi, N. Yasui, T. Den, Y. Yokota, T. Yanagida, A. Yoshikawa
“Phase-Separated Ce3+:GdAlO3-Al2O3 Scintillator with Light-Guiding Property”
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

35. S. Kurosawa, M. Sugiyama, Y. Yokota, S. Wakahara, T. Yanagida, A. Yoshikawa
“Optical Property and Radiation Reaction of RE:SrHfO3 (RE=Ce, Pr) prepared by the Spark Plasma Sintering Method”
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

36. E. Mihokova, K. Vavr?u, K. Kamada, V. Jary, A. Yoshikawa, M. Nikl
"Deep trapping states in Cerium doped (Lu,Y,Gd)3(Ga,Al)5O12 single crystal scintillators"
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

37. K. Brylew, W. Drozdowski, M. E. Witkowski, A. J. Wojtowicz, K. Kamada, T. Yanagida, A. Yoshikawa
"VUV, UV & VIS Spectroscopy of LuAG and LuAG:Pr Scintillator Crystals"
8th International Conference on Luminescent Detectors and Transformers of Ionizing Radiation - LUMDETR 2012 2012/9/10-14 Halle (Saale), Germany (2012)

38. A.Yoshikawa, A. Yamaji, K. Nishimoto, Y. Fujimoto, S. Kurosawa, Y. Yokota
"Growth of LiF/CeF3 eutectic crystals by the micro-pulling-down method and their scintillation properties"
4th internatinla Directionally Solidified Eutectic Ceramics (DSEC4) 2012/10/14-17 Washington, D.C. Area, USA (2012)

39. S. Kurosawa, Y. Yokota, A. Yamaji, Y. Futami, N. Kawaguchi, K. Fukuda
"Growth and optical properties of LiF/LaF3 eutectic crystals"
4th internatinla Directionally Solidified Eutectic Ceramics (DSEC4) 2012/10/14-17 Washington, D.C. Area, USA (2012)

40. K. Nishimoto, Y. Yokota, S. Kurosawa, Y. Fujimoto, N. Kawaguchi, K. Fukuda, A. Yoshikawa
"Crystal growth of LiF/ LiYF4 eutectic crystals and the luminescent properties"
4th internatinla Directionally Solidified Eutectic Ceramics (DSEC4) 2012/10/14-17 Washington, D.C. Area, USA (2012)

41. Y. Yokota, S. Kurosawa, N. Kawaguchi, K. Fukuda
"Growth and luminescent properties of LiF/LiLuF4 eutectic crystals grown by micro-pulling-down method"
4th internatinla Directionally Solidified Eutectic Ceramics (DSEC4) 2012/10/14-17 Washington, D.C. Area, USA (2012)

42. N. Kawaguchi, T. Yanagida, K. Fukuda, S. Kajimoto, H. Fukumura, Y. Fujimoto, S. Kurosawa, Yuui Yokota, A. Yoshikawa
"Microstructural studies and neutron responses of LiF/CaF2:Eu eutectic crystals"
4th internatinla Directionally Solidified Eutectic Ceramics (DSEC4) 2012/10/14-17 Washington, D.C. Area, USA (2012)

43. S. Kurosawa, Y. Yokota, A. Yamaji, N. Kawaguchi, K. Fukuda
"Luminescent properties of LiF/PrF3 eutectic crystals"
4th internatinla Directionally Solidified Eutectic Ceramics (DSEC4) 2012/10/14-17 Washington, D.C. Area, USA (2012)

44. K. Watanabe, Y. Kondo, Y. Takahashi, A. Yamazaki, A. Uritani, T. Iguchi, N. Kawaguchi, T. Yanagida, Y. Fujimoto, K. Fukuda, S. Ishidu, A. Yoshikawa
"Evaluation of Neutron/Gamma-Ray Sensitivity Ratio for LiCaAlF6 Scintillators"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

45. Y. Kawabata, K. Watanabe, S. Maruyama, A. Yamazaki, T. Iguchi, A. Uritani, A. Yoshikawa, T. Yanagida, Y. Fujimoto
"Development of an Optical Fiber Detector for Neutron Monitoring in Boron Neutron Caputure Therapy"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

46. M. Seki, S. Kurosawa, A. Suzuki, A. Yamaji, Y. Fujimoto, S. Wakahara, Y. Futami, Y. Yokota, K. Yubuta, T. Shishido, M. Kikuchi, A. Yoshikawa
"Temperature Dependence of Ce-Doped Gd3(Al,Ga)5O12 Scintillators on the Light Output"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

47. Y. Fujimoto, T. Yanagida, N. Kawaguchi, K. Fukuda, D. Totsuka, K. Watanabe, A. Yamazaki, S. Kurosawa, A. Yoshikawa
"Scintillation Properties of Undoped and Ce3+-Doped Strontium Metaborate Crystals"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

48. S. Wakahara, T. Yanagida, A. Yamaji, Y. Yokota, Y. Fujimoto, M. Sugiyama, N. Kawaguchi, S. Kurosawa, K. Fukuda, A. Yoshikawa
"Evaluation of Optical and Scintillation Properties of K Co-Doped Eu:LiSrAlF6 Complex Fluoride Single Crystals for Thermal Neutron Detector"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

49. K. Nishimoto, Y. Yokota, S. Kurosawa, Y. Fujimoto, T. Kojima, F. Nitanda, Y. Furukawa, A. Yoshikawa
"Eu Concentration Dependence on Scintillation Properties of Eu Doped SrI2 Single Crystals Grown"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

50. S. Suzuki, A. Yamaji, Y. Fujimoto, N. Kawaguchi, K. Watanabe, A. Yamazaki, S. Kurosawa, S. Wakahara, Y. Yokota, A. Yoshikawa
"Optimization of Eu Concentration in LiSrAlF6 Crystalline Scintilaltor"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

51. Y. Yokota, A. Yamaji, Y. Fujimoto, S. Kurosawa, N. Kawaguchi, K. Fukuda, A. Yoshikawa
"Shape-Controlled Scintillator Single Crystals Grown by Micro-Pulling-Down Method"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

52. A.Yoshikawa, S. Kurosawa, A. Suzuki, M. Seki, A. Yamaji, Y. Fujimoto, Y. Yokota, S. Nagata, T. Shikama, V. V. Kochurikhin
"Crystal Growth and Luminescent Properties of Nd-Doped Ca3(Nb,Ga)5O12"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

53. S. Kurosawa, Y. Yokota, A. Yoshikawa
"Scintillation Properties of Eu-Doped Scintillators"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

54. K. Kamada, P. Prusa, M. Nikl, T. Yanagida, T. Endo, K. Tsutsumi, A. Yoshikawa
"Czhocralski Growth and Gamma-Ray Response of Ce:(Gd,Lu,Y)3(Al,Ga)5O12 Single Crystals"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

55. K. Kamada1, K. Tsutsumi, T. Endo, M. Nikl, T. Yanagida, A. Yoshikawa
"Czhocralski Growth of Pr:(Lu,Y)3(Al,Ga)5O12 Single Crystals and Their Scintillation Properties"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

56. K. Kamada, M. Nikl, T. Yanagida, A. Yoshikawa
"Growth of Sc Doped RE3Al5O12 (RE=Y, Gd, Lu) Single Crystal by Micro-Pulling-down Method and Their Scintillation Properties"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

57. K. Kamada, P. Prusa, M. Nikl, T. Yanagida, T. E. Endo, K. Tsutumi, Y. Usuki, A. Yoshikawa
"2-Inch Size Crystal Growth of Ce:Gd3Al2Ga3O12 with Various Ce Concentration and Their Scintillation Properties"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

58. D. Totsuka, T. Yanagida, Y. Fujimoto, Y. Yokota, F. Moretti, A. Vedda, A. Yoshikawa
"Effect of Bi-Codoping on the X-Ray Induced Afterglow in CsI:Tl"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

59. N. Kawaguchi, T. Yanagida, Y. Fujimoto, A. Yamazaki, K. Watanabe, K. Fukuda, Y. Futami, S. Kurosawa, Y. Yokota, A. Yoshikawa
"Neutron Response with Different Sized Eu Doped LiCaAlF6 Crystals"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

60. J. D. Parker, M. Harada, K. Hattori, S. Iwaki, S. Kabuki, Y. Kishimoto, H. Kubo, S. Kurosawa, K. Miuchi, H. Nishimura, T. Oku, T. Sawano, T. Shinohara, J.-I. Suzuki, A. Takada, T. Tanimori, K. Ueno
"Neutron Imaging Detector Based on the μPIC Micro-Pixel Gaseous Chamber"
IEEE 2012 Nuclear Science Symposium (IEEE/NSS) 2012/10/29-11/3 Disneyland Hotel, Anaheim, CA, USA (2012)

61. Y. Yokota, S. Kurosawa, M. Sato, K. Tota, A. Yamaji, Y. Futami, K. Onodera, and A. Yoshikawa
"Shape-controlled Single Crystals with Rare-earth Elements Grown by μ-PD Method"
International Symposium on Rare Earths 2012 in Okinawa for the 30th Anniversary of The Rare Earth Society of Japan 2012/11/8-9 Okinawa, Japan (2012)

62. S. Kurosawa, Y. Yokota, and A. Yoshikawa
"Optical and Scintillation Properties of Eu-doped Fluoride Scintillator and Its Eu3+/Eu2+ Ratio"
International Symposium on Rare Earths 2012/11/8-9 Okinawa, Japan (2012)

63. A.Yoshikawa
"Comparison between transparent ceramics and single crystals for scintillator application"
ICC-IMR - ELyT workshop on materials science 2012/11/_26 Sendai, Japan (2012)

64. A.Yoshikawa, K. Kamada, S. Kurosawa, Y. Yokota, J. Pejchal, Y. Futami, Y. Fujimoto, M.Seki, M.Nikl
"Study on large-light-output scintillators I - Ce:GAGG"
The 8th International Workshop on Ionizing Radiation Monitoring (IWIRM8) 2012/12/1-2 Oarai, Japan (2012)

65. Yoshikawa, K. Nishimoto, Y. Yokota, S. Kurosawa
"Study on large-light-output scintillators II - Eu:SrI2"
The 8th International Workshop on Ionizing Radiation Monitoring (IWIRM8) 2012/12/1-2 Oarai, Japan (2012)

66. Y. Yokota, S. Kurosawa, A. Yoshikawa
"Doping effects on scintillation properties for Ce:LiYF4 single crystals"
The 8th International Workshop on Ionizing Radiation Monitoring (IWIRM8) 2012/12/1-2 Oarai, Japan (2012)

67. S. Kurosawa, Y. Yokota and A. Yoshikawa
"Temperature dependence of Ce:SrHfO3 ceramics scintillator"
The 8th International Workshop on Ionizing Radiation Monitoring (IWIRM8) 2012/12/1-2 Oarai, Japan (2012)

68. S. Kurosawa, A. Suzuki, T. Shishido, Y. Yokota and A. Yoshikawa
"Scintillation properties of lanthanum gadolinium pyrosilicate single crystals"
The 8th International Workshop on Ionizing Radiation Monitoring (IWIRM8) 2012/12/1-2 Oarai, Japan (2012)

69. Y. Fujimoto, T. Yanagida, S. Wakahara, K. Watanabe, M. Sugiyama, Y. Miyamoto,H. Nanto, Y. Yoshikawa
"Comparative Study of Radiation Response of Crystalline- and Glassy- Calcium Metaborates"
The 8th International Workshop on Ionizing Radiation Monitoring (IWIRM8) 2012/12/1-2 Oarai, Japan (2012)

70. Y. Shoji, M. Seki, S. Kurosawa, Y. Yokota,V.V. Kochurikhin and A. Yoshikawa
"Crystal growth and luminescent properties of Y3Al5O12 and sapphire (α-Al2O3) for a dosimeter"
The 8th International Workshop on Ionizing Radiation Monitoring (IWIRM8) 2012/12/1-2 Oarai, Japan (2012)

71. S. Wakahara, Y. Fujimoto, S. Suzuki, T. Yanagida, J. Pejchal, Y. Yokota, S. Kurosawa and A. Yoshikawa
"Development of borate glass scintillators activated with copper for thermal neutron detection"
The 8th International Workshop on Ionizing Radiation Monitoring (IWIRM8) 2012/12/1-2 Oarai, Japan (2012)

72. S. Suzuki, Y. Yokota, S. Wakahara , A. Yamaji, Y. Fujimoto, N. Kawaguchi, K. Fukuda, S. Kurosawa, A. Yoshikawa
"Eu concentration dependence of optical and scintillation properties for Eu : LiSrAlF6 crystals"
The 8th International Workshop on Ionizing Radiation Monitoring (IWIRM8) 2012/12/1-2 Oarai, Japan (2012)

73. M. Seki, S. Kurosawa, T. Shishido, J. Pejchal, Y. Yokota and A. Yoshikawa
"Scintillation property of a Ce-doped Gd3Al3Ga2O12 Crystal Grown by the Floating Zone Method"
The 8th International Workshop on Ionizing Radiation Monitoring (IWIRM8) 2012/12/1-2 Oarai, Japan (2012)

74. Y. Yokota, M. Kitahara, S. Kurosawa, M. Sato, K. Tota, K. Onodera, A. Yoshikawa
"Annealing effects for Ca3NbGa3Si2O14 piezoelectric single crystals grown by micro-pulling-down method"
The 8th Asian Meeting on Ferroelectrics (AMF-8) 2012/12/9-14 Pattaya, Thailand (2012)

75. M. Kitahara, Y. Yukota Y. Futami, S. Kurosawa, Y. Fujimoto, M. Sato, K. Tota, K. Onodera, A.Yoshikawa
"Fabrication and physical properties of Ca3Nb(Ga1-xAlx)3Si2O14 Piezoelectric materials"
The 8th Asian Meeting on Ferroelectrics (AMF-8) 2012/12/9-14 Pattaya, Thailand (2012)

76. B. Domestic conferences

国内学会

1. 吉川彰
"真空紫外域に発光する新規発光結晶の開発"
大阪大学レーザー研シンポジウム 2012 2012/4/17-18 大阪大学

2. 横田有為， 二見能資， 佐藤真人， 遠田一重， 藤本裕， 黒澤俊介， 小野寺晃， 吉川彰
"平板状及びチューブ状 Ca3NbGa3Si2O14 圧電結晶の結晶育成と特性評価"
第 29 回強誘電体応用会議(FMA29) 2012/4/23-26 コープイン京都

3. 河口範明，柳田健之，藤本裕，二見能資，渡辺賢一，山崎淳，福田健太郎，黒澤俊介，横田有為，吉川彰
"LiF/CaF2 共晶体の中性子応答特性"
第 73 回応用物理学会学術講演会（2012 年秋季講演会） 2012/9/11-14 愛媛大学・松山大学

4. 鈴木彬，黒澤俊介，藤本裕，永田晋二，山路晃広，四竈樹男，横田有為，吉川彰
"Yb:Y3Al5O12 単結晶材料の育成および発光特性の評価"
第 73 回応用物理学会学術講演会（2012 年秋季講演会） 2012/9/11-14 愛媛大学・松山大学

5. 関真冬，黒澤俊介，二見能資，横田有為，宍戸統悦，湯蓋邦夫，菊地昌枝，吉川彰
"Ce 添加 Gd3(Al,Ga)5O12 シンチレーターの温度依存性"
第 73 回応用物理学会学術講演会（2012 年秋季講演会） 2012/9/11-14 愛媛大学・松山大学

6. 高橋嘉彦，山崎淳，渡辺賢一，瓜谷章，河口範明，福田健太郎，石津澄人，柳田健之，吉川彰
"発光波長特性を用いた中性子/ガンマ線弁別に関する研究"
第 73 回応用物理学会学術講演会（2012 年秋季講演会） 2012/9/11-14 愛媛大学・松山大学

7. 川端勇矢，丸山秀典，山崎 淳，渡辺賢一，瓜谷 章，河口範明，福田健太郎，石津澄人，柳田健之，吉川 彰
“BNCT 中性子場モニタを目的とした光ファイバ型検出器の開発”
第 73 回応用物理学会学術講演会（2012 年秋季講演会） 2012/9/11-14 愛媛大学・松山大学

8. 鈴木祥太朗，吉川彰，河口範明，山路晃広，若原慎吾，藤本裕，福田健太郎，二見能資，横田有為，黒澤俊介
“Eu:LiSrAlF6 シンチレータ結晶における Eu 添加濃度の最適化”
第 73 回応用物理学会学術講演会（2012 年秋季講演会） 2012/9/11-14 愛媛大学・松山大学

9. 西本けい，横田有為，黒澤俊介，藤本裕，小島孝広，二反田文雄，古川保典，吉川彰
“マイクロ引下げ法による Eu 添加 SrI2 単結晶の作製とシンチレーション特性評価”
第 73 回応用物理学会学術講演会（2012 年秋季講演会） 2012/9/11-14 愛媛大学・松山大学

10. 横田有為，佐藤真人，二見能資，遠田一重，黒澤俊介，小野寺晃，吉川彰
“育成雰囲気を制御して育成した Ca3NbGa3Si2O14 圧電結晶の物性評価”
第 73 回応用物理学会学術講演会（2012 年秋季講演会） 2012/9/11-14 愛媛大学・松山大学

11. 北原正典，横田有為，二見能資，黒澤俊介，藤本 裕，佐藤真人，遠田一重，小野寺晃，吉川彰
“Ca3NbGa3Si2O14 圧電材料における元素置換効果”
第 73 回応用物理学会学術講演会（2012 年秋季講演会） 2012/9/11-14 愛媛大学・松山大学

12. 古村翔太郎，谷森達，窪秀利，Parker Joseph，水村好貴，水本哲矢，岩城智，澤野達哉，中村輝石，松岡佳大，佐藤快，中村祥吾，身内賢太朗，高田淳史，岸本祐二，上野一樹，株木重人，黒澤俊介
“電子飛跡検出型コンプトンカメラにおける飛跡取得アルゴリズムの改良 III”
日本物理学会 2012 年秋季大会 2012/9/11-14 京都産業大学

13. 水本哲矢，谷森達，窪秀利，Parker Joseph，水村好貴，岩城智，澤野達哉，中村輝石，松岡佳大，古村翔太郎，佐藤快，中村祥吾，身内賢太朗，高田淳史，岸本祐二，上野一樹，株木重人，黒澤俊介，田中真伸，池野正弘，内田智久
“SMILE14 : 電子飛跡検出型コンプトンカメラ(ETCC)の新データ取得システムの性能評価”
日本物理学会 2012 年秋季大会 2012/9/11-14 京都産業大学

14. 宍戸統悦、湯蓋邦夫、森孝雄、工藤邦男、岡田繁、野村明子、菅原孝昌、手嶋勝弥、大石修治、吉川彰
“RCo2B2（R＝希土類元素）の硬さおよび耐酸化性”
セラミックス協会第 25 回秋季シンポジウム 2012/9/19-21 名古屋大学

15. 黒澤俊介、横田有為、鈴木彬、吉川彰
“SPS 法によるシンチレータ材料の開発”
セラミックス協会第 25 回秋季シンポジウム 2012/9/19-21 名古屋大学

16. 藤本裕、柳田健之、若原慎吾、鈴木祥太郎、吉川彰
“Na2B4O7 ガラスの光学及びシンチレーション特性”
セラミックス協会第 25 回秋季シンポジウム 2012/9/19-21 名古屋大学

17. 黒澤俊介、横田有為、吉川彰
“シンチレータの開発”
大洗研究会 2012/9/27 秋葉原 UDX

18. 横田有為、黒澤俊介、山路晃広、吉川彰
“マイクロ引き下げ法を用いた大口径バルク単結晶育成の可能性”
第 42 回結晶成長国内会議（NCCG-42） 2012/11/9-11 九州大学筑紫キャンパス

19. 西本けい、横田有為、黒澤俊介、藤本裕、吉川彰
“チャンバー着脱型 μ-PD を用いた Eu : SrI2 単結晶の結晶育成”
第 42 回結晶成長国内会議（NCCG-42） 2012/11/9-11 九州大学筑紫キャンパス

20. 鈴木祥太朗、横田有為、若原慎吾、山路晃広、藤本裕、河口範明、福田健太郎、黒澤俊介、吉川彰
“μ-PD 法による Eu 添加 LiSAF 単結晶の育成および Eu 最適濃度の探索”
第 42 回結晶成長国内会議（NCCG-42） 2012/11/9-11 九州大学筑紫キャンパス

21. 吉川彰，横田有為，黒澤俊介，藤本裕，山路晃広，西本けい
“フッ化物共晶体を使った新しいシンチレータの開発”
第 7 回日本フラックス成長研究発表会 2012/12/7 物質・材料研究機構

22. 山路晃広，藤本裕，黒澤俊介，横田有為，吉川彰
“希土類フッ化物結晶(ReF3)のフラックス成長と光学特性”
第 7 回日本フラックス成長研究発表会 2012/12/7 物質・材料研究機構

23. 湯蓋邦夫，森 孝雄，田中雅彦，岡田 繁，工藤邦男，野村明子，菅原孝昌，戸澤慎一郎，小原和夫，鎌本喜代美，古曳重美，手嶋勝弥，大石修治，吉川 彰
“ThCr2Si2 型基調 YCo2B2，YCo2B2C の合成および性質”
第 7 回日本フラックス成長研究発表会 2012/12/7 物質・材料研究機構

24. 宍戸統悦，湯蓋邦夫，関 成之，野村明子，林好一，吉川彰，羽賀浩一
“有機－無機転換工程の考察 —SiC，ZnO 素材作製を例に—”
第 7 回日本フラックス成長研究発表会 2012/12/7 物質・材料研究機構

25. 横田有為，黒澤俊介，西本けい，吉川 彰
“LiF／LiLuF4 共晶体シンチレータ結晶の合成と組織観察及びその発光特性”
第 7 回日本フラックス成長研究発表会 2012/12/7 物質・材料研究機構

26. 鈴木彬，黒澤俊介, Jan Pejchal, Vladimir Babin, 藤本裕，山路晃広，関真冬，二見能資，横田有為，湯蓋邦夫，宍戸統悦，菊地昌枝, Martin Nikl，吉川彰
“Ce 添加 Gd3Al3Ga2O12 ガーネット結晶の光学・シンチレーター特性における育成条件依存性の実験的評価”
第 23 回光物性研究会 2012/12/7-8 大阪市立大学

27. 黒澤俊介，上村博，北原正典，鈴木彬，鈴木祥太郎，庄子育宏，関真冬，二見能資，藤本裕，西本けい，山路晃宏，若原慎吾, Jan Pejchal，横田有為，吉川彰
“Ce 添加 SrHfO3 セラミックスの発光特性”
第 23 回光物性研究会 2012/12/7-8 大阪市立大学

28. 藤本裕，柳田健之，若原慎吾，鈴木彬，関真冬，黒澤俊介，吉川彰
“CaB2O4 及び LiAlO2 結晶中の格子欠陥に起因する放射線励起発光”
第 23 回光物性研究会 2012/12/7-8 大阪市立大学

29. J. Pejchal, K. Fukuda, V. Babin, S. Kurosawa, Y. Yokota, M. Nikl, A. Yoshikawa “Luminescence properties of VUV single crystal scintillator based on high temperature modi cation of BaLu2F8”
第 23 回光物性研究会 2012/12/7-8 大阪市立大学

30. 関真冬，Vladimir V. Kochurikhin，黒澤俊介，鈴木彬，山路晃弘，藤本裕，若原慎吾，Jan Pejchal，横田有為，吉川彰
“Dy 添加 Y3Al5O12 結晶の発光特性”
第 23 回光物性研究会 2012/12/7-8 大阪市立大学

List of Publications

A.Original Papers

[1] M. Cadatal-Raduban, T. Shimizu, K. Yamanoi, K. Takeda, M.H. Pham, T. Nakazato, N. Sarukura, N. Kawaguchi, K. Fukuda, T. Suyama, T. Yanagida, Y. Yokota, A. Yoshikawa,
"Micro-pulling down method-grown Er3+:LiCaAlF6 as prospective vacuum ultraviolet laser material"
Journal of Crystal Growth **362** (2013) 167.

[2] W. Drozdowski, K. Brylew, A. Chruscinska, K. Kamada, T. Yanagida, A. Yoshikawa,
"Scintillation yield enhancement in LuAG:Pr crystals following thermal annealing"
Optical Materials **34** (2012) 1975.

[3] Y. Fujimoto, K. Kamada, T. Yanagida, N. Kawaguchi, S. Kurosawa, D. Totsuka, K. Fukuda, K. Watanabe, A. Yamazaki, Y. Yokota, A. Yoshikawa,
"Lithium Aluminate Crystals as Scintillator for Thermal Neutron Detection"
Ieee Transactions on Nuclear Science **59** (2012) 2252.

[4] A. Fukabori, L.Q. An, A. Ito, V. Chani, K. Kamada, T. Goto, A. Yoshikawa,
"Scintillation Characteristics of Undoped Sc2O3 Single Crystals and Ceramics"
Ieee Transactions on Nuclear Science **59** (2012) 2594.

[5] A. Fukabori, L.Q. An, A. Ito, V. Chani, K. Kamada, A. Yoshikawa, T. Ikegami, T. Goto,
"Correlation between crystal grain sizes of transparent ceramics and scintillation light yields"
Ceramics International **38** (2012) 2119.

[6] A. Fukabori, V. Chani, K. Kamada, A. Yoshikawa,
"Growth of Yb-doped Y2O3, Sc2O3, and Lu2O3 single crystals by the micro-pulling-down technique and their optical and scintillation characterization"
Journal of Crystal Growth **352** (2012) 124.

[7] Y. Futami, T. Yanagida, Y. Fujimoto, V. Jary, J. Pejchal, Y. Yokota, M. Kikuchi, M. Nikl, A. Yoshikawa,
"Photoluminescence and scintillation of LGS (La3Ga5SiO14), LNGA (La3Nb0.5Ga5.3Al0.2O14) and LTGA (La3Ta0.5Ga5.3Al0.2O14) single crystals"
Optical Materials **34** (2012) 1513.

[8] Y. Futami, Y. Yokota, M. Sato, T. Yanagida, N. Kawaguchi, Y. Fujimoto, K. Tota, K. Onodera, A. Yoshikawa,
"Optical and scintillation properties of Ca3NbGa3Si2O14 single crystal grown by micro-pulling down method"
Journal of Crystal Growth **352** (2012) 129.

[9] M. Ieda, T. Ishimaru, S. Ono, N. Kawaguchi, K. Fukuda, T. Suyama, Y. Yokota, T. Yanagida, A. Yoshikawa,
"Filterless Ultraviolet Detector Based on Cerium Fluoride Thin Film Grown by Pulsed Laser Deposition"
Japanese Journal of Applied Physics **51** (2012).

[10] K. Kamada, T. Yanagida, T. Endo, K. Tsutumi, Y. Usuki, M. Nikl, Y. Fujimoto, A. Fukabori, A. Yoshikawa,
"2 inch diameter single crystal growth and scintillation properties of Ce:Gd3Al2Ga3O12"
Journal of Crystal Growth **352** (2012) 88.

[11] K. Kamada, T. Yanagida, T. Endo, K. Tsutumi, M. Yoshino, J. Kataoka, Y. Usuki, Y. Fujimoto, A. Fukabori, A. Yoshikawa,
"Large size single crystal growth of Lu3Al5O12:Pr and their uniformity of scintillation properties"
Journal of Crystal Growth **352** (2012) 91.

[12] K. Kamada, T. Yanagida, J. Pejchal, M. Nikl, T. Endo, K. Tsutsumi, Y. Fujimoto, A. Fukabori, A. Yoshikawa,
"Crystal Growth and Scintillation Properties of Ce Doped Gd-3(Ga,Al)(5)O-12 Single Crystals"
Ieee Transactions on Nuclear Science **59** (2012) 2112.

[13] K. Kamada, T. Yanagida, J. Pejchal, M. Nikl, T. Endo, K. Tsutsumi, Y. Fujimoto, A. Fukabori, A. Yoshikawa,
"Growth and Scintillation Properties of Pr Doped (Gd, Y)(3)(Ga, Al)(5)O-12 Single Crystals"
Ieee Transactions on Nuclear Science **59** (2012) 2126.

[14] K. Kamada, T. Yanagida, J. Pejchal, M. Nikl, T. Endo, K. Tsutsumi, Y. Usuki, Y. Fujimoto, A. Fukabori, A. Yoshikawa,
"Scintillation properties of Ce doped Gd2Lu1(Ga,Al)(5)O-12 single crystal grown by the micro-pulling-down method"
Journal of Crystal Growth **352** (2012) 35.

[15] K. Kamada, T. Yanagida, J. Pejchal, M. Nikl, T. Endo, K. Tsutumi, Y. Fujimoto, A. Fukabori, A. Yoshikawa,
"Crystal Growth of Ce Doped (Lu, Y)(3)(Ga, Al)(5)O-12 Single Crystal by the Micro-Puling-Down Method and Their Scintillation Properties"
Ieee Transactions on Nuclear Science **59** (2012) 2116.

[16] K. Kamada, T. Yanagida, J. Pejchal, M. Nikl, T. Endo, K. Tsutumi, Y. Fujimoto, A. Fukabori, A. Yoshikawa,
"Improvement of Scintillation Properties in Pr Doped Lu3Al5O12 Scintillator by Ga and Y Substitutions"
Ieee Transactions on Nuclear Science **59** (2012) 2130.

[17] K. Kamada, T. Yanagida, J. Pejchal, M. Nikl, T. Endo, K. Tsutumi, Y. Usuki, Y. Fujimoto, A. Fukabori, A. Yoshikawa,
"Growth and scintillation properties of Pr doped Gd-3(Ga,Al)(5)O-12 single crystals"
Journal of Crystal Growth **352** (2012) 84.

[18] N. Kawaguchi, T. Yanagida, Y. Fujimoto, Y. Futami, K. Fukuda, S. Kajimoto, H. Fukumura, Y. Yokota, A. Yoshikawa,
"VUV Luminescence With Nd Doped KCaF3 Under X-Ray Excitation"
Ieee Transactions on Nuclear Science **59** (2012) 2183.

[19] S. Kurosawa, M. Sugiyama, T. Yanagida, Y. Yokota, A. Yoshikawa,
"Temperature dependence of the scintillation properties of Ce:GSO and Ce:GSOZ"
Nuclear Instruments & Methods in Physics Research Section a-Accelerators Spectrometers *Detectors and Associated Equipment* **690** (2012) 53.

[20] S. Kurosawa, T. Yanagida, Y. Yokota, A. Yoshikawa,
"Crystal Growth and Scintillation Properties of Fluoride Scintillators"
Ieee Transactions on Nuclear Science **59** (2012) 2173.

[21] J. Martincik, S. Ishizu, K. Fukuda, T. Suyama, T. Cechak, A. Beitlerova, A. Yoshikawa, M. Nikl,
"Concentration dependence study of VUV-UV-visible luminescence of Nd3+ and Gd3+ in LuLiF4"
Optical Materials **34** (2012) 1029.

[22] J. Martincik, M. Nikl, S. Ishizu, A. Baratova, T. Cechak, K. Fukuda, T. Suyama, A. Beitlerova, A. Yoshikawa,
"Concentration Dependence of VUV-UV-Visible Luminescence of Nd3+ and Gd3+ in LuLiF4"
Ieee Transactions on Nuclear Science **59** (2012) 2188.

[23] T. Murata, Y. Arikawa, K. Watanabe, K. Yamanoi, M. Cadatal-Raduban, T. Nagai, M. Kouno, K. Sakai, T. Nakazato, T. Shimizu, N. Sarukura, M. Nakai, T. Norimatsu, H. Nishimura, H. Azechi, A. Yoshikawa, S. Fujino, H. Yoshida, N. Izumi, N. Sato, H. Kan,
"Fast-Response and Low-Afterglow Cerium-Doped Lithium 6 Fluoro-Oxide Glass Scintillator for Laser Fusion-Originated Down-Scattered Neutron Detection"
Ieee Transactions on Nuclear Science **59** (2012) 2256.

[24] Y. Ohashi, N. Yasui, Y. Yokota, A. Yoshikawa, and T. Den,
"Submicron-diameter phase-separated scintillator fibers for high-resolution X-ray imaging"
Applied Physics Letters **102** (2013) 051907.

[25] J. Pejchal, Y. Fujimoto, V. Chani, T. Yanagida, Y. Yokota, A. Yoshikawa, M. Nikl, A. Beitlerova,
"Modifications of micro-pulling-down method for the growth of selected Li-containing crystals for neutron scintillator and VUV scintillation crystals"
Journal of Crystal Growth **360** (2012) 127.

[26] J. Pejchal, K. Fukuda, M. Nikl, N. Kawaguchi, Y. Yokota, T. Yanagida, A. Yoshikawa,
"Luminescence and Scintillation Properties of VUV Scintillation Crystals Based on Lu-Admixed BaY2F8"
Ieee Transactions on Nuclear Science **59** (2012) 2177.

[27] R. Simura, S. Kawai, K. Sugiyama, T. Yanagida, T. Sugawara, T. Shishido, A. Yoshikawa,
"Valence state of dopant and scintillation properties of Ce-doped Sr3Y(BO3)(3) crystal"
Journal of Crystal Growth **362** (2013) 296.

[28] R. Simura, T. Yagi, K. Sugiyama, T. Yanagida, A. Yoshikawa,
"Growth of Ce-doped Ba3Gd(BO3)(3) and Sr3Gd(BO3)(3) single crystals by micro-pulling-down method and analysis of luminescence properties"
Journal of Crystal Growth **362** (2013) 145.

[29] M. Sugiyama, Y. Fujimoto, T. Yanagida, A. Yamaji, Y. Yokota, A. Yoshikawa,
"Growth and scintillation properties of Nd-doped Lu3Al5O12 single crystals by Czochralski and micro-pulling-down methods"
Journal of Crystal Growth **362** (2013) 178.

[30] M. Sugiyama, T. Yanagida, Y. Fujimoto, D. Totsuka, Y. Yokota, S. Kurosawa, Y. Futami, A. Yoshikawa,
"Crystal Growth and Scintillation Properties of Ho-Doped Lu3Al5O12 Single Crystals"
Ieee Transactions on Nuclear Science **59** (2012) 2141.

[31] M. Sugiyama, T. Yanagida, D. Totsuka, Y. Yokota, Y. Futami, Y. Fujimoto, A. Yoshikawa,
"Crystal growth and luminescence properties of Cr-doped YAlO3 single crystals"
Journal of Crystal Growth **362** (2013) 157.

[32] M. Sugiyama, Y. Yokota, Y. Fujimoto, T. Yanagida, Y. Futami, S. Kurosawa, A. Yoshikawa,
"Dopant segregation in rare earth doped lutetium aluminum garnet single crystals grown by the micro-pulling down method"
Journal of Crystal Growth **352** (2012) 110.

[33] A. Suzuki, S. Kurosawa, T. Shishido, J. Pejchal, Y. Yokota, Y. Futami, A. Yoshikawa,
"Fast and High-Energy-Resolution Oxide Scintillator: Ce-Doped (La,Gd)(2)Si2O7"
Applied Physics Express **5** (2012).

[34] D. Totsuka, T. Yanagida, Y. Fujimoto, J. Pejchal, Y. Yokota, A. Yoshikawa,
"Growth and scintillation properties of pure Csl crystals grown by micro-pulling-down method"
Optical Materials **34** (2012) 1087.

[35] D. Totsuka, T. Yanagida, Y. Fujimoto, Y. Yokota, F. Moretti, A. Vedda, A. Yoshikawa,
"Afterglow Suppression by Codoping with Bi in CsI:Tl Crystal Scintillator"
Applied Physics Express **5** (2012).

[36] D. Totsuka, T. Yanagida, M. Sugiyama, Y. Fujimoto, J. Pejchal, Y. Yokota, A. Yoshikawa,
"Investigations of Optical and Scintillation Properties of (Lu0.1Y0.9)AlO3: Nd0.1%"
Ieee Transactions on Nuclear Science **59** (2012) 2156.

[37] D. Totsuka, T. Yanagida, M. Sugiyama, Y. Fujimoto, Y. Yokota, A. Yoshikawa,
"Crystal growth and characterization of Tm doped mixed rare-earth aluminum perovskite"
Materials Research Bulletin **47** (2012) 993.

[38] K. Watanabe, Y. Arikawa, K. Yamanoi, M. Cadatal-Raduban, T. Nagai, M. Kouno, K. Sakai, T. Nazakato, T. Shimizu, N. Sarukura, M. Nakai, T. Norimatsu, H. Azechi, A. Yoshikawa, T. Murata, S. Fujino, H. Yoshida, N. Izumi, N. Satoh, H. Kan,
"Pr or Ce-doped, fast-response and low-afterglow cross-section-enhanced scintillator with Li-6 for down-scattered neutron originated from laser fusion"
Journal of Crystal Growth **362** (2013) 288.

[39] A. Yamaji, T. Yanagida, Y. Yokota, K. Kamada, A. Yoshikawa, J. Pejchal,
"Quantitive Research of the Crystallinity of Pr Doped Lu3Al5O12"
Ieee Transactions on Nuclear Science **59** (2012) 2135.

[40] A. Yamaji, Y. Yokota, T. Yanagida, N. Kawaguchi, Y. Futami, Y. Fujimoto, A. Yoshikawa,
"Crystal growth and dopant segregation of Ce:LiSrAlF6 and Eu:LiSrAlF6 crystals with high dopant concentrations"
Journal of Crystal Growth **352** (2012) 106.

[41] T. Yanagida, Y. Fujimoto, K. Kamada, D. Totsuka, H. Yagi, T. Yanagitani, Y. Futami, S. Yanagida, S. Kurosawa, Y. Yokota, A. Yoshikawa, M. Nikl,
"Scintillation Properties of Transparent Ceramic Pr:LuAG for Different Pr Concentration"
Ieee Transactions on Nuclear Science **59** (2012) 2146.

[42] Y. Yokota, M. Sato, Y. Futami, K. Tota, T. Yanagida, K. Onodera, A. Yoshikawa,
"Crystal growth and physical properties of shape-controlled La3Ta0.5Ga5.5O14 single crystals by micro-pulling-down method"
Journal of Crystal Growth **352** (2012) 147.

[43] Y. Yokota, A. Yamaji, T. Yanagida, N. Kawaguchi, K. Fukuda, A. Yoshikawa,
"The control of mean ionic radius at Y site by Lu co-doping for Ce:LiYF4 single crystals"
Journal of Crystal Growth **362** (2013) 243.

[44] Y. Yokota, T. Yanagida, N. Kawacuchi, K. Fukuda, A. Yoshikawa,
"Effects of ionic radius control at Y site by Sc doping on crystal growth and physical properties for Ce:LiYF4 single crystals"
Journal of Crystal Growth **352** (2012) 95.

[45] A. Yoshikawa, T. Yanagida, Y. Fujimoto, S. Kurosawa, Y. Yokota, A. Yamaji, M. Sugiyama, S. Wakahara, Y. Futami, M. Kikuchi, M. Miyamoto, H. Sekiwa, M. Nikl,
"LPE Growth and Scintillation Properties of (Zn,Mg)O Single Crystalline Film"
Ieee Transactions on Nuclear Science **59** (2012) 2286.

B. Proceedings Papers

[1] Y. Miyamoto, T. Ohono, Y. Takei, H. Nanto, T. Kurobori, T. Yanagida, A. Yoshikawa, Y. Nagashima and T. Yamamoto
"Ionizing Radiation Sensor Utilizing RPL in Ag-doped Phosphate Glass"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[2] T. Yanagida, Y. Fujimoto, A. Yamaji, N. Kawaguchi, K. Kamada, D. Totsuka, K. Yamanoi, N. Ryosukec, Y. Futami, S. Kurosawa, Y. Yokota, T. Shimizu, A. Yoshikawa, N. Sarkura
"Study of the correlation of scintillation decay and emission wavelength"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[3] Y. Fujimoto, T. Yanagida, S. Kurosawa, A. Yoshikawa
"Luminescence Properties and Radiation Response of Sodium Borate Glasses Scintillators"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[4] Y. Futami, T. Yanagida, Y. Fujimoto, J. Pejchal, S. Kurosawa, M. Sugiyama, Y. Yokota, A. Yoshikawa, A. Ito, T. Goto
"Optical and scintillation properties of Sc2O3, Y2O3 and Lu2O3 transparent ceramics synthesized by SPS method"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[5] S. Kurosawa, T. Yanagida, Y.Yokota, A. Yoshikawa
"Optical and Scintillation property of BaF2 doped with rear earth"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[6] S. Kurosawa, T. Yanagida, Y. Yokota, Akira Yoshikawa
"Optical and Scintillation property of PbF2 with some dopant"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[7] S. Kurosawa, T. Yanagida, J. Pejchal, K. Fukuda, N. Kawaguchi, S.Ishizu, T. Suyama, M. Nakagawa, Y.Yokota,M. NIkl, A. Yoshikawa
"Evaluation of Nd:BaY2F8 for VUV scintillator"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[8] A. Yamaji, T.i Yanagida, Y.Yokota, N.Kawaguchi, A.Yoshikawa
"Czochralski growth and scintillation properties of Tm doped K2NaLuF6"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[9] A.Yamaji, T.Yanagida, Y. Yokota, N. Kawaguchi, K. Watanabe, A. Yamazaki, A. Yoshikawa
"Eu and Rb co-doped LiCaAlF6 scintillators for neutron detection"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[10] N. Kawaguchi, T. Yanagida, Y. Fujimoto, A. Yamaji, A.Yamazaki, K. Watanabe, S.Kurosawa, Y. Futami, Y.Yokota,A. Yoshikawa
"Neutron detection with 3d-transition metal ions doped LiCaAlF6 scintillator"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[11] D. Totsuka, T. Yanagida, Y. Fujimoto, Y. Yokota and A. Yoshikawa
"Growth and scintillation properties of (Lu1-x Tmx)2SiO5 [x=0.001, 0.01, 0.1, 1]"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[12] D. Totsuka, T. Yanagida, M. Sugiyama, Y. Fujimoto, Y. Yokota and A. Yoshikawa
"Optical and Scintillation Properties of Nd doped YAlO3 with different concentrations"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[13] M. Sugiyama, Y. Fujimoto, T. Yanagida, D. Totsuka, c, Y. Yokota, and A. Yoshikawa
"Nd-doped Lu3Al5O12 single crystalline scintillator for X-ray imaging"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[14] M. Sugiyama, T. Yanagida, Y. Yokota, Y. Fujimoto, and A. Yoshikawa
"Crystal growth and luminescence properties of Pr-doped LuLiF4 single crystals"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

[15] S.Wakahara, T.Yanagida, Y.Fujimoto, M.Sugiyama, Y.Yokota, A.Ikesue, A.Yoshikawa
"Evaluation of the scintillation properties of Yb3+ ion doped Lu2O3 ceramics"
The 7th International Workshop on Individual Monitoring of Ionizing Radiation (2012)

Copies of Selected Papers

CERAMICS INTERNATIONAL Volume: 38 Issue: 3 Pages: 2119-2123 Published: APR 2012

Correlation between crystal grain sizes of transparent ceramics and scintillation light yields

Fukabori [1]; LQ. An [1]; A. Ito [1]; V. Chani [1]; K. Kamada [2]; A. Yoshikawa [1,3]; T. Ikegami [4]; T. Goto [1]

1. Tohoku Univ, IMR, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. Furukawa Co Ltd, Tsukuba, Ibaraki 3050856, Japan
3. Tohoku Univ, NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan
4. Natl Inst Mat Sci, Tsukuba, Ibaraki 3050047, Japan

Abstract:

Light yields of Y2O3 ceramics are different from specimen to specimen. Nature of this phenomenon is not clear yet. Furthermore, origin of emission peaks for Y2O3 is not well understood. The results reported suggest that the emission derived from trapped excitons originates from the defects accumulated in the grain boundaries of the ceramics. In this paper, average grain size is introduced in order to evaluate defects inside the ceramics. Relationship between average crystal grain size and scintillation light yield is demonstrated. (C) 2011 Elsevier Ltd and Techna Group S.r.l. All rights reserved

E-mail Address:

akihirofukabori@gmail.com

Site Address:

http://www.sciencedirect.com/science/article/pii/S0272884211009072

MATERIALS RESEARCH BULLETIN Volume: 47 Issue: 4 Pages: 993-997 Published: APR 2012

Crystal growth and characterization of Tm doped mixed rare-earth aluminum perovskite

D. Totsuka [1,2]; T. Yanagida [3]; M. Sugiyama [1]; Y. Fujimoto [1]; Y. Yokota [1]; A. Yoshikawa [1,3]

1. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. Nihon Kessho Kogaku Co Ltd, Gunma 3740047, Japan
3. New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan

Abstract:

In this work, we present results of structural characterization and optical properties including radio luminescence of (LuxGdyY0.99-x-yTm0.01)AP single crystal scintillators for (x, y) = (C.30, 0.19), (0, 0.19) and (0, 0) grown by the micro-pulling-down (mu-PD) method. The grown crystals were single phase materials with perovskite structure (Pbnm) as confirmed by XRD and had a good crystallinity. The distribution of the crystal constituents in growth direction was evaluated, and significant segregation of Lu and Gd was detected in (Lu0.30Gd0.19Y0.50Tm0.01)AP sample. The crystals demonstrated 70% transmittance in visible wavelength range and some absorption bands due to Tm3+, Gd3+ and color centers were exhibited in 190-900 nm. The radioluminescence measurement under X-ray irradiation demonstrated several emission peaks ascribed to 4f-4f transitions of Tm3+ and Gd3+. The ratio of emission intensity in longer wavelength range was increased when Y was replaced by Lu or Gd. (C) 2012 Elsevier Ltd. All rights reserved.

E-mail Address:

totsuka@imr.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0025540812000189

OPTICAL MATERIALS Volume: 34 Issue: 7 Pages: 1087-1091 Published: MAY 2012

Growth and scintillation properties of pure Csl crystals grown by micro-pulling-down method

D. Totsuka [1,2]; T. Yanagida [4]; Y. Fujimoto [1]; J. Pejchal [3]; Y. Yokota [1]; A. Yoshikawa [1,4]

1. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. Nihon Kessho Kogaku Co Ltd, Gunma 3740047, Japan
3. Acad Sci Czech Republic, Inst Phys, Prague 16253 6, Czech Republic
4. New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan

Abstract:

Single crystals of pure cesium iodide (Csl) have been grown from the melt using micro-pulling-down (mu-PD) method. Two kinds of crucible (graphite one and quartz one) were used for the growth and the grown crystals were investigated by X-ray diffraction (XRD) and X-ray rocking curve (XRC) analysis. The XRD analysis did not confirm any impurity phases and a sub-grain structure was observed for each sample in the rocking curve measurement. Under X-ray irradiation, strong STE emission peaks around 300 nm were observed together with some luminescence related to unintentionally present impurities. The STE emission peaks are characterized by fast decay times of several ns and about 20 ns which are interpreted as the on-center-type STE (V-K + e) and off-center type STE (H + F) recombinations, respectively. The light yield of the STE-related emissions has been estimated to be 3000 ph/MeV. Other emission peaks were observed at 410 nm and 515 nm. The former one can be related to Br-contamination and it is characterized by a relatively slow decay time of 6 mu s. Concerning the latter one at 515 nm, similar luminescence was observed for the water-doped Csl grown by Bridgman method.

E-mail Address:

totsuka@imr.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0925346712000092

OPTICAL MATERIALS Volume: 34 Issue: 7 Pages: 1029-1033 Published: MAY 2012

Concentration dependence study of VUV-UV-visible luminescence of Nd^{3+} and Gd^{3+} in $LuLiF_4$

J. Martincik [1]; S. Ishizu [4]; K. Fukuda [3]; T. Suyama [3]; T. Cechak [2]; A. Beitlerova [1]; A. Yoshikawa [4]; M. Nikl [1]

1. Acad Sci Czech Republic, Inst Phys, Prague, Czech Republic
2. Czech Tech Univ, Fac Nucl Sci & Phys Engn, CR-11519 Prague, Czech Republic
3. Tokuyama Co Ltd, Sendai, Miyagi, Japan
4. Tohoku Univ, IMRAM, Sendai, Miyagi 980, Japan

Abstract:

An overview of absorption and luminescence characteristics of Nd3+ and Gd3+ centers in a LiLuF4 single crystal host is provided. Single crystals doped with the above rare earth ions were prepared by micropulling-down technique in the form of rods a few cm long with a diameter of about 2 mm. Excitation and emission spectra and fast decay kinetics in VUV and UV spectral regions were measured at room temperature. The observed absorption and emission peaks are due to the 5d-4f and 4f-4f optical transitions of Nd3+ and Gd3+ centers. Concentration dependence of the decay kinetics is also discussed.

E-mail Address:

jiri.martincik@fjfi.cvut.cz

Site Address:

http://www.sciencedirect.com/science/article/pii/S0925346711005714

APPLIED PHYSICS EXPRESS Volume: 5 Issue: 5 Article Number: 052601 Published: MAY 2012

Afterglow Suppression by Codoping with Bi in CsI:Tl Crystal Scintillator

D. Totsuka [1,3]; T. Yanagida [2]; Y. Fujimoto [3]; Y. Yokota [3]; F. Moretti [4]; A. Vedda [4]; A. Yoshikawa [2,3]

1. Nihon Kessho Kogaku Co Ltd, Gunma, Japan
2. New Ind Creat Hatchery Ctr NICHe, Sendai, Miyagi 9808579, Japan
3. Tohoku Univ, Inst Mat Res, Sendai, Miyagi 9808577, Japan
4. Univ Milano Bicocca, Dept Mat Sci, I-20125 Milan, Italy

Abstract:

Single crystals of CsI, CsI:Tl, and CsI:Tl, Bi were grown by the vertical Bridgman method. We studied the effect of Bi3+ codoping on the CsI:Tl X-ray-induced afterglow. Thermally stimulated luminescence measurements were carried out in order to investigate the role of traps. The results showed a remarkable reduction of afterglow, of about an order of magnitude, and of trap concentration by Bi codoping. These improvements could be related to a possible role of Bi in the compensation of intrinsic nonstoichiometry defects. (c) 2012 The Japan Society of Applied Physics

E-mail Address:

totsuka@imr.tohoku.ac.jp

Site Address:

http://apex.jsap.jp/link?APEX/5/052601/

JAPANESE JOURNAL OF APPLIED PHYSICS Volume: 51 Issue: 6 Article Number: 062202 Part: Part 1 Published: JUN 2012

Filterless Ultraviolet Detector Based on Cerium Fluoride Thin Film Grown by Pulsed Laser Deposition

M. Ieda [1]; T. Ishimaru [1]; S. Ono [1]; N. Kawaguchi [2,3]; K. Fukuda [2,3]; T. Suyama [2]; Y. Yokota [3]; T. Yanagida [4]; A. Yoshikawa [3]

1. Nagoya Inst Technol, Nagoya, Aichi 4668555, Japan
2. Tokuyama Corp, Chiyoda Ku, Tokyo 1008983, Japan
3. Tohoku Univ, Inst Mat Res, Sendai, Miyagi 9808577, Japan
4. Tohoku Univ, New Ind Creat Hatchery Ctr, Sendai, Miyagi 9808579, Japan

Abstract:

We report on an ultraviolet photoconductive detector based on cerium fluoride (CeF3) thin films. CeF3 thin films were grown on quartz glass substrates by the pulsed laser deposition (PLD) method. Optimization of the substrate temperature using the PLD method successfully increased the photocurrent of the CeF3 detector. The photocurrent increases linearly up to at least 600 V. The sample grown at 670 K shows the highest crystallinity and orientation. This sample shows a response in the wavelength range below 310 nm without any filters. Additionally, the measured dielectric-breakdown field of this detector exceeded 15 kV/cm. (c) 2012 The Japan Society of Applied Physics

E-mail Address:

cja16502@stn.nitech.ac.jp

Site Address:

http://jjap.jsap.jp/link?JJAP/51/062202/

OPTICAL MATERIALS Volume: 34 Issue: 9 Pages: 1513-1516 Published: JUL 2012

Photoluminescence and scintillation of LGS ($La_3Ga_5SiO_{14}$), LNGA ($La_3Nb_{0.5}Ga_{5.3}Al_{0.2}O_{14}$) and LTGA ($La_3Ta_{0.5}Ga_{5.3}Al_{0.2}O_{14}$) single crystals

Y. Futami [1]; T. Yanagida [2]; Y. Fujimoto [1]; V. Jary [3]; J. Pejchal [1,3]; Y. Yokota [1]; M. Kikuchi [1]; M. Nikl [3]; A. Yoshikawa [1,2]

1. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan
3. AS CR, Inst Phys, Prague 16253, Czech Republic

Abstract:

To examine scintillation response of piezoelectric crystals the Am-241 5.5 MeV alpha-ray excited emission spectra of langasite family crystals, LGS (La3Ga5SiO14), LNGA (La3Nb0.5Ga5.3Al0.2O14) and LTGA (La3Ta0.5Ga5.3Al0.2O14) were measured. Dominating emission bands were observed at 378 nm for LGS, 556 nm for LNGA and 425 nm for LTGA. X-ray excited radioluminescence intensity of these crystals was quantitatively compared with BGO standard scintillator. Photoluminescence 2D-spectra were measured as well and compared with radioluminescence ones. In LTGA also photoluminescence decays were measured for two dominant contributing emission centers. Observed emission bands within 300-360 nm and beyond 400 nm most probably belong to self-trapped or trapped excitons and lattice defects, respectively.

E-mail Address:

yoshisuke.futami@imr.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0925346712001322

JOURNAL OF CRYSTAL GROWTH Volume: 352 Issue: 1 Pages: 147-150 Published: AUG 1 2012

Crystal growth and physical properties of shape-controlled $La_3Ta_{0.5}Ga_{5.5}O_{14}$ single crystals by micro-pulling-down method

Y. Yokota [1]; M. Sato [1,2]; Y. Futami [3]; K. Tota [2]; T. Yanagida [3]; K. Onodera [2]; A. Yoshikawa [1,3]

1. Tohoku Univ, Inst Mat Res, Sendai, Miyagi 980, Japan
2. TDK Corp, Tokyo, Japan
3. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Sendai, Miyagi 980, Japan

Abstract:

Columnar-shaped La3Ta0.5Ga5.5O14 single crystals with a-axis and c-axis crystal orientations along the growth direction grown by the micro-pulling-down method and their physical properties were investigated. All diffraction peaks of the XRD pattern were identified as the langasite-type structure and the a-axis and c-axis lengths were a=8.239 angstrom and c = 5.124 angstrom, respectively. In the XRC measurement, a relatively sharp single peak was observed in the omega scan and the full width of half maximum was 82.1 arcsec. According to the chemical analysis by the EPMA system, the main phase was composed of LTG with the cation ratio of La:Ta:Ga = 3.31:0.465:5.22 and the LTG crystal included secondary phase, La-Ta-O system, in the periphery area. The piezoelectric constant d(11) that was measured using the plate-shape LTG crystal was 6.7 pC/N.

E-mail Address:

yokota@imr.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024812000474

JOURNAL OF CRYSTAL GROWTH Volume: 352 Issue: 1 Pages: 129-132 Published: AUG 1 2012

Optical and scintillation properties of $Ca_3NbGa_3Si_2O_{14}$ single crystal grown by micro-pulling down method

Y. Futami [1]; Y. Yokota [1]; M. Sato [2]; T. Yanagida [3]; N. Kawaguchi [1]; Y. Fujimoto [1]; K. Tota [2]; K. Onodera [2]; A. Yoshikawa [1,3]

1. Tohoku Univ, IMR, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. TDK Corp, Kisakata, Nikaho 0180193, Japan
3. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan

Abstract:

The Ca3NbGa3Si2O14 (CNGS) crystal was grown by the micro-pulling down (mu PD) method and the annealing effect on physical properties of CNGS crystal was investigated in this study. And the effects of oxygen content on the physical properties were systematically studied. Additionally, Photoluminescence (PL)-Mapping and radioluminescence spectra of CNGS were observed. The absorption peaks were observed around 350 and 500 nm. This absorption at 500 nm was very sensitive to a quantity of excess oxygen in the CNGS crystal. In contrast, it is expected that the absorption of 350 nm is related to a cation or anion defect. PL-Mapping indicated the emission around 400 nm by excitation at 270 and 350 nm wavelengths. The emission at 400 nm is considered to originate from trapped electron at an anion or cation defect. The emission of the Alpha-ray excited spectra was very similar in comparison with PL-Mapping.

E-mail Address:

f23@live.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024812000784

JOURNAL OF CRYSTAL GROWTH Volume: 352 Issue: 1 Pages: 124-128 Published: AUG 1 2012

Growth of Yb-doped Y_2O_3, Sc_2O_3, and Lu_2O_3 single crystals by the micro-pulling-down technique and their optical and scintillation characterization

A. Fukabori [1]; V. Chani [1]; K. Kamada [2]; A. Yoshikawa [1,3]

1. Tohoku Univ, IMR, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. Furukawa Co Ltd, Tsukuba, Ibaraki 3050856, Japan
3. Tohoku Univ, NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan

Abstract:

In this report, growth of Yb-doped sesqui-oxide crystals of Y2O3, Sc2O3, and Lu2O3 by the micro-pulling-down technique and their scintillation performance are discussed. Growth of these crystals is difficult mostly as a result of their extremely high melting point of around 2400 degrees C. Nevertheless, appropriate design of the thermal zone and careful control of the growth parameters allowed fabrication of these crystals of reasonable quality. Based on the results of measurements of emission spectra under alpha-ray excitation and pulse height spectra under alpha-ray and gamma-ray excitations, scintillation characteristics of above crystals including emission wavelength and light yields under alpha-ray and gamma-ray excitations were examined. Additionally, decay kinetics of these materials under alpha-ray excitation were evaluated.

E-mail Address:

akihirofukabori@gmail.com

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024812000760

JOURNAL OF CRYSTAL GROWTH Volume: 352 Issue: 1 Pages: 110-114 Published: AUG 1 2012

Dopant segregation in rare earth doped lutetium aluminum garnet single crystals grown by the micro-pulling down method

M. Sugiyama [1]; Y. Yokota [1]; Y. Fujimoto [1]; T. Yanagida [2]; Y. Futami [1]; S. Kurosawa [1]; A. Yoshikawa [1,2]

1. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan

Abstract:

Nd, Ho, Er, and Tm doped lutetium aluminum garnet (LuAG) single crystals were grown using the micro-pulling down (mu-PD) method. The crystals were produced from the melts containing 3 mol% of the dopants. The axial and radial dopant distribution were measured by electron probe micro analysis. Nd3+ and Ho3+ ions concentrated in the rim (k(0) < 1) and the radial concentration showed concave curvature. k(0) is the segregation coefficient of the dopant with respect to the given host phase. In the case of Er3+ and Tm3+ ions, the k(0) value is considered to be nearly 1 and the radial dopant distribution profiles were almost flat. (c) 2011 Elsevier B.V. All rights reserved.

E-mail Address:

yosikawa@tagen.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S002202481101058X

JOURNAL OF CRYSTAL GROWTH Volume: 352 Issue: 1 Pages: 106-109 Published: AUG 1 2012

Crystal growth and dopant segregation of Ce:LiSrAlF$_6$ and Eu:LiSrAlF$_6$ crystals with high dopant concentrations

A. Yamaji [1]; Y. Yokota [1]; T. Yanagida [2]; N. Kawaguchi [3]; Y. Futami [2]; Y, Fujimoto [1,2,3]; A. Yoshikawa [1,2]

1. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, New Ind Creat Hatchery Ctr, Aoba Ku, Sendai, Miyagi 9808579, Japan
3. Tokuyama Corp, Shibuya Ku, Tokyo 1508383, Japan

Abstract:

Ce:LiSrAlF6 and Eu:LiSrAlF6 crystals with different dopant concentrations were grown by the micro-pulling-down method. The crystals with high dopant crystal included the secondary phase as clusters with the plate shape in BSE images. The secondary phases were identified CeF3 and EuF2, respectively, by the EDS analysis and powder-XRD measurement. Eu concentration against the Sr sites in the Eu 2% doped LiSAF crystal were most uniform in the range 0.9-1.6 atm% using the EPMA. (C) 2012 Elsevier B.V. All rights reserved.

E-mail Address:

yosikawa@tagen.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024812001169

JOURNAL OF CRYSTAL GROWTH Volume: 352 Issue: 1 Pages: 95-98 Published: AUG 1 2012

Effects of ionic radius control at Y site by Sc doping on crystal growth and physical properties for Ce:$LiYF_4$ single crystals

Y. Yokota [1]; T. Yanagida [2]; N. Kawacuchi [1,3]; K. Fukuda [1,3]; A. Yoshikawa [1,2]

1. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan
3. Tokuyama Corp, Yamaguchi 7458648, Japan

Abstract:

We have grown the Sc and Ce doped LiYF4 [Sc,Ce:LYF] single crystals with various Sc and Ce concentrations and investigated the effects of ionic radius control at Y site by Sc doping on crystal growth and physical properties. All grown Sc,Ce:LYF crystals included the milky and transparent parts and the amount of the milky parts in the crystals was smaller than that of the Ce:LYF crystal. The milky parts were composed of the LYF main phase and YF3 inclusion and in contrast, the transparent parts were a single phase of LYF. The lattice parameters were almost constant for all Sc,Ce:LYF crystals. Full width at half maximum of the XRC for Sc5%Ce5%:LYF crystal was 86.8 arcsec and the effective segregation coefficients of Ce3+ ion in the Sc3%Ce3% and 5c5%Ce5%:LYF crystals were 0.21 and 0.18, respectively. In the transmittance and photoluminescence spectra, no clear effects of Sc co-doping were observed. (C) 2012 Elsevier B.V. All rights reserved.

E-mail Address:

yokota@imr.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024812001182

JOURNAL OF CRYSTAL GROWTH Volume: 352 Issue: 1 Pages: 91-94 Published: AUG 1 2012

Large size single crystal growth of $Lu_3Al_5O_{12}$:Pr and their uniformity of scintillation properties

K. Kamada [1]; T. Yanagida [2]; T. Endo [1]; K. Tsutumi [1]; M. Yoshino [4]; J. Kataoka [4]; Y. Usuki [1]; Y. Fujimoto [2]; A. Fukabori [2]; A. Yoshikawa [2,3]

1. Furukawa Co Ltd, Mat Res Lab, Tsukuba, Ibaraki 3050856, Japan
2. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
3. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan
4. Waseda Univ, Sch Adv Sci & Engn, Shinjuku Ku, Tokyo 1698555, Japan

Abstract:

Pr-doped Lu3Al5O12 (Pr:LuAG) single crystals were grown by the Czochralski method. The crystal was seeded-grown in the [100] direction. Dimensions up to 100 mm in length and 92 mm in diameter were achieved without cracking. Using 10 x 10 x 10 mm size sample coupled with photomultiplier (Hamamatsu R3998), energy resolution of 4.6% at 662 keV was achieved. Uniformity of light yield and energy resolution was also evaluated in whole crystal. The deviations of light output, energy resolution, and decay time were +/- 7.9%, 7.2%, and 4.8%, respectively. (C) 2011 Elsevier B.V. All rights reserved.

E-mail Address:

k-kamada@furukawakk.co.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024811010025

JOURNAL OF CRYSTAL GROWTH Volume: 352 Issue: 1 Pages: 88-90 Published: AUG 1 2012

2 inch diameter single crystal growth and scintillation properties of $Ce:Gd_3Al_2Ga_3O_{12}$

K. Kamada [1]; T. Yanagida [2]; T. Endo [1]; K. Tsutumi [1]; Y. Usuki [1]; M. Nikl [4]; Y. Fujimoto [2]; A. Fukabori [2]; A. Yoshikawa [2,3]

1. Furukawa Co Ltd, Mat Res Lab, Tsukuba, Ibaraki 3050856, Japan
2. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
3. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan
4. AS CR, Inst Phys, Prague 16253, Czech Republic

Abstract:

2inch size Ce:Gd3Al2Ga3O12 (Ce:GAGG) single crystals were grown by the Czochralski (Cz) method using [100] oriented seed. The crystals were up to 120 mm in length and 50 mm in diameter were achieved and had no cracks. Luminescence and scintillation properties were measured. In order to determine light yield, the energy spectra were collected under 662 keV gamma-ray excitation (Cs-137 source) were detected by a with avalanche photodiode (APD) S8664-55(Hamamatsu).The light yield of CeGAGG sample was calibrated from Fe-55 direct irradiation peak to APD. The light yield was around 46,000 photon/MeV. Energy resolution was 4.9%@662 keV for 5 x 5 x 1 mm sample. The theoretical density of CeGAGG is 6.63 g/cm(3).

E-mail Address:

k-kamada@furukawakk.co.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024811010153

JOURNAL OF CRYSTAL GROWTH Volume: 352 Issue: 1 Pages: 84-87 Published: AUG 1 2012

Growth and scintillation properties of Pr doped $Gd_3(Ga,Al)_5O_{12}$ single crystals

K. Kamada [1]; T. Yanagida [2]; J. Pejchal [3]; M. Nikl [3]; T. Endo [1]; K. Tsutumi [1]; Y. Usuki [1]; Y. Fujimoto [2]; A. Fukabori [2]; A. Yoshikawa [2,4]

1. Furukawa Co Ltd, Mat Res Lab, Tsukuba, Ibaraki 3050856, Japan
2. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
3. AS CR, Inst Phys, Prague 16253, Czech Republic
4. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan

Abstract:

Pr:Gd-3(Ga,Al)(5)O-12 single crystals were grown by the micro-pulling down (mu-PD) method. All grown crystals were greenish and transparent with 3.0 mm in diameter, 15-30 mm in length. Neither visible inclusions nor cracks were observed. Luminescence and scintillation properties were measured. The substitution at the Al3+ sites by Ga3+ in garnet structure has been studied. In these crystals, Pr3+ 5d-4f emission is observed with 340 nm wavelength. Pr1%:Gd3Ga3Al2O12 shows highest emission intensity. The light yield of Pr:Gd3Ga3Al2O12 sample with 3 mm phi x 1 mm size was around 4500 photon/MeV. Scintillation decay time was 7.9 ns (0.5%), 46 ns (0.7%) and 214 ns (98.8%).

E-mail Address:

k-kamada@furukawakk.co.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024812001170

JOURNAL OF CRYSTAL GROWTH Volume: 352 Issue: 1 Pages: 35-38 Published: AUG 1 2012

Scintillation properties of Ce doped $Gd_2Lu_1(Ga,Al)_5O_{12}$ single crystal grown by the micro-pulling-down method

K. Kamada [1,4]; T. Yanagida [2]; J. Pejchal [3]; M. Nikl [3]; T. Endo [1]; K. Tsutsumi [1]; Y. Usuki [1]; Y. Fujimoto [2]; A. Fukabori [2]; A. Yoshikawa [2,4]

1. Furukawa Co Ltd, Mat Res Lab, Tsukuba, Ibaraki 3050856, Japan
2. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
3. AS CR, Inst Phys, Prague 16253, Czech Republic
4. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan

Abstract:

Ce:Gd2Lu1(Ga,Al)(5)O-12 single crystals were grown by the micro-pulling down (mu-PD) method. All grown crystals were yellow and transparent with 3.0 mm in diameter, 15-30 mm in length. Neither visible inclusions nor cracks were observed. Luminescence and scintillation properties were measured. The substitution at the Al3+ sites by Ga3+ and at the Lu3+ sites by Gd3+ in garnet structure has been studied. In these crystals, Ce3+ 4f-5d emission is observed with 500-530 nm wavelength. The decay accelerates with increasing Ga and Ce concentration. Ce1%: Gd2Lu1Ga3Al2O12 shows the highest emission intensity. The light yield of Ce:Gd2Lu1Ga3Al2O12 sample with 3 mm phi x 1 mm size was around 22,000 photon/MeV using calibration from Fe-55 direct irradiation peak to APD. Scintillation decay time was around 50 ns. The theoretical density is 6.88 g/cm(3).

E-mail Address:

k-kamada@furukawakk.co.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024811009808

OPTICAL MATERIALS Volume: 34 Issue: 12 Special Issue: SI Pages: 1975-1978 Published: OCT 2012

Scintillation yield enhancement in LuAG:Pr crystals following thermal annealing

W. Drozdowski [1]; K. Brylew [1]; A. Chruscinska [1]; K. Kamada [2,3]; T. Yanagida [3]; A. Yoshikawa [3]

1. Nicholas Copernicus Univ, Inst Phys, Div Optoelect, PL-87100 Torun, Poland
2. Furukawa Co Ltd, Mat Res Lab, Tsukuba, Ibaraki 3050856, Japan
3. Tokohu Univ, Inst Multidisciplinary Res Adv Mat, Aoba Ku, Sendai, Miyagi 9808577, Japan

Abstract:

Effects of thermal annealing in various atmospheres of Czochralski-grown Lu3Al5O12:Pr (LuAG:Pr) crystals on their scintillation yield and energy resolution are discussed. It is shown that annealing in argon, air, or oxygen at 1373 K for 48 h is a simple way of achieving a ten-odd percent increase of yield together with an improvement of energy resolution. High temperature thermoluminescence measurements indicate significant reductions of trap concentrations in the annealed crystals compared to the "as grown" ones, which correlates well with the observed yield increase. A simple model is proposed to predict further available yield enhancement in LuAG:Pr upon thermal annealing.

E-mail Address:

wind@fizyka.umk.pl

Site Address:

http://www.sciencedirect.com/science/article/pii/S0925346711005404

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2594-2600 Part: Part 3 Published: OCT 2012

Scintillation Characteristics of Undoped Sc_2O_3 Single Crystals and Ceramics

A. Fukabori [1]; LQ. An [1]; A. Ito [1]; V. Chani [1]; K. Kamada [1,2]; T. Goto [1]; A. Yoshikawa [1]

1. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. Furukawa Co Ltd, Tsukuba, Ibaraki 3050856, Japan

Abstract:

Detailed scintillation properties of Sc2O3, especially gamma-ray response, are not well studied because of low density and low effective atomic number of this compound. They are reported in this paper. Sc2O3 single crystals grown by the micro-pulling-down method and Sc2O3 translucent ceramics produced by the spark plasma sintering are analyzed. Optical, luminescence, and scintillation properties of these single- and poly-crystalline solids are discussed and compared based on examination of their optical transmittance, radio-luminescence spectra, light yields under gamma-ray excitation, non-proportionality, energy resolution, and scintillation decay profiles. Spectrally corrected light yields of the Sc2O3 single crystals and Sc2O3 ceramics were approximately 7,700 and 19,200 photons/MeV, respectively.

E-mail Address:

akihirofukabori@gmail.com

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6265348

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2286-2289 Part: Part 2 Published: OCT 2012

LPE Growth and Scintillation Properties of (Zn,Mg)O Single Crystalline Film

A. Yoshikawa [1,2]; T. Yanagida [2]; Y. Fujimoto [1]; S. Kurosawa [1]; Y. Yokota [1]; A. Yamaji [1]; M. Sugiyama [1]; S. Wakahara [1]; Y. Futami [1]; M. Kikuchi 1; M. Miyamoto 3; H. Sekiwa 3; M. Nikl 4

1. Tohoku Univ, Inst Mat Res, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan
3. Mitsubishi Gas Chem MGC Co Inc, Katsushika Ku, Tokyo 1250051, Japan
4. Inst Phys AS CR, Vvi, Prague 16253, Czech Republic

Abstract:

Among the direct wide band-gap semiconductors, ZnO is an attractive scintillator for alpha particle monitoring. However, the undoped ZnO has a dominant slow luminescence around 500-600 nm due to lattice defects. In this study, the Mg-substituted ZnO ((Zn,Mg)O) single crystalline films with high crystallinity are investigated. Mg doping is found to improve the lattice order and suppress slow luminescent component around 500-600 nm. (Zn,Mg) O single crystalline films were grown by the Liquid Phase Epitaxy (LPE) method. Alpha-ray excited radio-luminescence spectra of (Zn,Mg) O film show only one emission peak around 400 nm and decay time of a few nanoseconds. This emission is assigned to free exciton. Light yield of LPE grown (Zn,Mg) O film is evaluated of about 90% of BGO.

E-mail Address:

yoshikawa@imr.tohoku.ac.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6217290

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2256-2259 Part: Part 2 Published: OCT 2012

Fast-Response and Low-Afterglow Cerium-Doped Lithium 6 Fluoro-Oxide Glass Scintillator for Laser Fusion-Originated Down-Scattered Neutron Detection

T. Murata [1,2,3]; Y. Arikawa [3]; K. Watanabe [3]; K. Yamanoi [3]; M. Cadatal-Raduban [3]; T. Nagai [3]; M. Kouno [3]; K. Sakai [3]; T. Nakazato [3]; T. Shimizu [3]; N. Sarukura [3]; M. Nakai [3]; T. Norimatsu [3]; H. Nishimura [3]; H. Azechi [3]; A. Yoshikawa [4]; S. Fujino [5]; H. Yoshida [6]; N. Izumi [7]; N. Sato [8]; H. Kan [8]

1. Kumamoto Univ, Fac Educ, Kumamoto 8608555, Japan
2. Kumamoto Univ, Masters Course Educ, Kumamoto 8608555, Japan
3. Osaka Univ, Inst Laser Engn, Suita, Osaka 5650871, Japan
4. Tohoku Univ, Inst Mat Res, Sendai, Miyagi 9808577, Japan
5. Kyushu Univ, Art Sci & Technol Ctr Cooperat Res, Kasuga, Fukuoka 8168580, Japan
6. Ceram Res Ctr Nagasaki, Hasami 8593726, Japan
7. Lawerence Livermore Natl Lab, Livermore, CA 94550 USA
8. Hamamatsu Photon KK, Dev Bur, Hamamatsu, Shizuoka 4311202, Japan

Abstract:

Scintillation properties of Ce3+-doped 20Al(PO3)(3)-80LiF glasses were investigated in order to seek a candidate for down-scattered neutron scintillator in nuclear fusion diagnostics. The decay constant of APLF80+3Ce with 5.5 MeV alpha particles from Am-241 radioisotope excitation was measured to be 32.1 ns. Moreover, sufficiently low afterglow decay profile and improved light output of APLF80+3Ce were experimentally demonstrated.

E-mail Address:

mu-rata@educ.kumamoto-u.ac.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6307903

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2252-2255 Part: Part 2 Published: OCT 2012

Lithium Aluminate Crystals as Scintillator for Thermal Neutron Detection

Y. Fujimoto [1]; K. Kamada [1]; T. Yanagida [2,1]; N. Kawaguchi [3]; S. Kurosawa [1]; D. Totsuka [4]; K. Fukuda [3]; K. Watanabe [5]; A. Yamazaki [5]; Y. Yokota [1]; A. Yoshikawa [2,1]

1. Tohoku Univ, IMRAM, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, NICHe, Sendai, Miyagi 9808579, Japan
3. Tokuyama Corp, Tokyo 1508383, Japan
4. Nihon Kessho Kogaku Co Ltd, Gunma 3740047, Japan
5. Nagoya Univ, Nagoya, Aichi 4648603, Japan

Abstract:

Undoped and Cu+-doped lithium aluminate LiAlO2 singe crystals have been grown using micro-pulling down (mu-PD) technique. After cutting and polishing, optical properties and scintillation characteristics of the crystals were examined. From the transmittance measurements, Cu+-doped crystal showed absorption band around 270 nm, which is corresponding to the transition between Cu(+)3d(10) and 3d(9)4sstates. Ultra violet emission peak appeared around 360 nm under 270 nm excitation. The emission decay time was calculated to be about 17.3 mu s. Am-241 5.5 MeV alpha-ray excited radioluminescence spectra exhibited intense luminescence band at 360 nm due to the Cu(+)3d(9)4s-3d(10) transitions. By the pulse height spectra Cf-252 neutron source excitation, the scintillation light output of Cu+-doped LiAlO2 was found to be about 8700 ph/n.

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6218140

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2188-2192 Part: Part 2 Published: OCT 2012

Concentration Dependence of VUV-UV-Visible Luminescence of Nd^{3+} and Gd^{3+} in $LuLiF_4$

J. Martincik [1]; M. Nikl [1]; S. Ishizu [2]; A. Baratova [3]; T. Cechak [4]; K. Fukuda [2]; T. Suyama [2]; A. Beitlerova [1]; A. Yoshikawa [5]

1. Inst Phys AS CR, Prague 16253, Czech Republic
2. Tokuyama Co, Tokyo 1008983, Japan
3. LN Gumilyov Eurasian Natl Univ, Astana 010008, Kazakhstan
4. Czech Tech Univ, FNSPE, Prague 11519, Czech Republic
5. Tohoku Univ, Inst Mat Res, Sendai, Miyagi 9808577, Japan

Abstract:

The research and development of new VUV scintillators includes also LuLiF4 single crystals doped by Nd3+. Due to their lower light yield, the Gd3+ codoping is studied as a tool to improve an energy transfer from the host to Nd3+ emission centers and increase the light yield consequently. Emission spectra and decays with respect to the different concentration of Gd and Nd ions are studied and discussed as well.

E-mail Address:

jiri.martincik@fjfi.cvut.cz

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6200902

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2183-2187 Part: Part 2 Published: OCT 2012

VUV Luminescence With Nd Doped $KCaF_3$ Under X-Ray Excitation

N. Kawaguchi [1,2,3]; T. Yanagida [4]; Y. Fujimoto [5]; Y. Futami [5]; K. Fukuda [6]; S. Kajimoto [7]; H. Fukumura [7]; Y. Yokota [5]; A. Yoshikawa [2,4]

1. Tokuyama Corp, Tokyo 1008983, Japan
2. Tohoku Univ, IMR, Sendai, Miyagi 9808577, Japan
3. Tohoku Univ, Dept Chem, Grad Sch Sci, Sendai, Miyagi 9808577, Japan
4. Tohoku Univ, NICHe, Sendai, Miyagi 9808579, Japan
5. IMR Tohoku Univ, Sendai, Miyagi 9808577, Japan
6. Tokuyama Corp, Shunan 7450024, Japan
7. Tohoku Univ, Dept Chem, Grad Sch Sci, Sendai, Miyagi 9808578, Japan

Abstract:

Radioluminescence properties of Nd doped KCaF3 single crystals were studied. X-ray excited luminescence spectra were measured in the vacuum ultraviolet (VUV) region by using a custom-made device filled with nitrogen atmosphere. As a result, VUV luminescence was observed at 190 nm. Radioluminescence intensity due to the core-valence luminescence (CVL) of KCaF3 decreased with increasing of Nd3+ concentration.

E-mail Address:

kawaguchi@imr.tohoku.ac.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6308738

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2177-2182 Part: Part 2 Published: OCT 2012

Luminescence and Scintillation Properties of VUV Scintillation Crystals Based on Lu-Admixed BaY_2F_8

J. Pejchal [1,2]; K. Fukuda [3]; M. Nikl [2]; N. Kawaguchi [3]; Y. Yokota [1]; T. Yanagida [4]; A. Yoshikawa [1]

1. Tohoku Univ, Inst Mat Res, Sendai, Miyagi 9808577, Japan
2. Inst Phys AS CR, Prague 16253, Czech Republic
3. Tokuyama Co, Chiyoda Ku, Tokyo 1008983, Japan
4. Tohoku Univ, New Ind Creat Hatchery Ctr, Sendai, Miyagi 9808577, Japan

Abstract:

Nd and Tm-doped Lu-admixed BaY2F8 crystals were grown by micro-pulling-down method. Lu was added to modify the host matrix to suppress the unwanted energy transfer from exciton levels to the Tm3+ 4f-levels. It was found that low Tm and Nd codoping does not bring much improvement of the scintillation performance and that 1% Nd-doped BaY0.8Lu1.2F8 single crystal reached nearly the same scintillation efficiency as the LaF3:Nd8% one, which is known as a suitable candidate for a VUV scintillator. It is clear there is a considerable room for an optimization of this material by changing the Lu/Y ratio and increasing the content of Nd. On the other hand, very high Tm concentrations (around 20%) suppress the excitonic emission (and also the 4f-4f emission) while increasing the 5d-4f one significantly.

E-mail Address:

pejchalj@imr.to-hoku.ac.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6218206

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2173-2176 Part: Part 2 Published: OCT 2012

Crystal Growth and Scintillation Properties of Fluoride Scintillators

S. Kurosawa [1]; T. Yanagida [2]; Y. Yokota [1]; A. Yoshikawa [2,1]

1. Tohoku Univ, Inst Mat Res, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Sendai, Miyagi 9808579, Japan

Abstract:

Fluoride single crystals have a wide band gap. Thus, we were interested in studying the scintillation properties of fluoride single crystals. We investigated the scintillation properties of fluoride crystals grown by the micro-pulling-down and annealing methods. The time required to grow crystals using these methods is lesser than that using conventional methods such as the Czochralski and Bridgman methods. Both ZnF2 and PbF2 exhibited small light outputs of less than 1,000 photons/MeV, while BaF2 and CeF3 exhibited light outputs of similar to 6,000 and similar to 2,000 photons/MeV, respectively. In addition, BaF2 is a well-known fast scintillator, but it also has a slow component. We tested a BaF2 crystal with a Ce/La co-dopant and observed the suppression of the slow component.

E-mail Address:

kurosawa@imr.tohoku.ac.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6180198

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2156-2160 Part: Part 2 Published: OCT 2012

Investigations of Optical and Scintillation Properties of $(Lu_{0.1}Y_{0.9})AlO_3$: Nd0.1%

D. Totsuka [1]; T. Yanagida [2]; M. Sugiyama [3]; Y. Fujimoto [3]; J. Pejchal [3]; Y. Yokota [3]; A. Yoshikawa [3]

1. Nihon Kessho Kogaku Co Ltd, Gunma 3740047, Japan
2. Tohoku Univ, NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan
3. Tohoku Univ, IMR, Aoba Ku, Sendai, Miyagi 9808577, Japan

Abstract:

(Lu0.1Y0.9)AlO3 : Nd0.1% crystal was grown by the mu-PD method and pure YAP single crystal was prepared as a reference sample. Then, two annealing procedures were performed for each sample at 1350 degrees C and 1500 degrees C for 20 hours in oxygen atmosphere to improve the crystallinity and scintillation properties. The XRD results for all the samples were consistent with JCPDS data (#33-0041) and possessed a space group of orthorhombic Pbnm while no impurity peaks were observed. The FWHM values of X-ray rocking curve measurements of the as-grown crystals and the crystals annealed at 1500 degrees C were 70 and 200 arcsec, respectively. It can be due to the onset of decomposition. In the transmittance measurements, intense absorption peaks were observed approximately at 240 and 290 nm and they were consistent with the bands for color centers: the two-electron F center and one-electron F+ center, respectively. These absorptions were enhanced by Lu substitution. The radio-luminescence spectra show several emission peaks due to Nd3+ 4f-4f transitions and the most intense of which were assigned to F-2(2)(5/2) - F-4(5/2), F-2(2)(5/2) - (4)G(7/2) and F-2(2)(5/2) - (4)G9(/2) transitions at 395, 540 and 550 nm, respectively. The light yield after annealing annealing was as high as 5025 +/- 500 (N-phe/MeV) when using Si-APD (S8664). The scintillation decay time constants were evaluated to be 3.44-3.80 mu s for each sample. Afterglow upon X-ray excitation of the as-grown and annealed samples coupled with PIN Si-photodiode was found to be approximately 1200 and 1000 ppm after 100 ms.

E-mail Address:

totsuka@imr.tohoku.ac.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6170584

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2146-2151 Part: Part 2 Published: OCT 2012

Scintillation Properties of Transparent Ceramic Pr:LuAG for Different Pr Concentration

T. Yanagida [1]; Y. Fujimoto [2]; K. Kamada [3]; D. Totsuka [4]; H. Yagi [5]; T. Yanagitani [5]; Y. Futami [2]; S. Yanagida [6]; S. Kurosawa [2]; Y. Yokota [2]; A. Yoshikawa [2]; M. Nikl [7]

1. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan
2. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
3. Furukawa Co Ltd, Tsukuba, Ibaraki 3050856, Japan
4. Nihon Kessho Kogaku Co Ltd, Tatebayashi Gunma 3740047, Japan
5. Konoshima Chem Co Ltd, Mitoya, Kagawa 7691103, Japan
6. Tohoku Univ, Inst Multidisciplinary Res Adv Mat, Aoba Ku, Sendai, Miyagi 9808577, Japan
7. ASCR, Inst Phys, Prague 16253 6, Czech Republic

Abstract:

We manufactured transparent optical ceramic of Pr 0.2-1% doped Lu3Al5O12 (Pr:LuAG) by the sintering method. We compare its optical and scintillation properties with the single crystal counterpart grown by the conventional Czochralski method. So far the scintillation ceramic of Pr: LuAG appeared inferior to its single crystal analog especially in terms of light yield. However, in the present case our ceramic Pr 0.25%-doped sample exhibited by 20% higher light yield compared to single crystal under gamma-ray excitation. Furthermore, in the ceramic sample the slower scintillation decay components were suppressed and the defect related host emission as well. The optimized technology of optical ceramics thus appears very competitive to single crystals and opens great practical prospectives for the former materials in the field of fast scintillators.

E-mail Address:

yanagida@imr.tohoku.ac.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6190751

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2141-2145 Part: Part 2 Published: OCT 2012

Crystal Growth and Scintillation Properties of Ho-Doped $Lu_3Al_5O_{12}$ Single Crystals

M. Sugiyama [1]; T. Yanagida [2]; Y. Fujimoto [1]; D. Totsuka [3,1]; Y. Yokota [1]; S. Kurosawa [1]; Y. Futami [1]; A. Yoshikawa [2,1]

1. Tohoku Univ, Inst Mat Res, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, New Ind Creat Hatchery Ctr, Sendai, Miyagi 9808579, Japan
3. Nihon Kessho Kogaku CO Ltd, Gunma 3740047, Japan

Abstract:

The crystals of 0.1, 0.5, 1, and 3% Ho doped Lu3Al5O12 (Ho:LuAG) grown by the micro-pulling-down method were examined for their scintillation properties. At wavelengths longer than 300 nm, Ho: LuAG crystals demonstrated around 60% transparency with many absorption peaks attributed to Ho3+ 4f(10)-4f(10) transitions. When excited by Am-241 alpha-ray to obtain radio luminescence spectra, broad host emission and four sharp Ho3+ 4f(10)-4f(10) emission peaks were detected in the visible region. Light yields and decay time profiles of the samples irradiated by Cs-137 gamma-ray were measured using photomultiplier tubes R7600 (Hamamatsu). Ho 0.5%:LuAG showed the highest light yield of 3100 +/- 310 photons/MeV among the present samples. The decay time profiles were well reproduced by two components exponential approximation consisting of 0.5-1 mu s and 3-6 mu s.

E-mail Address:

msugiyama500@gmail.com

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6180202

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2135-2140 Part: Part 2 Published: OCT 2012

Quantitive Research of the Crystallinity of Pr Doped $Lu_3Al_5O_{12}$

A. Yamaji [1]; T. Yanagida [2]; Y. Yokota [1]; K. Kamada [3]; A. Yoshikawa [1]; J. Pejchal [1]

1. Tohoku Univ, Inst Mat Res, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, New Ind Creat Hatchery Ctr, Sendai, Miyagi 9808577, Japan
3. Furukawa Co Ltd, Mat Res Lab, Tsukuba, Ibaraki 3050856, Japan

Abstract:

In this study, we investigated the relation between crystallinity and scintillation properties of Pr:LuAG crystals grown by Czochralski (Cz) method. The crystallinity was determined as the dislocation density using the X-ray rocking curve technique. The scintillation pulse-height spectra were collected under 662 keV Cs-137 gamma-ray excitation to evaluate the light yield and energy resolution. It was confirmed that both the light yield and energy resolution correlates with the crystalinity; however, the other factors also have an influence.

E-mail Address:

yamaji-a@imr.tohoku.ac.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6179359

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2130-2134 Part: Part 2 Published: OCT 2012

Improvement of Scintillation Properties in Pr Doped $Lu_3Al_5O_{12}$ Scintillator by Ga and Y Substitutions

K. Kamada [1]; T. Yanagida [2]; J. Pejchal [3]; M. Nikl [3]; T. Endo [1]; K. Tsutumi [1]; Y. Fujimoto [2]; A. Fukabori [2]; A. Yoshikawa [2]

1. Furukawa Co Ltd, Mat Res Lab, Tsukuba, Ibaraki 3050856, Japan
2. Tohoku Univ, IMR, Aoba Ku, Sendai, Miyagi 9808577, Japan
3. AS CR, Inst Phys, Prague 16253, Czech Republic

Abstract:

Pr : (Lu, Y)(3)(Ga, Al)(5)O-12 single crystals were grown by the micro-pulling down (mu-PD) method. Luminescence and scintillation properties were measured. The substitution phenomenon in the Lu3+ sites with Y3+ and Al3+ sites with Ga3+ in garnet structure has been studied. Pr3+ 5d-4f emission within 300-400 nm accompanied by weak Pr3+ 4f-4f emission in 480-650 nm were observed in Ga 0-60 at.% substituted samples. Only Pr3+ 4f-4f emission was observed in Ga 80 at.% substituted sample. The light yield of Pr1% : Lu2Y1Ga2Al2O12 sample was almost the same as that of Cz grown Pr:LuAG standard. Two-component scintillation decay of 17.9 ns (93%) and 68.0 ns (7%) were obtained using the PMT and digital oscilloscope TDS5032B. Slower decay components were reduced by Ga and Y substitution in LuAG structure.

E-mail Address:

k-kamada@furukawakk.co.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6198315

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2126-2129 Part: Part 2 Published: OCT 2012

Growth and Scintillation Properties of Pr Doped $(Gd, Y)_3(Ga, Al)_5O_{12}$ Single Crystals

K. Kamada [1]; T. Yanagida [2]; J. Pejchal [3]; M. Nikl [3]; T. Endo [1]; K. Tsutsumi [1]; Y. Fujimoto [2]; A. Fukabori [2]; A. Yoshikawa [2]

1. Furukawa Co Ltd, Mat Res Lab, Tsukuba, Ibaraki 3050856, Japan
2. Tohoku Univ, IMR, Aoba Ku, Sendai, Miyagi 9808577, Japan
3. AS CR, Inst Phys, Prague 16253, Czech Republic

Abstract:

Pr:(Gd, Y)(3)(Ga, Al)(5)O-12 single crystals were grown by the mu-PD method with RF heating system. Pr3+ 5d-4f emission within 300-350 nm, Pr3+ 4f-4f emission within 480-650 nm and Gd3+ 4f-4f emission at 310 nm are observed in Pr:(Gd, Y)(3)(Ga, Al)(5)O-12 crystals. In order to determine light yield, the energy spectra were measured under 662 keV gamma-ray excitation (Cs source), detected by a PMT H6521 (Hamamatsu). The light output of Pr1%:Gd1Y2Ga3Al2O12 sample was of about one fifth of that of the Cz grown Pr: LuAG standard sample, i.e., around 4,000 photon/MeV. Two component scintillation decay shows the decay times (intensity) of 5.7 ns(5%), 38.7 ns (31%) and 187 ns (63%) using the PMT and digital oscilloscope TDS5032B detection.

E-mail Address:

k-kamada@furukawakk.co.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6327752

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2116-2119 Part: Part 2 Published: OCT 2012

Crystal Growth of Ce Doped $(Lu, Y)_3(Ga, Al)_5O_{12}$ Single Crystal by the Micro-Puling-Down Method and Their Scintillation Properties

K. Kamada [1]; T. Yanagida [2]; J. Pejchal [3]; M. Nikl [3]; T. Endo [1]; K. Tsutumi [1]; Y. Fujimoto [2]; A. Fukabori [2]; A. Yoshikawa [2]

1. Furukawa Co Ltd, Mat Res Lab, Ibaraki 3050856, Japan
2. Tohoku Univ, IMR, Sendai, Miyagi 9808577, Japan
3. AS CR, Inst Phys, Prague 16253, Czech Republic

Abstract:

Ce : (Lu, Y)(3)(Ga, Al)(5)O-12 single crystals were grown by the mu-PD method with RF heating system. In these crystals, Ce3+ 4f-5d emission is observed within 500-530 nm wavelength. Emission peak shifts to shorter wavelength and the decay accelerates with increasing Ga concentration. In the case of Ce : Lu2Y1 (Ga, Al)(5)O-12 series, the Ce0.2% Lu2Y1Ga3Al2O12 crystal showed the highest emission intensity. In order to determine light yield, the energy spectra were measured under 662 keV (a) over bar -ray excitation (Cs-137 source) and detection by an APD S8664-55(Hamamatsu). The light yield was calibrated from Fe-55 direct irradiation peak to APD. The light yield of Ce0.2%: Lu2Y1Ga3Al2O12 sample was of about 30,000 photon/MeV. Dominant scintillation decay time was of about 50 ns.

E-mail Address:

k-kamada@furukawakk.co.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6151861

IEEE TRANSACTIONS ON NUCLEAR SCIENCE Volume: 59 Issue: 5 Pages: 2112-2115 Part: Part 2 Published: OCT 2012

Crystal Growth and Scintillation Properties of Ce Doped $Gd_3(Ga,Al)_5O_{12}$ Single Crystals

K. Kamada [1]; T. Yanagida [2]; J. Pejchal [3]; M. Nikl [3]; T. Endo [1]; K. Tsutsumi [1]; Y. Fujimoto [2]; A. Fukabori [2]; A. Yoshikawa [2]

1. Furukawa Co Ltd, Mat Res Lab, Ibaraki 3050856, Japan
2. Tohoku Univ, IMR, Sendai, Miyagi 9808577, Japan
3. AS CR, Inst Phys, Prague 16253, Czech Republic

Abstract:

Ce1%, 2% and 3% doped Gd-3(Ga,Al)(5)O-12 (GAGG) single crystals were grown by the Cz method. Luminescence and scintillation properties were measured. Light yield change along the growth direction and effects of Ce concentration on scintillation properties in Ce:GAGG were studied. Ce3+ 5d-4f emission within 520-530 nm was observed in the Ce:GAGG crystals. The Ce1%:GAGG sample with 3 x 3 x 1 mm size showed the highest light yield of 46000 photon/MeV. The energy resolution was 7.8%@662 keV. With increasing solidification fraction, the LY were decreased. It is proposed that the increase of Ga concentration along the growth direction is the main cause of the decrease of LY. The scintillation decay times were accelerated with increasing Ce concentration in the Ce: GAGG crystals. The scintillation decay times were 92.0 ns, 79.1 ns and 68.3 ns in the Ce1, 2 and 3% GAGG, respectively.

E-mail Address:

k-kamada@furukawakk.co.jp

Site Address:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6212487

APPLIED PHYSICS EXPRESS Volume: 5 Issue: 10 Article Number: 102601 Published: OCT 2012

Fast and High-Energy-Resolution Oxide Scintillator: Ce-Doped $(La,Gd)_2Si_2O_7$

A. Suzuki [1]; S. Kurosawa [1]; T. Shishido [1]; J. Pejchal [1,3]; Y. Yokota [1]; Y. Futami [1]; A. Yoshikawa [1,2]

1. Tohoku Univ, Inst Mat Res, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Sendai, Miyagi 9808579, Japan
3. Inst Phys AS CR, Prague 16253, Czech Republic

Abstract:

A novel scintillation crystal (Ce-0.01,Gd-0.90,La-0.09)(2)Si2O7 (Ce:La-GPS) was grown by the floating zone method, and its optical and scintillation properties were investigated. The emission wavelength of this material was 390 nm. Gamma ray excited pulse height and scintillation decay measurement showed that Ce:La-GPS had a high energy resolution (FWHM) of 5% at 662 keV, high light output of 36,000 photons/MeV and fast scintillation decay time of 46 ns. (C) 2012 The Japan Society of Applied Physics

E-mail Address:

akira_suzuki@imr.tohoku.ac.jp

Site Address:

http://apex.jsap.jp/link?APEX/5/102601/

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT Volume: 690 Pages: 53-57 Published: OCT 21 2012

Temperature dependence of the scintillation properties of Ce:GSO and Ce:GSOZ

S. Kurosawa [1]; M. Sugiyama [1]; T. Yanagida [2]; Y. Yokota [1]; A. Yoshikawa [1,2]

1. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan

Abstract:

The light output and decay times of Ce:GSO and Ce:GSOZ scintillators depend on Ce concentration and temperature. We investigated the temperature dependence of the light output and the decay time for Ce:GSO and Ce:GSOZ doped with 0.3 (only GSO), 0.5, 1.0, and 1.5 mol% Ce. These samples were measured with a ruggedized photomultiplier (PMT) (Hamamatsu R6877A) at 175 degrees C (in the thermostat chamber). Up to 100 degrees C, the relative light output of all of the samples remained within 10% after correcting the PMT gain, which depends on the temperature. The decay times of the GS and GSOZ samples with the identical Ce concentrations were equal. Moreover, the quenching energy values for all the samples were equivalent. (C) 2012 Elsevier BM. All rights reserved.

E-mail Address:

kurosawa@imr.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0168900212006717

JOURNAL OF CRYSTAL GROWTH Volume: 360 Special Issue: SI Pages: 127-130 Published: DEC 1 2012

Modifications of micro-pulling-down method for the growth of selected Li-containing crystals for neutron scintillator and VUV scintillation crystals

J. Pejchal [1]; Y. Fujimoto [2]; V, Chani [2]; T. Yanagida [2,3]; Y. Yokota [2]; A. Yoshikawa [2,3]; M. Nikl [1]; A. Beitlerova [1]

1. AS CR, Inst Phys, Prague 16253, Czech Republic
2. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
3. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan

Abstract:

To develop new and efficient neutron scintillator, Ti-doped LiAlO2 single crystal was grown by micro-pulling-down method. The X-ray excited radioluminescence spectra and neutron light yield were measured. Positive effect of Mg codoping on the overall scintillation efficiency was found. The BaLu2F8 single crystal was grown by micro-pulling-down method using low temperature gradient at growth interface and applying quenching immediately after growth process.

E-mail Address:

pejchal@fzu.cz

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024811009857

JOURNAL OF CRYSTAL GROWTH Volume: 362 Pages: 145-148 Published: JAN 1 2013

Growth of Ce-doped $Ba_3Gd(BO_3)_3$ and $Sr_3Gd(BO_3)_3$ single crystals by micro-pulling-down method and analysis of luminescence properties

R. Simura [1]; T. Yagi [1]; K. Sugiyama [1]; T. Yanagida [2]; A. Yoshikawa [1,2]

1. Tohoku Univ, Inst Mat Res KINKEN, Sendai, Miyagi 980, Japan
2. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Sendai, Miyagi 980, Japan

Abstract:

Ce-doped double borates Ba3Gd(BO3)(3) and Sr3Gd(BO3)(3) (Ce:BGB and Ce:SGB, respectively) were grown by the micro-pulling-down method, and the luminescence properties of the crystals were investigated and compared with those of Ce-doped H-Ba3Y(BO3)(3)(Ce:H-BYB) crystals grown by the same method. Transmittance measurements showed the wavelength of absorption band was around 380 nm for all the samples. Emission bands corresponding to the 5d -> 4f transition of Ce3+ were observed at around 425 nm for Ce:BGB and Ce:SGB and at 435 nm for Ce:H-BYB. The photoluminescence decay times of Ce:BGB, Ce:SGB, and Ce:BYB were 29.5 ns, 35.2 ns, and 26.8 ns, respectively. The emission spectra obtained by excitation of Am-241 (an alpha-emitter) revealed that the host luminescence was dominant (at around 315 nm) in BGB and SGB and that a very low-intensity Ce3+ 5d -> 4f luminescence peak appeared at around 430 nm. The relative light yield strength observed under Am-241 excitation was corresponding to <100 and similar to 270 photons/neutron for Ce:BGB and Ce:SGB, respectively, and these values were lower than that of Ce:H-BYB (similar to 400 photons/neutron).

E-mail Address:

ray@imr.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024811010657

JOURNAL OF CRYSTAL GROWTH Volume: 362 Pages: 157-161 Published: JAN 1 2013

Crystal growth and luminescence properties of Cr-doped $YAlO_3$ single crystals

M. Sugiyama [1]; T. Yanagida [2]; D. Totsuka [1,3]; Y. Yokota [1]; Y. Futami [1]; Y. Fujimoto [1]; A. Yoshikawa [1,2]

1. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan
3. Nihon Kessho Kogaku CO LTD, Gunma 3740047, Japan

Abstract:

We have investigated optical and scintillation properties of Cr-doped YAlO3 (Cr:YAP) single crystals with different Cr concentrations. Cr:YAP crystals were grown by the micro-pulling-down (mu-PD) method. The grown crystals had a single-phase confirmed by the powder XRD analysis. For all the Cr-doped samples, a peak positioned near 700 nm wavelength dominates the spectra. It can be ascribed to the Cr3+ E-2 ->(4)A(2) emission. In X-ray induced radioluminescence spectra, E-2 ->(4)A(2) emissions were observed. The light output of Cr 0.5%:YAP under X-ray excitation was more than twice as high as the standard CdWO4. (c) 2011 Elsevier B.V. All rights reserved.

E-mail Address:

makoto.sugiyama@imr.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024811009365

JOURNAL OF CRYSTAL GROWTH Volume: 362 Pages: 167-169 Published: JAN 1 2013

Micro-pulling down method-grown Er^{3+}:$LiCaAlF_6$ as prospective vacuum ultraviolet laser material

M. Cadatal-Raduban [1]; T. Shimizu [1]; K. Yamanoi [1]; K. Takeda [1]; MH. Pham [1]; T. Nakazato [1]; N. Sarukura [1]; N. Kawaguchi [2,3]; K. Fukuda [2,3]; T. Suyama [2]; T. Yanagida [3]; Y. Yokota [3]; A. Yoshikawa [3]

1. Osaka Univ, Inst Laser Engn, Suita, Osaka 5650871, Japan
2. Tokuyama Corp, Shibuya Ku, Tokyo 1508383, Japan
3. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan

Abstract:

We report the successful growth of trivalent erbium-doped lithium calcium aluminum fluoride (Er3+:LiCaAlF6) using the micro-pulling down method. Several absorption bands were observed at 139 nm (71,942 cm(-1)), 149 nm (67,114 cm(-1)), and 162 nm (61,728 cm(-1)), which can be ascribed to 4f -> 5d transitions in Er3+ Evaluation of its optical properties using the 157-nm emission of a F-2 laser reveal that it has a 163-nm vacuum ultraviolet fluorescence with 1.3-mu s decay time, involving a transition originating from the high-spin state of the 4f (10)5d excited state configuration. This is one of the shortest emission wavelengths from solid-state materials reported at room temperature. (C) 2011 Elsevier B.V. All rights reserved.

E-mail Address:

cadatal-m@ile.osaka-u.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024811008803

JOURNAL OF CRYSTAL GROWTH Volume: 362 Pages: 178-181 Published: JAN 1 2013

Growth and scintillation properties of Nd-doped $Lu_3Al_5O_{12}$ single crystals by Czochralski and micro-pulling-down methods

M. Sugiyama [1]; Y. Fujimoto [1]; T. Yanagida [2]; A. Yamaji [1]; Y. Yokota [1]; A. Yoshikawa [1,2]

1. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan

Abstract:

The Nd-doped Lu3Al5O12 (Nd:LuAG) single crystal was grown by the Czochralski (CZ) method. In XRC profiles, the full-width at half-maximum (FWHM) value was 58 arcsec, which was much higher than that of the mu-PD (194 arcsec). In photo and radio-luminescence spectra, the CZ grown sample showed strong emission peaks attributed to Nd3+ 4f-4f transitions in visible wavelengths longer than 400 nm. The Nd:LuAG grown with the CZ method showed light yield of 7900 photons/MeV, which is comparable with the standard EGO and energy resolution of 14% under Cs-137 gamma-ray excitation.

E-mail Address:

makoto.sugiyama@imr.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024811008736

JOURNAL OF CRYSTAL GROWTH Volume: 362 Pages: 243-246 Published: JAN 1 2013

The control of mean ionic radius at Y site by Lu co-doping for Ce:$LiYF_4$ single crystals

Y. Yokota [1]; A. Yamaji [1]; T. Yanagida [1]; N. Kawaguchi [1,3]; K. Fukuda [1,3]; A. Yoshikawa [1,2]

1. Tohoku Univ, IMR, Aoba Ku, Sendai, Miyagi 9808577, Japan
2. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Aoba Ku, Sendai, Miyagi 9808579, Japan
3. Tokuyama Corp, Yamaguchi 7458648, Japan

Abstract:

Lu co-doped Ce:LiYF4 single crystals with Lu 0, 25, 50, 75 and 100 at% concentrations were grown for the control of mean ionic radius at Y site and the effects on crystal growth, structural phase, crystallinity and segregation were investigated. Lu co-doped Ce 2 at%:LiYF4 single crystals with Lu 0, 25, 50, 75 and 100 at% concentrations were grown by the micro-pulling-down method and while the initial part of Ce:LiYF4 single crystal indicated opaque and milky due to the increase of mean ionic radius at Y site by Ce3+ doping, Lu co-doped crystals had transparency in all part of crystals. All Lu co-doped crystals indicated a single phase in XRD measurements and the lattice parameters were systematically decreased with an increase in Lu concentration. Crystallinity of grown crystals became worse by Lu co-doping and the effective segregation coefficients of Ce3+ ion for Lu co-doped crystals were almost the same, 0.15-0.19.

E-mail Address:

yokota@imr.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S002202481100933X

JOURNAL OF CRYSTAL GROWTH Volume: 362 Pages: 288-290 Published: JAN 1 2013

Pr or Ce-doped, fast-response and low-afterglow cross-section-enhanced scintillator with Li-6 for down-scattered neutron originated from laser fusion

K. Watanabe [1]; Y. Arikawa [1]; K. Yamanoi [1]; M. Cadatal-Raduban [1]; T. Nagai [1]; M. Kouno 1; K. Sakai [1]; T. Nazakato [1]; T. Shimizu [1]; N. Sarukura [1]; M. Nakai [1]; T. Norimatsu [1]; H. Azechi [1]; A. Yoshikawa [2]; T. Murata [3]; S. Fujino [4]; H. Yoshida [5]; N. Izumi [6]; N. Satoh [7]; H. Kan [7]

1. Osaka Univ, Inst Laser Engn, Suita, Osaka 5650871, Japan
2. Tohoku Univ, Inst Mat Res, Aoba Ku, Sendai, Miyagi 9808577, Japan
3. Kumamoto Univ, Kumamoto 8608555, Japan
4. Kyushu Univ, Kishi Ku, Fukuoka 8190395, Japan
5. Ceram Res Ctr Nagasaki, Nagasaki 8593726, Japan
6. Lawrence Livermore Natl Lab, Livermore, CA 94550 USA
7. Hamamatsu Photon Kk, Kita Ku, Hamamatsu, Shizuoka 4312103, Japan

Abstract:

We explore the potential of Pr- or Ce-doped 20Al(PO3)(3)-80LiF (APLF80+3Pr or +3Ce) scintillator to observe the lower edge of down-scattered neutron and discriminate fusion originated neutron from strong X-ray signals. APLF80+3Pr or +3Ce scintillator exhibits considerably fast decay profiles and negligible slow-decay components. Using these newly developed APLF80+3Pr or +3Ce scintillators, we have successfully observed fusion-originated neutron signal in the midst of strong X-ray-excited fluorescence in an integrated experiment using our 10 kJ class GEKKO XII Nd-glass laser system. A sophisticated neutron detection system using APLF80+3Pr or 3Ce will be used for the first fast ignition experiment.

E-mail Address:

watanabe-k@ile.osaka-u.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024811010712

JOURNAL OF CRYSTAL GROWTH Volume: 362 Pages: 296-299 Published: JAN 1 2013

Valence state of dopant and scintillation properties of Ce-doped $Sr_3Y(BO_3)_3$ crystal

R. Simura [2]; S. Kawai [2]; K. Sugiyama [2]; T. Yanagida [1]; T. Sugawara [2]; T. Shishido [2]; A. Yoshikawa [1,2]

1. Tohoku Univ, New Ind Creat Hatchery Ctr NICHe, Sendai, Miyagi 980, Japan
2. Tohoku Univ, Inst Mat Res KINKEN, Sendai, Miyagi 980, Japan

Abstract:

A transparent Ce:SYB crystal was grown by employing the floating zone method in a dry-air atmosphere, and the growth rate was 1 mm/h. The feed/seed rods were formed by sintering raw powder at 1000 degrees C for 24 h. The Ce content in the grown crystal was measured by electron probe microanalysis and was found to be very low (approximately 0.1 at%). Ce LIII XANES measurement showed that 90% of the Ce in the sintered powder was quadrivalent. On the other hand, approximately 80% of the Ce in the grown crystal was trivalent. Emission bands centered at 415 nm corresponding to the 5d-4f transition of Ce3+ were observed when the excitation wavelength was 365 nm. The decay time under this condition was approximately 12.26 +/- 0.45 ns. The light yield strength excited by an a-source was approximately similar to 6% of that from the Li-glass.

E-mail Address:

ray@imr.tohoku.ac.jp

Site Address:

http://www.sciencedirect.com/science/article/pii/S0022024811010682

APPLIED PHYSICS LETTERS Volume: 102 Pages: 051907 Published: Feb 5 2013

Submicron-diameter phase-separated scintillator fibers for high-resolution X-ray imaging

Y. Ohashi, N. Yasui, Y. Yokota, A. Yoshikawa, and T. Den [1,2]

1. Canon Inc., Frontier Research Center, Ohta-ku, Tokyo 1468501, Japan
2. Tohoku Univ., Institute for Materials Research, Sendai, Miyagi 9808577, Japan

Abstract:

We demonstrated micrometer-scale resolution X-ray imaging by using phase-separated scintillator fibers. Hexagonally well-aligned 680-nm-diameter GdAlO3(GAP):Ce3t scintillator fibers surrounded with a-Al2O3 were fabricated from directionally solidified eutectics. The GAP:Ce3t fibers convert X-rays to lights and emitted lights are confined and transported along the fiber direction by a total reflection mode. High-resolution X-ray image of a gold grating phantom with a 4 lm aperture, corresponding to a bundle of 12 fibers, was achieved even with a 150 -lm-thick scintillator. These scintillator fibers overcome resolution reduction caused by light scattering and almost reach the resolution limit of the material nature itself.VC 2013 American Institute of Physics.

E-mail Address:

den.toru@canon.co.jp.

Site Address:

http://apl.aip.org/resource/1/applab/v102/i5/p051907_s1

Ionizing Radiation Sensor Utilizing RPL in Ag-doped Phosphate Glass

Yuka MIYAMOTO[1, 2)]*, Takeru OHNO[1)], Yoshinori TAKEI[1)], Hidehito NANTO[1)], Toshio KUROBORI[3)], Takayuki YANAGIDA[4)], Akira YOSHIKAWA[4)], Yukari NAGASHIMA[2)] and Takayoshi YAMAMOTO[2)]

[1]*Adv. Mater. Sci. R&D Center, Kanazawa Inst. of Tech., 3-1 Yatsukaho, Hakusan, Ishikawa 924-0838 JAPAN*

[2]*OaraiRes. Center, Chiyoda Tecknol Corp., 3681Narita-cho, Oarai-machi, Ibaraki 311-1313 JAPAN*

[3]*Nature Science, Kanazawa Univ., Kakuma, Kanazawa 920-1192 JAPAN*

[4]*Tohoku Univ. Katahira, Sendai Miyagi 980-0557 JAPAN*

Optical properties such as optical absorption and radiophotoluminescence (RPL) spectra of Ag^{+}-doped phosphate glass before and after x-ray irradiation were investigated in this study. It is found that the RPL spectrum consists of two emission bands which are peaked at 2.70 eV (460 nm blue emission) and 2.21 eV (560 nm yellow emission). It is also found that RPL emission intensity gradually increases with x-ray irradiation dose. From the results it is suggested that origin of each 460 nm and 560 nm RPL emission band is ascribed to Ag^{0} ion and Ag^{2+} ion, respectively, which are produced by x-ray irradiation. The application of the RPL phenomenon in Ag-doped phosphate glass to the environmental natural radiation monitoring and alpha-ray detection is also demonstrated.

Study of the correlation of scintillation decay and emission wavelength

Takayuki Yanagida[a], Yutaka Fujimoto[b], Akihiro Yamaji[b], Noriaki Kawaguchi[b,c], Kei Kamada[b], Daisuke Totsuka[b], Kohei Yamanoi[c], Nishi Ryosuke[c], Yoshisuke Futami[b], Shunsuke Kurosawa[b], Yuui Yokota[b], Toshihiko Shimizu[c], Akira Yoshikawa, Nobuhiko Sarkura[c]

[a]*NICHe, Tohoku University*

[b]*Institute for Materials Research, Tohoku University*

[c]*ILE, Osaka University*

The speed of the scintillation, decay time, is one of the most important scintillation properties. The decay time fundamentally depends on the speed of transfer of free electrons and holes from ionization track to the emission center and the life time of the luminescence state of the activator. The relation between the decay time and other optical properties are written as

$$\Gamma = \frac{1}{\tau} \propto \frac{n}{\lambda^3}\left(\frac{n^2+2}{3}\right)^2 \sum_f \left|< f|\mu|i >\right|^2,$$

where Γ, τ, n, and λ represent the decay rate of an excited state, decay time, refractive index, and emission wavelength, respectively. The matrix element connecting an initial state $|i>$ with a final state $|\varphi>$ via the dipole operator μ will only be of appreciable size for transitions between states of different parity [1]. Therefore, scintillation decay time is expected to be in proportional to λ^3. Previously, the relation between the scintillation decay time and refractive index was experimentally well studied [2]. However, to our knowledge, the relation between the scintillation decay time and the emission wavelength was not studied enough, possibly because most of measurements of scintillation decay time were not resolved in the wavelength.

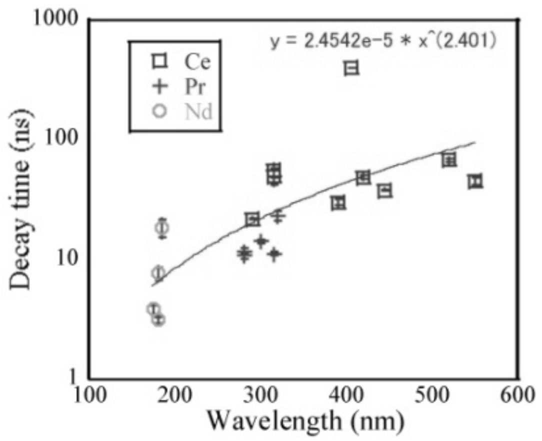


Figure 1: Scintillation decay time plotted against X-ray induced emission wavelength.

Recently, we developed pulsed X-ray equipped streak camera system to investigate time and wavelength resolved scintillation phenomenon [3]. This instrument enables us to observe the relation between the scintillation decay time and X-ray excited emission wavelength. The purpose of the present study is to investigate this relation using 5d-4f transition related emission of Nd^{3+}, Pr^{3+}, and Ce^{3+}. Figure 1 demonstrates the observed results. As a result, the scintillation decay time τ is in proportional to $\lambda^{2.4}$. In the workshop, we will present the results and discuss the fundamental limitation of scintillation decay time using 5d-4f transition. In addition, photoluminescence decay time measured by the photoluminescence based streak camera system [4] will be compared with scintillation decay times.

References

1. B. Henderson, G.F. Imbush, Optical Spectroscopy of Inorganic Solids, Oxford, 1989
2. P. Dorenbos, IEEE Trans. Nucl. Sci., **57**, 1162 (2010).
3. T. Yanagida et al., Appl. Phys. Express, **3** ,056202 (2010).
4. Y. Furukawa, M. Cadatal, K. Yamanoi, S. Takatori, M. Pham, E. Estacio, T. Nakazato, T. Shimizu, N. Sarukura, K. Kitano, K. Ando, K. Uchiyama, Y. Isobe, K. Fukuda, T. Suyama, T. Yanagida, A. Yoshikawa, F. Saito, Jpn. J. Appl. Phys., **48**, 096503 (2009).

Luminescence Properties and Radiation Response of Sodium Borate Glasses Scintillators

Yutaka Fujimoto[a], Takayuki Yanagida[b], Shunsuke Kurosawa[a], Akira Yoshikawa[a, b]

[a]*IMR, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai 980-8577, Japan.*

[b]*NICHe, Tohoku University, 6-6-10 Aoba, Aramaki, Aoba-ku, Sendai, 980-8579, Japan.*

There is an increasing amount of interest in amorphous materials for optical devise and radiation detector applications, e.g., phosphors, active laser medium, photochromatic lens for sun protection, amplifier device, dosimeter, and scintillator. Fluoride, phosphate, and silicate glasses with high UV transmission and doped with active luminescence center ions were much investigated. Especially, lithium silicate glasses activated with Ce^{3+} are known to be scintillation material for thermal neutron detection [1], and at present, intense studies are carried out to find an alternative detector for ^{3}He gas counter because ^{3}He gas resources became strictly limited as a result of excessive demand for security applications [2]. Thus despite the performance of ^{6}Li-loaded glass scintillator has been studied for a long time, number of report about ^{10}B based glasses scintillator for thermal neutron detection are small. Borate glass scintillator are expected to have high thermal neutron detection efficiency because ^{10}B have a high cross section to thermal neutrons than ^{6}Li, and when neutron is captured by ^{10}B, it releases high energy secondary charged particles based on ^{10}B(n, α)^{7}Li reactions [3]. Previously the only related reports were L_2O-B_2O_3 and Al_2O_3-Na_2O-B_2O_3-SiO_2 based glass activated with Cu^+ and rare-earth ions [4-6]. In this work, we developed sodium tetraborate glass scintillators doped with several luminescence center ions except rare-earth ions, such as the ions with s^2 (Pb^{2+}, Bi^{3+}) and d^0 (Ti^{4+}, V^{5+}, W^{6+}) configurations because they yield intense emission bands in blue-green wavelength range in other glass host [7]. The luminescence properties and radiation response of the glasses were studied by the measurements of photo- and radio-luminescence spectra, and ^{241}Am irradiated pulse height spectra.

Reference

[1] R.J. Ginther and J.H. Schulman. IRE Trans. Nucl. Sci., NS-5 (1958) 92-95..

[2] R.T.Kouzes, in: The ^{3}He supply problem, Technical Rpt. PNNL-18388, Pacific Northwest National Laboratory, Richland, WA, 2009.

[3] C. W. E. van Eijk, Radiat. Meas. 38 (2004) 337–342.

[4] M. Ishii and et al, Nucl. Instrum. Meth-A 537 (2005) 282-285.

[5] B. I. Zadneprovski, N. V. Eremin, A. A. Paskhalov, Func. Mate. 12 (2005) 261-268.

[6] L. M. Bollinger and G. E. Thomas, Nucl. Instr. Meth. 17 (1962) 97-116.

[7] G. Blasse and B.C. Grabmaier, "Luminescencent Materials" Springer-Verlag, Berlin, Heidelberg (1994).

Optical and Scintillation property of BaF_2 doped with rear earth

Shunsuke Kurosawa[1,*], Takayuki Yanagida[2], Yuui Yokota[1], Akira Yoshikawa[1,2]

Institute for Materials Research, Tohoku University

New Industry Creation Hatchery Center (NICHe), Tohoku University,

BaF_2 scintillator is a well-known fast scintillator. However, the short cross luminescence (CL) (~0.65 ns) is accompanied by a much more intense slow component (700 ns) ascribed to the relaxation of self-trapped excitons (STE) [1]. Thus some groups tested some dopants including co-dopants such as Lu:BaF_2 [1, 2], and we studied BaF_2 doped with some dopants (Ce, Eu, Pr, Ce/La).

These crystals were grown with an annealing furnace, because it takes for approximately 10 hours to grow crystals. Transmittance was measured with spectrophotometer (V-530, JASCO), and the radio--luminesecence spectra at room temperature were measured with a spectrofluorometer (FLS920, Edingurgh Instrument) using 5.5-MeV alpha rays (^{241}Am) as the excitation source. To determine the light yields, we obtained the pulse height spectra of these crystals irradiated with 662-keV gamma rays from a ^{137}Cs source. Scintillation photons were detected by a photomultiplier (PMT, R7600U, Hamamatsu), and then the signals from the PMT were amplified (113, ORTEC), shaped (572A, ORTEC), and readout with a multi-channel analyzer (8000A, Amptek).

Figure 1 shows decay time spectra of non-doped and Ce/La co-doped BaF_2 as a function of time, and we found the slow component in the decay time spectra was suppressed. In this presentation, we report the Optical and Scintillation property, especially time responses, for BaF_2 with some dopant.

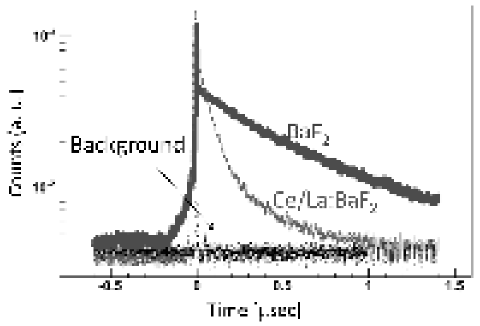


Figure 1 Decay time spectra of non-doped BaF_2 and Ce/La-codoped BaF_2 irradiated with gamma rays from a ^{137}Cs source. Background spectrum is also shown.

References

[1] V. Nesterkina, N. Shiran,A. Gektin, K. Shimamura, and E. Villora, Radiation Measurements **42**, (2007), 819.

[2] R. Visser, P. Doreneos, J. Andriessen, and C. W. E. van Euk, Nucl. Tracks Radiat. Meas. **21**, (1993), 201..

Optical and Scintillation property of PbF_2 with some dopant

Shunsuke Kurosawa[1,*], Takayuki Yanagida[2], Yuui Yokota[1], Akira Yoshikawa[1,2]

Institute for Materials Research, Tohoku University

New Industry Creation Hatchery Center (NICHe), Tohoku University,

PbF_2 scintillator has a heavy density (7.77 g/cm^3), short radiation length (0.93 g/cm^3), and high transmittance in the ultra violet region, and this scintillator is used in a detector for high-energy charged particle due to the above advantage. However, PbF_2 has a small light output.

To obtain brighter PbF_2 scintillator, we have investigated PbF_2 doped with Ho, Ce, and Eu grown with an annealing furnace using Ar+CF_4 (9:1) gas mixture as a gas atmosphere. Here, the reason we selected Ho dopant is to obtain green-emission which is the maximum sensitivity region for some avalanche photodiode (APD). Ce dopant was used to obtain the fast decay time.

Figure 1 shows the transmittance of PbF_2 doped with 0.1 mol% Eu, Ce, Ho and undoped PbF_2 measured with a spectrophotometer (V-530, JASCO). Figure 2 shows 5.5-MeV alpha-ray (^{241}Am) excited radio-luminescence as a function of wavelength for Ce:PbF_2. Although these crystals had enough transmittance, the radio luminescence spectra were not clear due to the low reaction except Eu:PbF_2 which emitted from Eu^{3+} by 5.5-MeV alpha-ray excitation. In this presentation, we also show the radiation reaction of these crystals irradiated with gamma or alpha rays measured with a photomultiplier tube (Hamamatsu R7600U) and, the APD (Hamamatsu, S8664-55).

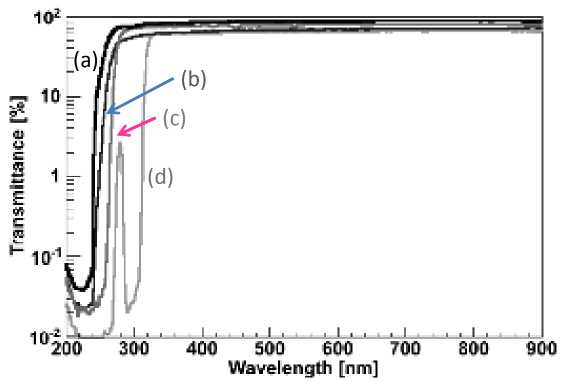


Figure 1. Transmittance of undope (a), Eu (b), Ho(c), and Ce(d) doped PbF_2as a function of wavelength.

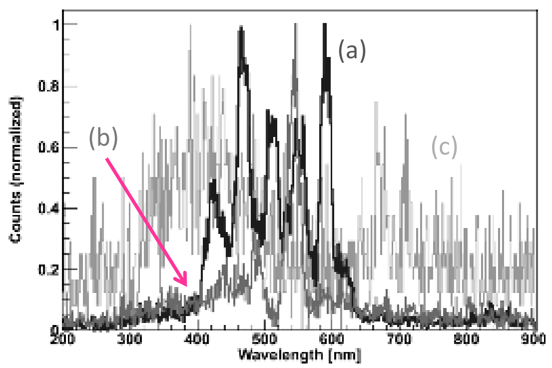


Figure 2. 5.5-MeV alpha-ray (^{241}Am) excited radio--luminescence of PbF_2 Doped with Eu(a), Ho(b), and Ce(c).

Evaluation of $Nd:BaY_2F_8$ for VUV scintillator

Shunsuke Kurosawa[1,*], Takayuki Yanagida[2], Jan Pejchal[1,3], , Kentaro Fukuda[4], Noriaki Kawaguchi[4], Sumito Ishizu[4], Toshihisa Suyama[4], Masanori Nakagawa[4], Yuui Yokota[1], Martin NIkl[3], Akira Yoshikawa[1,2]

[1]*Institute for Materials Research, Tohoku University*

[2]*New Industry Creation Hatchery Center (NICHe), Tohoku University*

[3] *Institute of Physics, Academy of Sciences of the Czech Republic*

[4] *Tokuyama cooperation*

Vacuum Ultra violet (VUV) scintillator, generally, has short decay time of a few to 10 ns, and this scintillator can be used for high rate counting. However, few VUV scintillators were reported. Here, BaY_2F_8 doped with Nd (0.1, 0.5, 1, 3, 10, 20 mol%) single crystals were successfully grown by a micro-pulling down (μ-PD) method as a new VUV scintillator [1, 2]. Then we investigated the optical and scintillation properties. Figure 1 shows a decay curve of BaY_2F_8 doped with 10-mol% Nd (excitation and emission wavelength were 160, and 180 nm, respectively) at 300 K using the DESY synchrotron beam. The sample had 13.3 nsec (99 %) and 30 nsec (1 %). Although this scintillator has low light output by our pulse height measurement, we found this crystal had a typical decay time in the VUV scintillators.

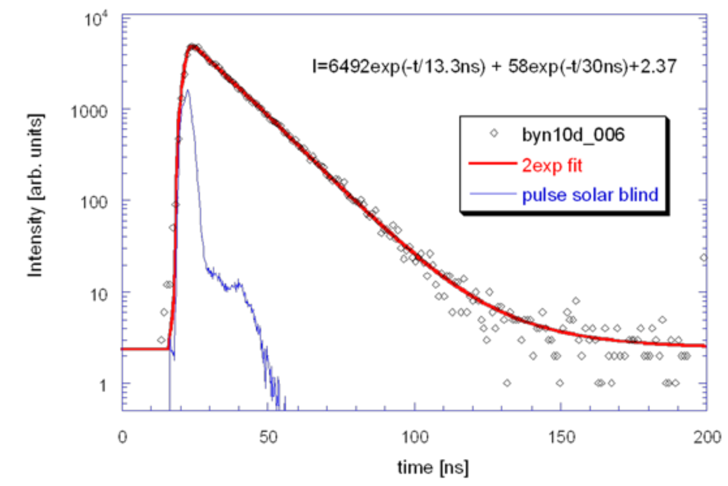


Figure 1 decay curve of BaY_2F_8 doped with 10-mol% Nd.

References

[1] A. Yoshikawa et al., J. Cryst. Growth **270**, (2004), 427.

[2] A. Yoshikawa, M. Nikl, G. Boulon, T. Fukuda, Opt. Mater. **30**, (2007), 6.

Czochralski growth and scintillation properties of Tm doped K_2NaLuF_6

[a]Akihiro Yamaji, [b]Takayuki Yanagida, [a]Yuui Yokota, [c]Noriaki Kawaguchi, [a]Akira Yoshikawa

[a]*Institute for Materials Research, Tohoku University, Japan*

[b]*New Industry Creation Hatchery Center, Tohoku University, Japan*

[c]*Tokuyama Corporation, Japan*

One of the candidates of the next generation computed tomography (CT) detectors are considered to use the novel scintillation detectors consisting of VUV scintillator and gas photo-detector (gas PMT) [1]. The gas PMT employs photosensitive gases (such as TMAE or TEA) or photocathodes (such as CsI) which are mainly sensitive to VUV photons. Therefore, the development of efficient VUV scintillator is required and we reported that the crystal growth and scintillation properties of Tm doped K_2NaLuF_6. In that report, Tm doped K_2NaLuF_6 showed good scintillation properties as a candidate VUV scintillator [2]. To bring forward this research, the large-size single crystal is required to develop imaging detectors. Therefore, in this study, undoped and Tm-doped K_2NaLuF_6 single crystals were grown by the Czochralski method and the scintillation properties were investigated.

The nominal chemical composition of $K_{2.1}Na_{0.9}Lu_{1.0\text{-}x}\ Tm_xF_6$ (x = 0.1) for the crystal growth was optimum condition and it was grown by a vacuum-tight Czochralski system equipped with radio frequency induction heater. The crucible and heater which were made of high-density carbon graphite and the heat insulator which was made of porus graphite were used. The crystal growth rate was 0.7-1.0 mm / h and the rotation rate was 10 rpm.

The grown crystals were about half inch in diameter and have some cracks and milky parts, as shown Fig. 1. The phase characterizations of grown crystals were confirmed by powder-XRD and with EDS analysis. The crystal had the emission peak at around 188 nm under X-ray excitation and this emission was ascribed to Tm^{3+} ion 5d-4f transition. The light yield was also evaluated to 680 photon / 5.5 MeV α-ray and this was one of the brightest VUV scintillators so far. In the conference, optical properties as well as the scintillation characteristics will be presented.

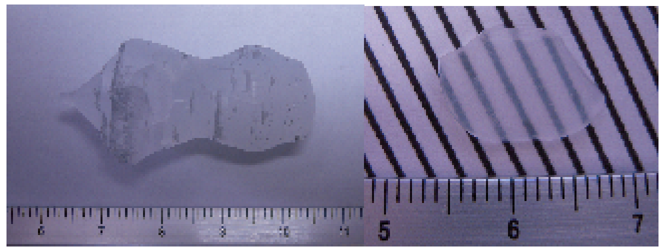


Fig. 1. Photograph and cross-section of Tm 10% doped K_2NaLuF_6 crystal.

Reference

1. H. Sekiya, C. Ida, H. Kubo, S. Kurosawa, K. Miuchi, T. Tanimori, K. Taniue, A. Yoshikawa,, T. Yanagida, Y. Yokota, K. Fukuda, S. Ishizu, N. Kawaguchi, T. Suyama, Nucl. Instrum. Methods A **633** S36 (2011).
2. N. Abe, Y. Yokota, T. Yanagida, N. Kawaguchi, J. Pejchal, M. Nikl, K. Fukuda, A. Yoshikawa, IEEE. Trans. Nucl. Sci. **57**, NO. 3, 1278-1281, 2010

Eu and Rb co-doped $LiCaAlF_6$ scintillators for neutron detection

Akihiro Yamaji[a] *, Takayuki Yanagida[b], Yuui Yokota[a],
Noriaki Kawaguchi[c], Kenichi Watanabe[d], Atsushi Yamazaki[d], Akira Yoshikawa[a,b]

[a]*Institute for Materials Research, Tohoku University, Japan*
[b]*New Industry Creation Hatchery Center, Tohoku University, Japan*
[c]*Tokuyama Corporation, Japan*
[d]*Department of Material, Physics and Energy Engineering, Nagoya University, Japan*

In our previous studies, Eu doped $LiCaAlF_6$ (LiCAF) scintillator was developed for an alternative to ^3He gas based neutron detectors. Eu 2% doped LiCAF showed the highest light yield (29,000 ph / neutron) by thermal neutron irradiation [1]. However, the light yield has plateaued by only optimization of dopant concentration or controlling crystal growth condition. In this study, we investigated the effect of Rb co-doping to Eu:LiCAF aiming to improve the light yield.

Rb co-doped Eu LiCAF single crystal was grown by the micro-pull-down method with a Radio Frequency heating system [2]. Crystal growth was performed in a graphite crucible under high purity Ar and CF_4 atmosphere after baking the crucible under a high vacuum ($<10^{-4}$Pa) to prevent oxygen contamination. A platinum wire was used as the seed for crystal growth, and the crystal growth rate was 0.1 mm / min. The fabricated crystals were cut and polished for optical measurements.

The transmission spectrum was measured by using absorption and fluorescence spectrometer (JASCO V-550). The crystal resulted in approximately 80 – 90 % transmittances in wavelengths from 400 nm to 900 nm, as shown Fig. 1. The absorption lines of Rb 1% co-doped Eu 2%:LiCAF were observed at 200-220 nm and 280-350 nm due to Eu^{3+} 4f-4f and Eu^{2+} 4f-5d transition, respectively.

Fig.2 shows the pulse height distribution of Rb 1% co-doped Eu 2%:LiCAF compared with Li-glass GS-20 under moderated ^{252}Cf thermal neutron flux. Li-glass GS-20 was well known conventional neutron scintillator and showed the absolute neutron light yield of 6000 ph /neutron [3]. The light yield was calculated from comparing with the pulse heights of the thermal neutron peaks and taking into consideration the quantum efficiency of the used photomultiplier (Hamamatsu R7600P). As a result, the light yield of Rb 1% co-doped Eu 2%:LiCAF resulted 36,000 ph/ neutron which was superior than only Eu doped LiCAF.

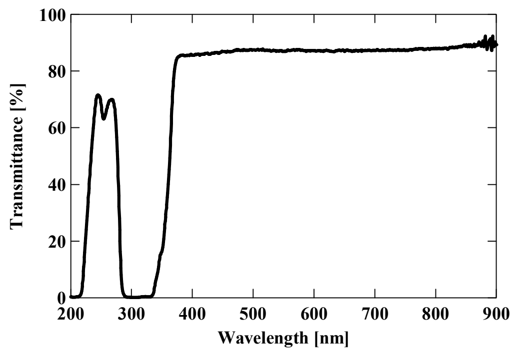


Fig.1 Transmittance spectrum of Rb 1% co-doped Eu 2% LiCAF single crystal.

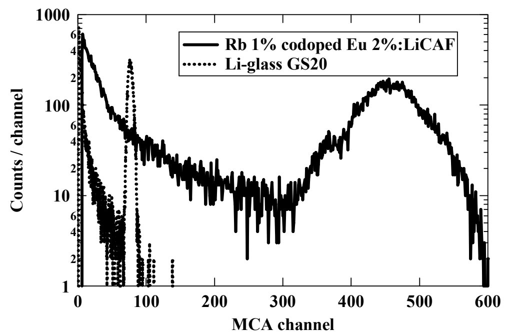


Fig.2 ^{252}Cf excited pulse height spctra of Rb 1% co-doped Eu 2% LiCAF single crystal and GS-20.

References

1. T. Yanagida, et al., *Opt Mater.*, **33**, 1243-1247 (2011).
2. A. Yoshikawa, et al., *Opt Mater*, **30**(1), 6–10, (2007).
3. Carel W.E. van Eijik,, Rad. Meas., **38**, 337-342 (2004).

Neutron detection with 3d-transition metal ions doped $LiCaAlF_6$ scintillator

Noriaki Kawaguchi[1]*, Takayuki Yanagida[1], Yutaka Fujimoto[1], Akihiro Yamaji[1], Atsushi Yamazaki[2], Kenichi Watanabe[2], Shunsuke Kurosawa[1], Yoshisuke Futami[1], Yuui Yokota[1], Akira Yoshikawa[1]

[1]*Tohoku University*, [2]*Nagoya University*

One of the radiation monitoring technologies, the neutron detection technique currently has a significant problem which is a shortage of ^3He gas. ^3He gas has been used as ^3He proportional counters for thermal neutron detection. After the terrorism of 9.11 in 2001, requirement about the development of thermal neutron detectors for security applications has dramatically increased. This requirement has been mainly filled with ^3He proportional counters and the depletion of ^3He gas has become a worldwide problem, because the supply of ^3He gas (20 kl/yr) is not enough to fill the demands (100 kl/yr). Therefore the alternative neutron detectors for ^3He gas are highly required.

For this purpose, we investigated neutron scintillators and found $LiCaAlF_6$ (LiCAF) based materials show excellent scintillation properties against neutron irradiation [1-6]. In LiCAF, neutron is detected by $^6Li(n,\alpha)^3H$ reaction. Due to low effective atomic number (Z_{eff} = 14) and low density of 2.98 g/cm^3, excellent suppression of background γ-rays can be expected. Up to now, Ce [3] or Eu [4-5] doped LiCAF exhibited good scintillation responses against neutron irradiation. Figure 1 exemplifies LiCAF single crystalline ingot grown by the conventional Czochralski method. In addition to these typical dopants, we have already investigated Tm and Er doped LiCAF [7].

In this workshop, we will represent a new attempt of 3d-transition ions doped LiCAF. We grew transitional metal ions doped LiCAF by the micro-pulling down method and evaluated their optical and scintillation properties systematically. Among grown samples, Cu^+ and Mn^{2+} doped LiCAF showed excellent scintillation responses.

Fig. 1. LiCAF single crystal ingot (left) and disk (right) with 4 inches diameter.

References

[1] H. Takahashi et al., "A Thermal-Neutron Detector with a Phoswich System of $LiCaAlF_6$ and BGO Crystal Scintillators onboard PoGOLite", IEEE NSS/MIC Conference record, 32-37 (2010).
[2] A. Yamazaki, et al., "Neutron-gamma discrimination based on pulse shape discrimination in a Ce:$LiCaAlF_6$ scintillator" Nucl. Instr. and Meth. A, 652, 435-438 (2011)
[3] T. Yanagida et al., "Crystal growth, Optical Properties, and Alpha-ray responses of Ce doped $LiCaAlF_6$ for different Ce concentration", Opt. Mater. 32 (2009) 311.
[4] T. Yanagida et al., "Europium and Sodium Codoped $LiCaAlF_6$ Scintillator for Neutron Detection", Appl. Phys. Exp., 4 106401 (2011).
[5] T. Yanagida et al., "Basic study of Europium doped $LiCaAlF_6$ scintillator and its capability for thermal neutron imaging application", Opt. Mater. ,33, 1243-1247 (2011).
[6] N. Kawaguchi, et al., "Thermal neutron imaging with rare-earth-ion-doped $LiCaAlF_6$ scintillators and a sealed ^{252}Cf source", Nucl. Instrum. Metho. A, 652 351 (2011).
[7] A. Yoshikawa et al., "Crystal growth and VUV luminescence properties of Er doped and Tm doped $LiCaAlF_6$", Opt. Mater., 32, 845 (2010).

Growth and scintillation properties of $(Lu_{1-x}Tm_x)_2SiO_5$ [x=0.001, 0.01, 0.1, 1]

Daisuke Totsuka[1], Takayuki Yanagida[2], Yutaka Fujimoto[1], Yuui Yokota[1]
and Akira Yoshikawa[1,2]
[1]IMR, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai 980-8577, Japan.
[2]NICHe, Tohoku University, 6-6-10 Aoba, Aramaki, Aoba-ku, Sendai, 980-8579, Japan.

In recent years, much attention has been focused on oxide-base scintillators for applications in nuclear spectroscopy, radiation detection and medical imaging. In medical applications, such as X-ray computed tomography (XCT) and positron emission tomography (PET), light output and stopping power are critical parameters. Ce^{3+}-doped Lu_2SiO_5 (Ce:LSO) is widely used for gamma-ray detection due to its high light yield of 33,000 ph/MeV and high density of host components mostly due to Lu. However, rare earth metals (without Ce^{3+}) doped LSO single crystals still have not been studied so much.

Tm^{3+} has been investigated as an emission center of phosphor materials and shows an interesting visible emission located in the blue range. As well as a phosphor application, it is proposed to use as an activator for scintillators. Relatively high light yield of 15,100 ph/MeV and moderate decay time with μs order when coupled to photo-detectors were exhibited in perovskite host and garnet host.

In this study, $(Lu_{1-x}Tm_x)_2SiO_5$ (x=0.001, 0.01, 0.1, 1) crystals were grown by the micro-pulling-down (μ-PD) method. All Lu sites can be substituted by Tm ions because ionic radii of Tm^{3+} are similar to that of Lu^{3+}. Then, scintillation properties including optical properties and radiation responses were investigated.

Figure 1 represents luminescence spectra by X-ray irradiation. The emission peaks are identified as $^3P_0\rightarrow{}^3H_6$, $^1D_2\rightarrow{}^3H_6$, $^3P_0\rightarrow{}^3F_3$, $^1D_2\rightarrow{}^3H_4$, $^1G_4\rightarrow{}^3H_4$, and $^1G_4\rightarrow{}^3F_5$ electronic transitions of Tm^{3+}. Figure 2 shows ^{137}Cs gamma-ray pulse height spectra of four different Tm concentration crystals compared with BGO scintillator of which light yield is well determined as 8200 ph/MeV. The 1% Tm doped crystal exhibited the highest light yield.

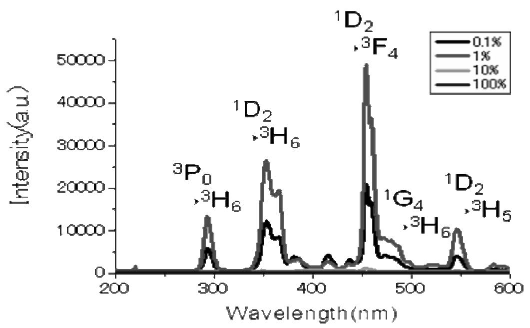


Figure 1. X-ray induced luminescence spectra of $(Lu_{1-x}Tm_x)_2SiO_5$. Black, red, green and blue lines represent Tm 0.1, 1, 10 and 100%, respectively.

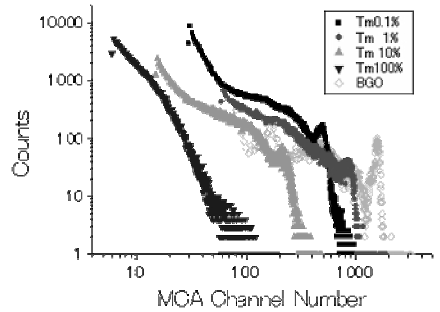


Figure 2. Pulse height spectra of $(Lu_{1-x}Tm_x)_2SiO_5$ under ^{137}Cs irradiation. Black, red, green, blue and light blue lines represent Tm 0.1, 1, 10, 100%, and BGO, respectively.

Optical and Scintillation Properties of Nd doped $YAlO_3$ with different concentrations

Daisuke Totsuka[1], Takayuki Yanagida[2], MakotoSugiyama[1], Yutaka Fujimoto[1], Yuui Yokota[1]
and Akira Yoshikawa[1,2]
[1]IMR, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai 980-8577, Japan.
[2]NICHe, Tohoku University, 6-6-10 Aoba, Aramaki, Aoba-ku, Sendai, 980-8579, Japan.

Inorganic scintillators play a major role in radiation detection in many sectors of fundamental and applied research, in almost all medical diagnostic imaging modalities and in many industrial measuring systems. In these applications, Ce^{3+}-doped scintillators are widely recognized as the promising materials due to their advantages such as fast decay time of several tens of nanoseconds and high light yield, e.g. Lu_2SiO_5 (LSO), $(Lu,Y)_2SiO_5$ (LYSO) and $YAlO_3$ (YAP). On the other hand, slow 4f-4f transitions have been playing an important role in X-ray detectors such as computed tomography (XCT) and security inspection system, because they show a low afterglow, high light yield and suitable emission wavelength to Si-photodiode (PD). The Si-PD has high quantum efficiency from 400 to 1100 nm where a lot of lines originated from the 4f-4f transitions of lanthanide elements are observed. In recent years, Nd^{3+} has been proposed to use as a scintillation activator. The 4f-4f transitions show several emission peaks from UV to IR wavelength range and μs order decay time. It has been reported that Nd doped scintillators exhibited light yield of 7500 photons/MeV with decay time of 5.0 μs in $Lu_3Al_5O_{12}$ (LuAG) host and light yield of 11000 photons/MeV with decay time of 2.5 μs and $Y_3Al_5O_{12}$ (YAG) transparent ceramics host .

Figure 1 represents pulse height spectra when YAP:Nd single crystals were coupled with the Si-APD (S8664-55) which has a wide sensitivity range from UV to NIR wavelength. The N_{phe}/MeV were estimated using ^{137}Cs 662 keV photo-absorption peak, compared with the direct irradiation to Si from ^{55}Fe 5.9 keV X-ray which creates 1639 electron–hole pairs. The results are represented in figure 2.

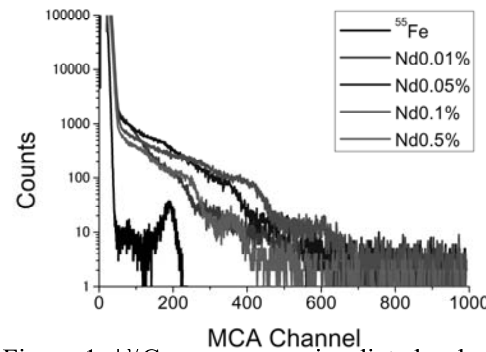


Figure 1. ^{137}Cs gamma-ray irradiated pulse height spectra of pure (black), Nd 0.01 (red), 0.05 (blue) and 0.1 (pink) and 0.5 (green) mol% doped YAP single crystals compared with the X-ray direct irradiation to Si-APD photodetector from ^{55}Fe 5.9 keV (black).

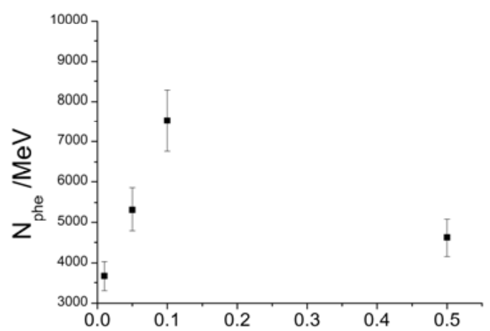


Figure 2. Photoelectron yields of Nd:YAPs against Nd concentration.

Nd-doped $Lu_3Al_5O_{12}$ single crystalline scintillator for X-ray imaging

Makoto Sugiyama[a, *], Yutaka Fujimoto[a], Takayuki Yanagida[b], Daisuke Totsuka[a, c], Yuui Yokota[a], and Akira Yoshikawa[a, b]

[a] *Institute for Materials Research, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai, Miyagi 980-9577, Japan*

[b] *New Industry Creation Hatchery Center (NICHe), Tohoku University, 6-6-10 Aoba, Aramaki, Aoba-ku, Sendai, Miyagi 980-8579, Japan*

[c] *NIHON KESSHO KOGAKU CO., LTD., 810-5 Nobe-cho, Tatebayashi, Gunma, Japan*

Our group recently studied scintillation properties of Nd-doped $Lu_3Al_5O_{12}$ (Nd:LuAG) single crystals. The material showed intense emission lines attributed to Nd^{3+} 4f-4f transitions in the visible region and the light yield of 7600 photons/MeV when coupled with the conventional PMT. Generally, silicon based photodetectors have higher quantum efficiency in this wavelength region than that of PMT. That is why we think scintillation photons will be collected more efficiently with the silicon based photodetector. The goal of this study is to investigate scintillation characteristics of Nd:LuAG scintillator against X-rays and to perform two dimensional X-ray imaging test with the bulk Nd:LuAG single crystal coupled with the silicon based photodetector.

The Nd:LuAG single crystalline scintillator was grown by the Czochralski method. Radioluminescence spectra were collected with a spectrograph (FICS 77441, Oriel) and CCD system (DU420-OE, Andor). As an excitation source, X-ray tube with Cu anode was used. To perform the imaging test using the scintillator, Teflon was used as a reflector in order to increase light collection efficiency. The crystal was directly coupled with a two dimensional CCD imaging sensor (S8985-02, Hamamatsu). In the imaging experiment, X-ray was generated from a tungsten target.

The fabricated single crystal was transparent and cut and polished. Fig. 1 illustrated X-ray excited radioluminescence spectum of Nd:LuAG scintillator. The broad emission around 300 nm due to the host emission was observed. In addition, sharp emission peaks attributed to Nd^{3+} 4f-4f transitions were clearly detected in the wavelengths longer than 400 nm. The result of X-ray imaging will be discussed in the workshop.

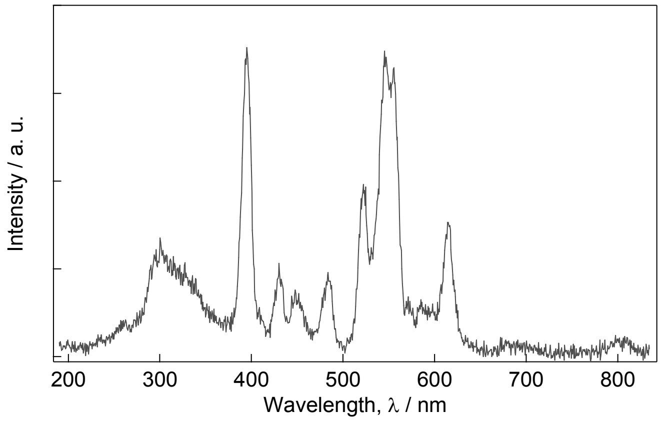


Fig. 1 X-ray induced radioluminescence spectrum of the Nd:LuAG single crystal.

Crystal growth and luminescence properties of Pr-doped $LuLiF_4$ single crystals

Makoto Sugiyama[a, *], Takayuki Yanagida[b], Yuui Yokota[a], Yutaka Fujimoto[a], and Akira Yoshikawa[a, b]

[a] *Institute for Materials Research, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai, Miyagi 980-9577, Japan*

[b] *New Industry Creation Hatchery Center (NICHe), Tohoku University, 6-6-10 Aoba, Aramaki, Aoba-ku, Sendai, Miyagi 980-8579, Japan*

Ce-doped scintillators have been developed in past two decades because Ce^{3+} exhibits highly efficient and fast 5d-4f luminescence. On the other hand, recent studies have shown that Pr-doped materials also exhibit 5d-4f transitions and can be alternative to Ce^{3+} doped scintillators. The parity and spin allowed 5d-4f transitions of Pr^{3+} receive attention from the aspect of the decay time which is generally faster than that of Ce^{3+}. Recently, our group examined scintillation properties of Ce-doped $LuLiF_4$ scintillator and the material exhibited the light yield of 3600 photons/MeV under gamma-ray irradiation. Instead of Ce^{3+}, Pr^{3+} ions were doped in the $LuLiF_4$ host lattice in this study and scintillation properties of the material were investigated. This is the first time to investigate scintillation responses of Pr:$LuLiF_4$.

The Pr-doped $LuLiF_4$ single crystal was grown with the vacuum tight micro-pulling-down (μ-PD) method. The grown crystal was cut perpendicular to the growth axis and polished for the evaluation of the optical and scintillation properties.

The grown single crystal was transparent and about 80% transparency was achieved at UV to visible wavelengths and some absorption bands due to Pr^{3+} 5d-4f and 4f-4f transition were observed. Fig. 1 demonstrated the radioluminescence spectrum of the Pr-doped $LuLiF_4$ single crystal. Emission peaks due to Pr^{3+} 5d-4f transitions at approximately 210-270 nm were detected. Emission lines at wavelengths longer than 430 nm are attributed to 4f-4f transitions of Pr^{3+}. In the workshop, other properties such as γ-ray induced light yield and decay time will be discussed.

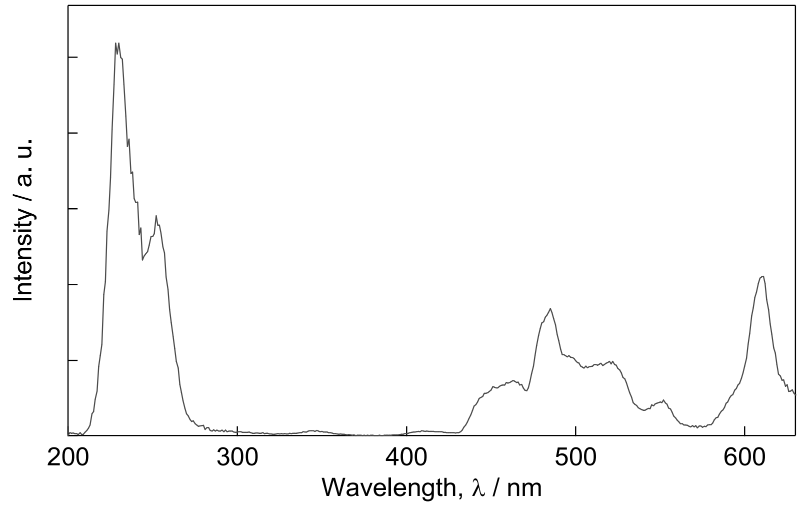


Fig. 1 ^{241}Am α-ray excited radioluminescence spectrum of the Pr-doped $LuLiF_4$ single crystal.

Evaluation of the scintillation properties of Yb^{3+} ion doped Lu_2O_3 ceramics

S.Wakahara[A], T.Yanagida[B], Y.Fujimoto[A], M.Sugiyama[A], Y.Yokota[A], A.Ikesue[C], A.Yoshikawa[A,B]

[A]*Institute for Materials Research, Tohoku University*

[B]*New Industry Creation Hatchery Center (NICHe), Tohoku University*

[C]*World Labo. Co. Ltd.*

The applications of scintillator require luminescent materials that can absorb high-energy photons or particles and convert them to luminescence. Therefore, single crystals are suited and generally used, however there are some merits of using transparent ceramics as scintillator instead of single crystals, for example they have better chemical uniformity and can be produced with higher amount of the dopant comparing to corresponding single crystals.

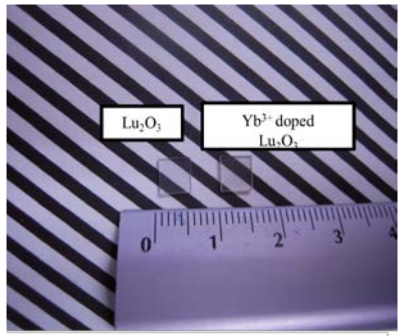


Fig.1 View of transparent ceramic specimens: pure (left) and Yb 0.5% doped (right) Lu_2O_3.

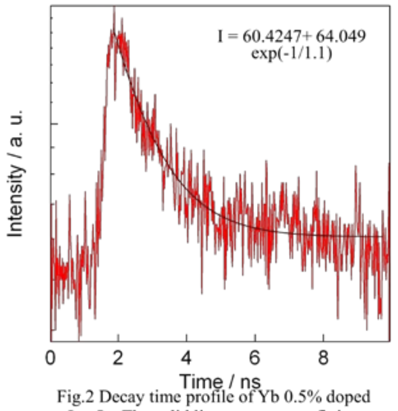


Fig.2 Decay time profile of Yb 0.5% doped Lu_2O_3. The solid line represents a fitting function. (λ_{em}=350nm)

Lu_2O_3 ceramics are high density and have high effective atomic number, i.e., γ-ray stopping power is fine. Furthermore, Yb^{3+} charge transfer transition is well known as fast and intense emission. Therefore, we have estimated the optical and scintillation properties of pure and Yb^{3+} doped Lu_2O_3 transparent ceramics.

Pure and Yb^{3+} doped Lu_2O_3 ceramics samples were made by sintering method in *World Labo.Co. Ltd.*. The characteristic of the method is synthesizing the precursor by solid state reaction. Sintered samples were cut and polished to the physical dimensions of 5.0×5.0×1.0 mm^3. The transmittance spectra of the samples were measured as the optical property. Radio luminescence spectra were measured using 5.5MeV α-ray (^{241}Am) as the excitation source. The decay time of Yb^{3+} doped one was measured using streaks camera. The light yield of Yb^{3+} doped one was also measured under 5.5MeV α-ray excitation.

The appearance of the samples is shown in Fig. 1. Both of the samples were visibly transparent and they had neither cracks nor inclusions. Fig.2 shows the decay curve of the Yb^{3+} doped Lu_2O_3. The decay time profile was well reproduced by single exponential function, and the decay time found for the sample was 1.1 ns.

TV, Journals and Newspaper Items

H24.3.30 化学工業日報（3面 基礎／石油／自動車・機能材料）

太陽電池用石英ルツボ

耐久性向上で差別化

使用回数増加など武器 新規顧客を開拓

倉元製作所

倉元製作所は、石英事業を強化する。主力の太陽電池用石英ルツボの高耐久性化を図ることで、ユーザーが単結晶シリコン引き上げに使用できる回数を増加、品質向上も期待できるというメリットを強みとして需要拡大を目指す。太陽電池産業は、市場低迷や参入企業の拡大から価格競争が激化し、製造メーカーの再編も進んでいる。同社ではこうした機会を好機と捉え積極的な営業活動を展開、従来以上に新規顧客の開拓を推進していく方針だ。

倉元製作所の石英事業は、石英ルツボを中心にこれまで順調に出荷を拡大してきたが、昨年の東日本大震災の影響から生産が一時停止を余儀なくされ、出荷が減少した。その後生産も再開し、市場は徐々に回復したが、秋ごろから需要が冷え込み、今年初めには震災前と比べて売上高が半分ほどまでに落ち込んだ。欧州需要の低迷などを受けて太陽電池は供給過剰傾向にあり、在庫増加も継続している。

こうしたなか、同社は石英ルツボの高機能化を推進、他社との差別化を追求することで事業の拡大を狙う。

石英ルツボはシリコン単結晶を製造する際の引き上げに利用され、シリコン単結晶の歩留まりや品質を決定する重要部材になっている。同社は高温状態でも石英ルツボの変形を抑えることができる高耐久性の製品開発を進めることで、ユーザーのメリットを高める方針。シリコン単結晶の品質向上に加え、繰り返し使用する回数を増やすことができるという強みを武器に採用件数を拡大し、売り上げ増を目指す。

太陽電池業界では現在需要が停滞、供給過剰の状況となっているが、年後半には需要も回復すると見込まれる。同社では今後も製品開発に力を注ぎ、競争力向上を狙う。

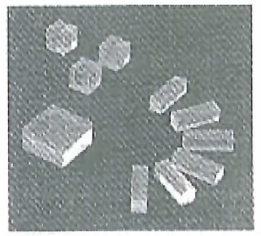
H24.4.2 化学工業日報（6面 エレクトロニクス）

GAGG結晶 用途開拓を強化

古河機械金属

放射線測定器を拡販

古河機械金属は、新開発のシンチレーター結晶「GAGG（ガドリニウム・アルミニウム・ガリウム・ガーネット）結晶」の用途開拓を強化する。発光量や発光波長など、GAGG結晶が有する優れた特性を活用。同結晶を搭載した放射線測定器「ガンマスポッター」の拡販に加え、ラインアップ強化の一環として食品用測定器の開発に注力する。さらに次世代がん診断装置「MRI－PET」（核磁気共鳴－陽電子放射断層撮影装置）やPEM（陽電子撮像乳がん検診装置）など、医療関連機器への応用も検討していく。



GAGG結晶

医療用にも応用

シンチレーターは、アルファ線やガンマ線、X線などの放射線を可視光に変換する半透明の発光材料。PETでの利用では、被験者に投与した薬剤をがん細胞が吸収するとガンマ線が放出、これを受けシンチレーターが発光し、がん細胞を検出する。また石油探査用装置への搭載も見込まれている。

食品用の開発に力

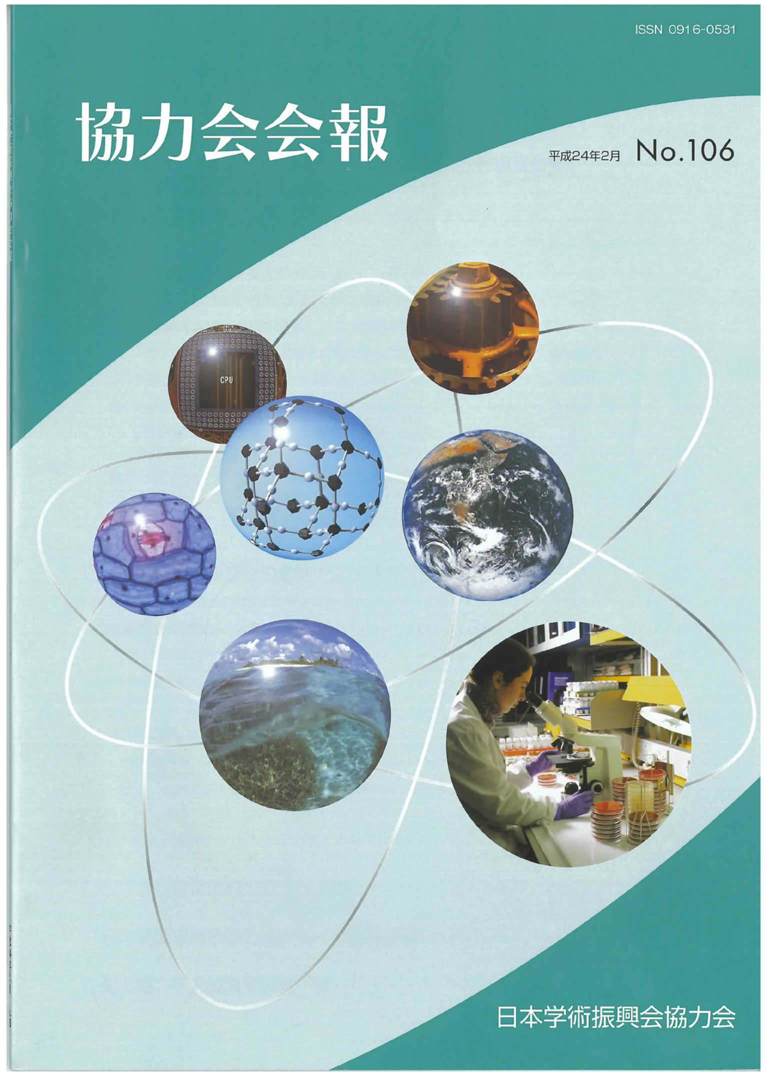
古河機械金属が東北大学と共同で開発したLuAG（ルテチウム・アルミニウム・ガーネット）結晶は、従来のBGO結晶に比べ発光量が3倍で発光減衰時間が20ナノ秒と短く、機械的強度が大きいことが特徴。同社は現在、LuAG結晶を搭載したPEMの13年の市場投入へ向け準備を進めている段階。

今回新たに開発したGAGG結晶は、LuAG結晶に比べ発光量を3倍強となる6万5000ph／MeVに向上。融点をおよそ100度C低い1850度Cとすることで、ルツボの耐久性向上にも貢献する。最大発光波長が520ナノメートルと長いことから、機器の小型化を実現できる。アイソトープを含有するルテチウムを使用していないことから自己放射線がなく、より正確な放射線量測定も可能となる。

同社は現在、複数の次世代シンチレーター結晶の開発に取り組んでいる。GAGG結晶に関しては、2011年夏に2インチへの成長を実現したことから、同年11月に同結晶を搭載したガンマスポッターを発売した。この3月には、測定範囲と電池寿命などを向上した新製品「FGS－02A」を市場投入している。

同社は今後のGAGG結晶への取り組みとして、さまざまな展開を計画している。放射線測定器については、現在の空間放射線量測定に加え、食品の放射線量を測定できる装置などを開発、製品バリエーションの拡充を進める。すでに販売されている他社製品に比べリーズナブルな価格に設定し、少ない検体で短時間に測定が行える装置とする予定。

また、GAGG結晶はLuAG結晶同様、PETやPEMでの利用が可能なことから、将来的には医療関連機器用途での展開も視野に入れる。同結晶に関しては、2インチサイズの結晶を安定的に成長できる体制を構築。結晶での提供も実施していく考え。



◇産学協力研究委員会の設置等

前号掲載以降、産学協力研究委員会の設置１件、設置継続２件が独立法人日本学術振興会より承認された。各研究委員会の概要は次のとおり。

「放射線科学とその応用第186委員会」の設置

(1) 委員会名：「放射線科学とその応用第186委員会」
(2) 設立発起人代表：井口　哲夫（名古屋大学大学院工学研究科　教授）
(3) 委員数：53名（学界委員27名，産業界委員26名）
(4) 設置期間：平成24年4月1日から平成29年3月31日（5年間）
(5) 設置趣旨等：以下のとおり。なお、本委員会の設立総会及び第1回研究会は平成24年4月以降に開催予定

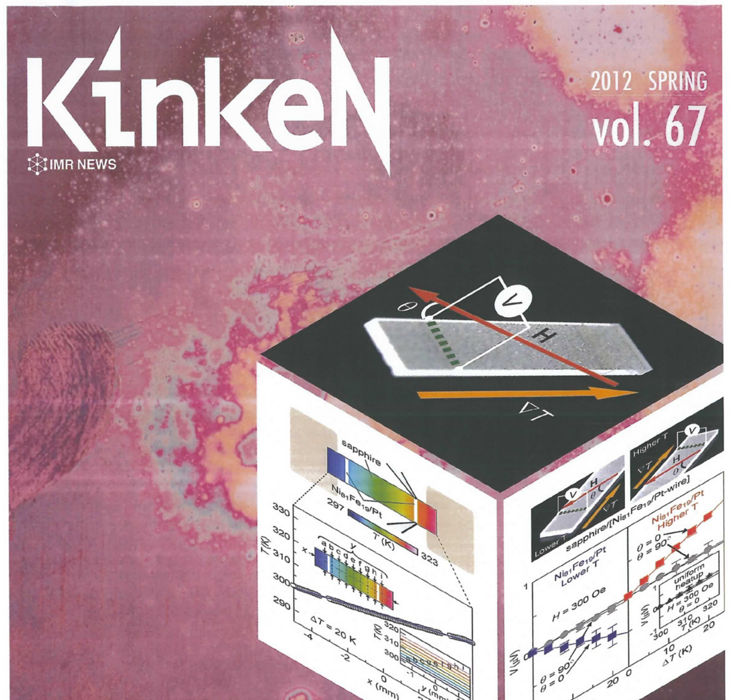
「放射線科学とその応用第186委員会」の設置申請書

1．経緯・目的

発起人らは、我が国における医療、セキュリティ、基礎科学において近年とみにその重要性が高まっているにも関わらず、学界、産業界を統合して意見交換を行う場が皆無であることを憂い、発起人らを中心に平成20年度より「放射線物理学研究会」を結成し、継続的に意見交換を行ってきた。同研究会は、学界、産業界のメンバーが放射線の応用分野、計測技術、デバイス開発、検出器開発などの分野で活躍する研究者に情報交換と討論の場を提供し、問題提起の場となった。殊に当該分野においては、放射線計測機器の材料・デバイス側と検出器・装置側との乖離が大きく、その溝を埋めるため、学界のみならず、材料・デバイスメーカー、検出器・装置メーカーからの出席者が議論する場を設けることを主眼に活動を行ってきた。

最近はこうした活動が実を結び、幾つかの研究機関と材料企業・検出器企業が協力して研究開発を行い、共同で国家プロジェクトを獲得する等の産学連携活動も行われるようになってきた。今後も医療、セキュリティ、基礎科学など広汎な応用分野を有する放射線科学において、こうした産学連携活動の充実は望ましく、またその中心となる活動母体の必要性も増してきている。こうした情勢に加えて、現在、日本の置かれている状況、放射線検出に対する国民の要請等も鑑み、「放射線物理学研究会」委員（東大、京大、名大、東北大、九大、北大等で構成）より、「放射線物理学研究会」により多くの知を集積させ、放射線計測と表裏一体をなす放射線発生技術も包含し、日本学術振興会の産学協力研究委員会として活動を行うべきであるという意見が出された。

この意見提示に基づき、「放射線物理学研究会」委員の間で慎重に討議し、関係のある企業の方々に判断を求めたところ、ほぼ全員の方より賛同を得、「放射線科学とその応用」委員会設立の申請を行うこととした。



CONTENTS 目次

■トップメッセージ／所長　新家光雄
■研究室紹介／バウアー研究室　吉川研究室
■研究最前線／スピン注入により銀に巨大な磁気を持たせることに成功
音波から磁気の流れを創り出すことに成功
■退職のご挨拶／川添良幸　石黒三岐雄　笹森賢一郎
■金研物語 第二部／金研低温の歴史:本多光太郎欧州留学ー青山新一ー袋井忠夫、神田英蔵ー日本初のヘリウム液化まで
■金研ニュース／東北大学金属材料研究所共同研究ワークショップおよび日本バイオマテリアル学会
東北地域講演会「次世代金属系バイオマテリアル開発の新たな展開」報告
材料科学国際週間2011報告
「復興祭」報告

上／音波によるスピン流生成実験に用いた試料の写真　左右／音波誘起スピン流の測定結果
写真提供：齋藤研究室

TOHOKU UNIVERSITY

先駆的機能性結晶開発と先進センサーの具現化で未来を拓く

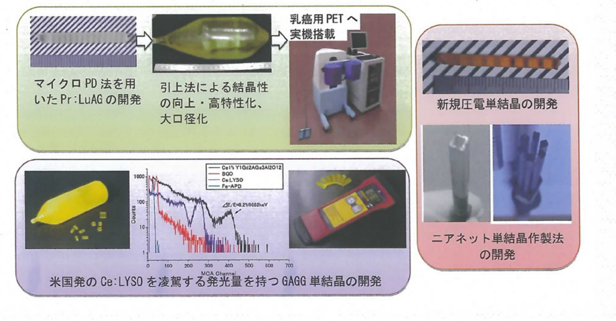
先端結晶工学研究部
吉川　彰

本研究室では、放射線や光、熱、圧力などの外部からのエネルギーと結晶との相互作用に興味を持ち、①化学と物理の両側面からの材料設計、②合成プロセスの開発、③相互作用の評価と理解、の3つの切り口から先駆的な機能性結晶の開発研究を進めています。研究体制は、研究室内で異分野融合を行っており、要素技術の上流から下流までを垂直統合する体制で取り組んでいます。下流のデバイス側の要請を踏まえて上流の材料設計を行うことで、ユーザーに求められる特性の発現をターゲットにして、産学連携体制で取り組んでおり、優れた特性を持つ結晶に関しては、そのデバイス化、実機搭載にも主体的に関わる点も研究室の特徴です。

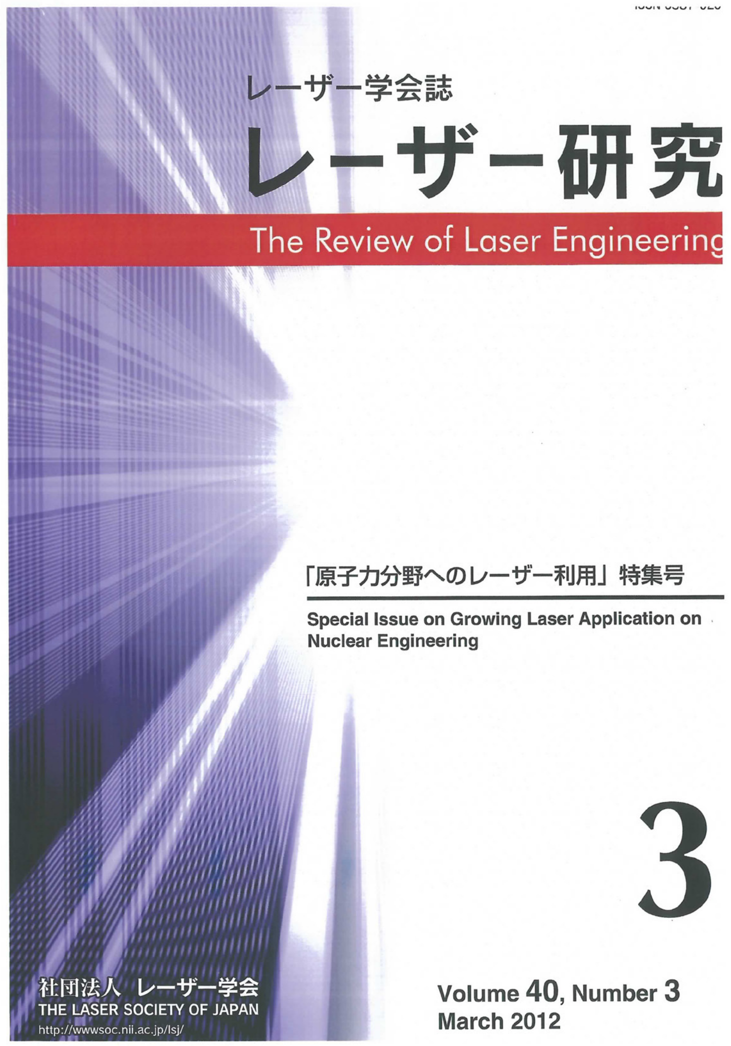
新規機能性結晶の開発には、スクリーニングと高品質化との2つのプロセスが重要になります。スクリーニングにはマイクロ引下法という独自の迅速単結晶作製法を用いております。当該法は従来法に比して数十倍の高速作製も可能であるため、これを駆使して一連の組成の結晶を短期間で作製し、組成分析、結晶性評価、光や放射線、圧力、熱等の応答評価からのフィードバックを反映させて最適化して行きます。組成最適化後の高品質化は引上げ法という半導体の高品質バルク単結晶の量産に用いられる方法を利用し、結晶性が最も高い状態での特性評価も行っています。

これまでに乳癌診断用LuAG結晶やハンディータイプの放射線量モニタ用GAGG結晶、新規中性子線用のLiCAF結晶（セキュリティー、宇宙観測用等）といった、シンチレータ開発を産学連携体制で取り組み、実用化させてきました。また、自動車の燃焼圧センサ用のランガサイト型圧電体の開発や心筋梗塞や動脈硬化用ステントなどの医療応用が期待される難加工性合金の形状制御といった結晶成長技術の開発も産学連携体制で取り組んでいます。その他にも中性子・ガンマ線分別法や真空紫外線発光シンチレータ用ガス検出器の開発といった検出器の基礎的な研究開発を大学間で連携しながら進めています。

今後も新規結晶材料の開発やそれを用いた新規の応用分野開拓に尽力して参る所存です。



■吉川研究室URL　http://yoshikawa-lab.imr.tohoku.ac.jp/



Special Issue

Laser Review

シンチレータとそれを用いた放射線モニター

吉川 彰[1,3]，柳田 健之[2]，福田 健太郎[1,3]，河口 範明[1,3]，鎌田 圭[1,4]，藤本 裕[1]，横田 有為[1]，黒澤 俊介[1]
[1]東北大学金属材料研究所（〒980-8577 宮城県仙台市青葉区片平2-1-1）
[2]東北大学未来科学技術共同研究センター（〒980-8579 宮城県仙台市青葉区荒巻字青葉6-6-10）
[3](株)トクヤマ（〒100-8983 東京都千代田区霞が関3-2-1）
[4]古河機械金属(株)（〒100-8370 東京都千代田区丸の内二丁目2番3号）

Survey Meter Using Novel Inorganic Scintillators

Akira YOSHIKAWA,[1,3] Takayuki YANAGIDA,[2] Kentaro FUKUDA,[1,3] Noriaki KAWAGUCHI,[1,3] Kei KAMADA,[1,4] Yutaka FUJIMOTO,[1] Yuui YOKOTA,[1] and Shunsuke KUROSAWA[1]
[1]Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai, Miyagi 980-8577
[2]New Industry Creation Hatchery Center (NICHe), 6-6-10 Aoba, Aramaki, Aoba-ku, Sendai, Miyagi 980-8579
[3]Tokuyama Corporation, 3-2-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8983
[4]Furukawa Co., Ltd., 2-3 Marunouchi 2-chome, Chiyoda-ku, Tokyo 100-8370

(Received January 20, 2012)

Single crystal scintillator materials are widely used for detection of high-energy photons and particles. There is continuous demand for new scintillator materials with higher performance because of increasing number of medical, industrial, security and other applications. This article presents the recent development of three novel inorganic scintillators; Pr-doped $Lu_3Al_5O_{12}$ (Pr:LuAG), Ce doped $Gd_3(Al, Ga)_5O_{12}$ (Ce:GAGG) and Ce or Eu-doped $^6LiCaAlF_6$ (Ce:LiCAF, Eu:LiCAF). Pr:LuAG shows very interesting scintillation properties including very fast decay time, high light yield and excellent energy resolution. Taking the advantage of these properties, positron emission mammography (PEM) equipped with Pr:LuAG were developed. Ce:GAGG shows very high light yield, which is much higher than that of Ce:LYSO. Survey meter using Ce:GAGG is developed using this scintillator. Ce:LiCAF and Eu:LiCAF were developed for neutron detection. The advantage and disadvantage are discussed comparing with halide scintillators. Eu-doped LiCAF indicated five times higher light yield than that of existing Li-glass. It is expected to be used as the alternative of ^3He.

Key Words: Inorganic scintillator, High-energy photons and particles, Survey meter, Positron emission mammography

1. はじめに

シンチレータは陽電子断層撮影装置(PET)やX線コンピュータ断層映像装置(X線CT)に代表される核医学、石油や鉱物資源探査装置、空港の手荷物検査などのセキュリティチェック、原子炉モニタリングポスト、大型建造物の非破壊検査、高エネルギー物理学など多岐に渡る。装置の性能を決定づけるのがシンチレータであり、高い発光量、高いエネルギー分解能、早い応答速度（短い蛍光寿命）、高い阻止能、化学的安定性、量産性などが求められる。シンチレータはX線、γ線、中性子などの放射線を光に変換する材料であり、光電子増倍管などの光検出器と組み合わせて放射線検出器に用いられる。

最も重要な特性は発光量であるが、PETの様に同時計測を必要とする応用では、高速応答のシンチレータが求められており、time of flight方式の導入を視野に入れれば、今後は蛍光寿命が発光量以上に重要な特性と位置付けられる可能性も高い。蛍光寿命と発光波長における式(1)の関係があることが経験的に知られており[1]、同じ発光メカニズムであれば発光波長の短いシンチレータが好ましいことになるが、実用の観点からは受光素子の波長感度も考えねばならない。

$$\Gamma = \frac{1}{\tau} = \frac{n}{\lambda_{em}^3}\left(\frac{n^2+2}{3}\right)^2 \sum_f |\langle f|\mu|i\rangle|^2 \quad (1)$$

ここで、Γは遷移確率、τは蛍光寿命、nは屈折率、λ_{em}は発光波長、f, iは基底状態と励起状態の波動関数、μは双極子演算子である。

金窓会会報

第64号
発行所
東北大学工学部
マテリアル・開発系金窓会
印刷・東北大生協プリントコープ

出会いは人生の宝

金窓会会長　今井 卓雄（昭和三十四年金工卒）

日本一安全・安心な教育・研究棟を目指して

マテリアル・開発系新教育・研究A棟設計WG長　杉本 諭（昭和五十七年金材卒）

図1　マテリアル・開発系新教育・研究A棟外観イメージ図

●名簿代金納入のお願い

今回皆様のお手元に、平成24年度版の金窓会名簿をお届け致しました。この名簿発行に係わる費用は、会員の皆様から頂戴する名簿代金で賄われます。また、名簿代金と共に3年間分の通信費（1,000円）を併せて頂戴することになっております。

名簿代金は印刷版：6,000円、CD版：5,000円、両方：7,000円（いずれも通信費込）となります。

つきましては、名簿代金及び通信費を同封の振込用紙（郵便局またはコンビニエンスストア）をご利用の上、お早めにご納入下さいますよう、お願い申し上げます。

※金窓会では、年会費を頂いていない事から皆様より納入される名簿代金で運営を続けております。ご理解の上、早めの納入をお願い申し上げます。

金属材料研究所　先端結晶工学研究部

吉川　彰（教員会員）

平成二十三年四月より金属材料研究所先端結晶工学研究部の教授を拝命することになり、研究室のメンバーと色々構想を練っていた矢先に、東日本大震災が起こりました。犠牲者の方々のご冥福をお祈りいたしますとともに、ご家族にお悔やみを申し上げます。震災時には、研究室の居室及び実験室はまだ移設準備中で、多元物質科学研究所内にあったのですが、幸い私ども研究室の学生やスタッフは全員無事でした。建物などの被害も軽微で済んだようなのですが、研究室の実験装置（結晶合成装置は全て）が損傷してしまい、実験の完全な再開には時間を要しました。その際に、多くの共同研究先の大学や企業の方々からの多大なご支援を頂きましたこと、この場を借りて厚く御礼申し上げます。

研究は人類の幸福のために役に立つ結晶を創成することが大目的です。その意味で、実用化を意識した産学連携の研究を多く進めております。産学連携研究体制の中での我々の担当は基礎研究の部分となっておりますが、材料設計、ものつくり、特性評価、デバイス化といった要素技術の上流から下流までを研究室内で全て行う一気通貫研究体制を特徴としております。化学系、物理系両方のスタッフが必須であり、研究室内で異分野融合を行っております。

研究室では現在、主に三つの大きなテーマについて取り組んでおります。一つはシンチレータ材料の開発であり、ガンマ線用ガドリウム・アルミニウム・ガリウムガーネット（GAGG）や熱中性子用リチウム・カルシウム・アルミニウムフロライド（LiCAF）、赤外発光シンチレータの開発などが挙げられます。GAGGは開発から二年弱ですが、放射線量計測用のサーベイメータとしてすでに実機搭載され、現在、福島原発周辺の環境放射線の把握などに使用されております。LiCAFは昨年、宇宙放射線の観測を目的とした日米欧の国際共同プロジェクトのPoGOLite気球実験に使用され、宇宙からの中性子線の検出に成功という快挙を成し遂げました。赤外発光シンチレータの開発は、放射線治療用のリアルタイム線量計として、最先端・次世代研究開発支援プログラムの下に進めております。二つ目のテーマとして自動車の燃焼圧センサー用ランガサイト型圧電結晶の形状制御技術開発を四社と共同研究で戦略的基盤技術高度化支援事業の支援の下に行っています。また、別の四社と共同研究も始まり、難加工性合金材料の形状制御技術とその際に用いる坩堝の開発をテーマに、こちらも戦略的基盤技術高度化支援事業の支援の下、研究を進めております。

研究活動を通じて東北の復興のため、日々精進して参る決意です。また、今回の震災では風評被害なども多く、改めてパブリックアウトリーチ活動の重要性を認識致しました。……重要視しながら研究活動……て参る所存です。

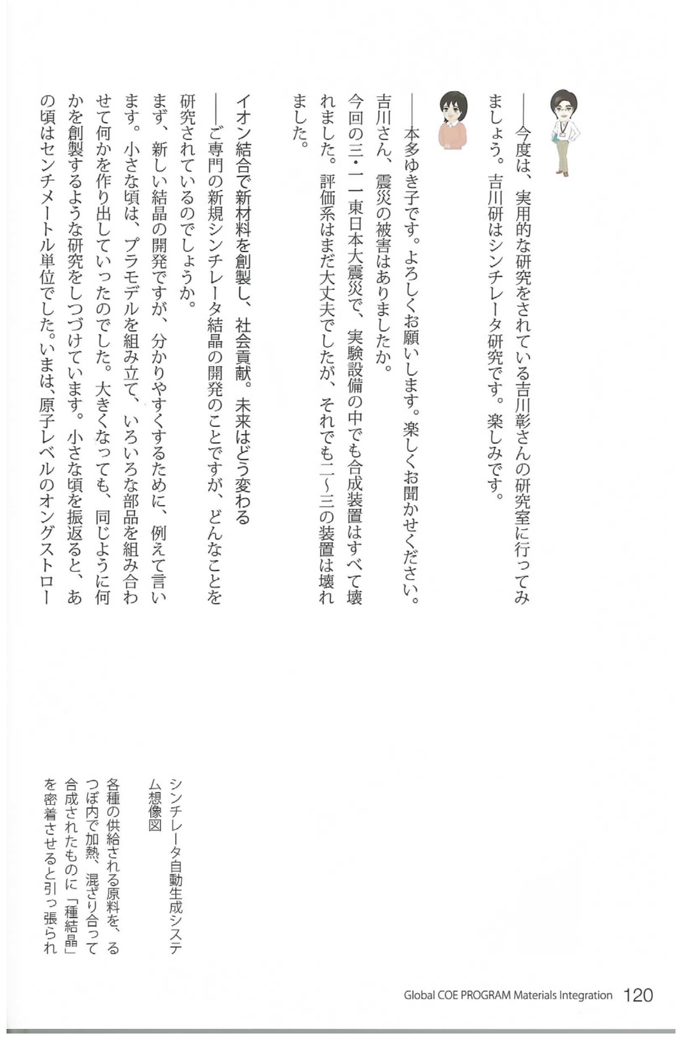
多元物質科学研究所　新機能無機物質探索研究センター

蔡　安邦（昭和六十二年…）

会員の皆様にはますますのご健勝と慶びを申し上げます。

多元研の新機能無機物質探索研究センター、金属機能設計研究分野を担当する蔡 安邦と申します。多元研において、国内外の「新物質探索」の最近の動向に先駆けた戦略的な活動を展開するという趣旨で平成二十四年度より本センターが設立されました。材料システム工学の協力講座として平成十六年一月に発足以来、一貫して金属を中心に「準結晶」と「触媒」の二本立てで研究を推進しています。準結晶は結晶やアモルファスとは異なる新しい構造物質であり、準周期に由来する新奇な性質が期待されています。昨年、準結晶の発見でノーベル化学賞に輝いたことは皆様には記憶新しいと思います。研究室では新しい準結晶の合成、単準結晶の育成、構造解析および準結晶の表面科学などの基礎研究と、準結晶を用いた触媒調製および高強度軽合金の研究開発などを進めています。また、価電子制御および組織制御に基づき、新しいタイプの触媒を調製すると同時に、触媒作用における金属電子構造と組織の役割を解明することで、合金触媒設計の基本原理を確立することを目指します。

Cd-Yb系2元準結晶……



――今度は、実用的な研究をされている吉川彰さんの研究室に行ってみましょう。吉川研はシンチレータ研究です。楽しみです。

――本多ゆき子です。よろしくお願いします。楽しくお聞かせください。吉川さん、震災の被害はありましたか。

今回の三・一一東日本大震災で、実験設備の中でも合成装置はすべて壊れました。評価系はまだ大丈夫でしたが、それでも二～三の装置は壊れました。

――ご専門の新規シンチレータ結晶の開発のことですが、どんなことを研究されているのでしょうか。

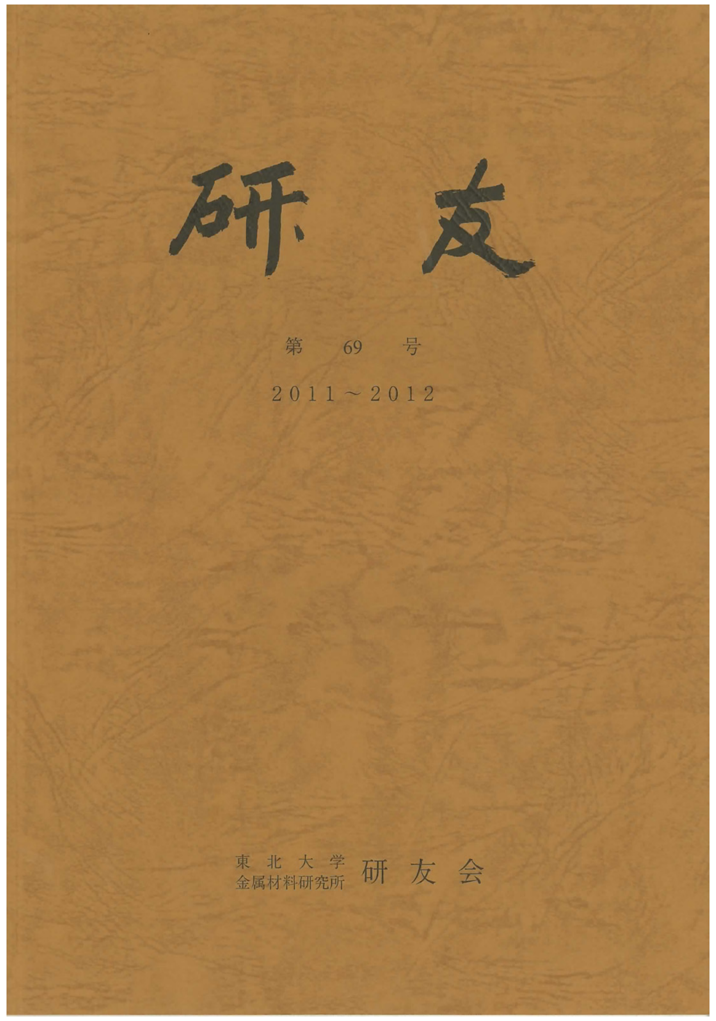
イオン結合で新材料を創製し、社会貢献。未来はどう変わる

まず、新しい結晶の開発ですが、分かりやすくするために、例えて言います。小さな頃は、プラモデルを組み立て、いろいろな部品を組み合わせて何かを作り出していったのでした。大きくなっても、同じように何かを創製するような研究をしつづけています。小さな頃を振返ると、あの頃はセンチメートル単位でした。いまは、原子レベルのオングストロー

シンチレータ自動生成システム想像図

各種の供給される原料を、るつぼ内で加熱、混ざり合って合成されたものに「種結晶」を密着させると引っ張られ

Global COE PROGRAM Materials Integration 120



23

先端結晶工学研究部

吉川 彰（教授），横田有為（助教），黒澤俊介（助教）

【キャッチコピー】

先駆的機能性結晶開発と先進センサーの具現化で未来を拓く

【紹介文】

本研究室では，外部からのエネルギーと結晶との相互作用に興味を持ち，①化学と物理の両側面からの材料設計，②合成プロセスの開発，③相互作用の評価と理解，の3つの切り口から先駆的な機能性結晶の開発研究を進めています。また，「物質」を実際に使われる「材料」へと昇華させることも重要視し，優れた特性を持つ「材料候補」に関しては，そのデバイス化，実機搭載にも主体的に関わる点も研究室の特徴です。

研究体制は，研究室内で異分野融合を行っており，要素技術の上流から下流までを垂直統合する体制で取り組んでいます。下流のデバイス側の要請を踏まえて上流の材料設計を行うことで，ユーザーに求められる特性の発現をターゲットにして，産学連携体制で取り組んでおります。

新規機能性結晶の開発には，スクリーニングと高品質化との2つのプロセスを用います。単結晶材料開発では，スクリーニングにマイクロ引下法という独自の高速単結晶作製法を用いていますが，この方法は従来法に比して数十倍の高速作製が可能であるため，これを駆使して一連の組成の結晶を短期間で作製し，組成分析，結晶性評価，光や放射線，圧力，熱等の応答評価からのフィードバックを反映させて最適化して行きます。組成最適化後の高品質化は引上げ法という半導体の高品質バルク単結晶の量産に用いられる方法を利用し，結晶性が最も高い状態での特性評価も行っています。

これまでに乳癌診断用 Pr:LuAG 結晶（図1）やハンディータイプの放射線量モニタ用 GAGG 結晶(現状の世界最高シンチレータの倍の発光量を記録)(図2)，高発光量・高エネルギー分解能の SrI_2 結晶，新規中性子線用の LiCAF 結晶（セキュリティー，宇宙観測用等）といった，シンチレータ開発を産学連携体制で取り組み，実用化させてきました。また，自動車の燃焼圧センサー用のランガサイト型圧電結晶の開発（図3）や心筋梗塞や動脈硬化用ステントなどの医療応用が期待される難加工性合金の形状制御といった結晶成長技術の開発も産学連携体制で取り組んでいます。

Pr:LuAG を実機搭載した純国産の乳がん用 PET (PEM) 装置（図1）は，乳がんの検査装置である。乳がんは最近30年の間に急激に増加しており，女性の罹患するがんの第一となっています。毎年一万人が乳がんで命を落としており，特に30－50代の働き盛りの年代が犠牲となっています。乳がんは早期に発見されれば治癒率が高いため，その検出精度が上がることで早期発見，ひいては生存率の向上に繋がり，働き盛りの世代を救うことができます。本研究室で開発した Pr:LuAG の特性を活かし，JST の助成を受けて東北大病院，古河機械金属，仙台画像検診クリニックと協力し世界に先駆けて PEM 装置を開発致しました。

Ce: GAGG は化学的に安定で潮解性の無いシンチレータの中で世界最高発光量有します。また発光波長が520nm と長波長のため，APD やガイガーモード Si-APD（Si-PM）などの小型，薄型の半導体光検出器と相性が良く，組合せることで高いエネルギー分解能が実現できます。このため，従来の PMT を用いる方式に比べ革新的な小型化が可能となっております。技術移転を行い，古河機械金属にて，Ce:GAGG と Si-PM を組合せた小型，高感度のサーベイメータである商品名「ガンマスポッター」を商品化して頂きました（図2）。本サーベイメータでは潮解性のなく高感度な GAGG を用いることで，高湿度名環境下でもリアルタイ

List of Events

2012年度（平成24年度）吉川研究室行事

月	吉川研究室	学会	研究会・講演会
4		4/23-26 Solid State Chemistry(Russia)	4/17-18 大阪大学レーザー研シンポジウム 2012（大阪） 4/23-26 FMA29（京都）
5		5/12-17 SORMA-WEST2012(Oakland)	5/30 学振１８６委員会(東京) 5/17-18 学振１６１委員会(宮崎)
6		6/6-7 ICOOPMA2012(奈良)	
7		7/1-6 EXCON2012(Russia) 7/9-13 ISAF ECAPD 2012(Portugal)	7/13-14 学振１６１委員会(京都)
8			8/31 学振１８６委員会(東京) 8/20-21 3rd International symposium (蔵王)
9		9/18-14 LUMDETR2012(HALE,GERMANY) 9/11-14 日本物理学会 2012（京都）	9/19-21 セラミックス協会第25回秋季シンポジウム（名古屋） 9/21 学振１６１委員会(名古屋) 9/27 大洗研究会（大洗）
10		10/13-18 DSEC4 (Washington) 10/29-11/4 IEEE NSS/MIC 2012(Anaheim)	10/19 学振１８６委員会(京都)
11		11/7-10 日本希土類学会（沖縄） 11/8-10 結晶成長国内会議（九州）	
12	12/21 忘年会	12/1-3 放射線ﾓﾆﾀﾘﾝｸﾞﾜｰｸｼｮｯﾌﾟ（大洗） 12/7 AMF-8（Pattaya,Thailand）	12/7 第7回日本フラックス成長研究発表会（つくば） 12/7-8 第23回光物性研究会（大阪） 12/20 学振１８６委員会(名古屋)
1			1/15-16 学振１６１委員会(山口）
2			2/4-7 研究会「放射線検出器とその応用」(つくば)
3	3/7-8 研究室シンポジウム＆スキー旅行(蔵王)	3/27-30 応用物理学関連講演会(東京) 3/17-19 日本セラミクス協会 2013 年会(東京)	3/1-2 学振１８６委員会(仙台)

Events and Memorieas

Welcome to Yoshikawa Lab.!!, April , 2012

Hanami (Cherry-blossom viewing) Mikamine park, April 21, 2012

Summer Trip, Zao, August 20, 2012

Wedding Parties, 21 Jul, 05 Aug, 07 Oct, 2012

Sports events, October 22 and November 13, 2012

IEEE/ NSS2012, The U.S., 27 Oct.– 03 Nov., 2012

Imoni Party, Hirose river, November 19, 2012

Year-End Party, Tenkainorobata., Dec. 21, 2012

吉川研究室 研究報告書

2012 Research Reports of the Yoshikawa Laboratory

〒980-8577
宮城県仙台市青葉区片平 2-1-1
東北大学　金属材料研究所
先端結晶工学研究部　吉川研究室
〒980-8579
宮城県仙台市青葉区荒巻字青葉 6-6-10
未来科学技術共同研究センター（NICHe）　兼任

Yoshikawa Laboratory
Research Laboratory on Advanced Crystal Engineering,
Institute for Materials Research (IMR), Tohoku University
2-1-1 Katahira, Aoba-ku, Sendai, 980-8577, JAPAN

New Industry Creation Hatchery Center (NICHe)
6-6-10 Aoba, Aramaki, Aoba-ku, Sendai, Miyagi 980-8579, JAPAN

ANNUAL REPORT 2011

Published on 発行日	February 10, 2012 2012 年 2 月 10 日
Publisher 発行者	Akira Yoshikawa 吉川　彰
Editors	Akira Yoshikawa, Yoshisuke Futami Yoshikawa Laboratory Research Laboratory on Advanced Crystal Engineering, Institute for Materials Research (IMR), Tohoku University New Industry Creation Hatchery Center (NICHe), Tohoku University
編集者	吉川　彰、二見　能資 東北大学　金属材料研究所 先端結晶工学研究部　吉川研究室
Printed by 印刷所	Yoshikawa Laboratory 吉川研究室

Yoshikawa Lab.
Research Report
Published on February 10, 2013

ANNUAL REPORT 2012

編集・発行
東北大学　金属材料研究所
吉川研究室
吉川 彰・二見 能資

Edited and published by
A. Yoshikawa
Yoshikawa Laboratory
Institute for Materials Research,
Tohoku University