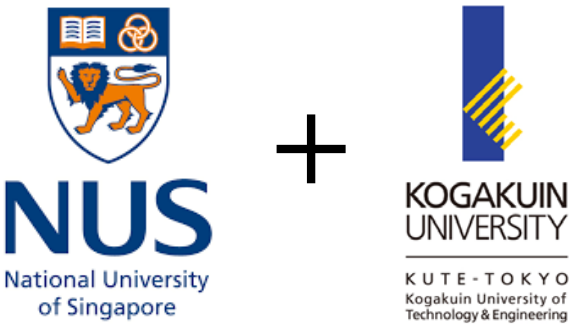
The 3rd Symposium for Collaborative Research on Energy Science and Technology



The 3rd Symposium for Collaborative Research on Energy Science and Technology (SCREST-3rd)

・March 5, 2021, On-line （Start: SGT; 12:20, JST; 13:20）

https://zoom.us/j/97691092331?pwd=VTZ1TmxwOUdBKzVWTVUrV2NpT2x6UT09

Meeting ID: 976 9109 2331

Passcode: 618611

Main theme of SCREST-3rd: Energy Materials and Devices for Collaboration

Topics of SCREST-3rd include, but not limited to:

- Energy materials
- Hydrogen energy
- Hydrogen production
- Fuel cells
- Biofuels
- Solar energy
- Alternative energy
- Photocatalysis
- Supercapacitors
- Photovoltaics
- Nanomaterials
- Nanoenergy
- Geothermal Energy

Organized by

National University of Singapore

Kogakuin University of Technology and Engineering

Co-Organized by

Functional Materials Society

Sponsored by

Department of Mechanical Engineering, National University of Singapore

Kogakuin University of Technology and Engineering

Functional Materials Society (Singapore)

INVITATION

Dear Colleagues,

To solve global problems, interdisciplinary collaboration is being required. The innovative energy materials would be created by collaborating among various researchers in the field of physics, chemistry, materials, mechanical, and electrical engineering, because such collaboration can promote effective acquisition of state-of-the-art technology in each field. The SCREST-3rd (The 3rd Symposium for Collaborative Research on Energy Science and Technology) will be held at online on March 5, 2021. The International Advisory and Organizing Committees cordially invite you to attend the symposium and participate in its scientific programs. In this symposium, we aim to construct a novel consortium between the two universities, having many researchers related intensively to energy materials. Presentations will consist only oral presentation. The official language of the symposium will be English.

Important Deadlines

Deadline of Abstract Submission; Feb. 15, 2021

Registration; March 1, 2021

Advisory and Committee members

Organizing committee

Chairperson:

Li Lu	National University of Singapore
Mitsunobu Sato	President of Kogakuin University

Program Committee

Program Chairperson:

Toshinori Okura	Kogakuin University

Committee member

Daniel Chua	National University of Singapore
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Tohru Honda	Kogakuin University of Technology and Engineering
Tetsuo Sakamoto	Kogakuin University of Technology and Engineering
Hiromitsu Takaba	Kogakuin University of Technology and Engineering

■Language

English will be the official language during the symposium.

■Symposium Venue

The symposium will be held at National University of Singapore.

CORRESPONDENCE

If you have any inquiry, you can contact with the general secretary via e-mails.

Hiroki Nagai (KUTE)
Tel: +81-42628-4616
E-mail: nagai@cc.kogakuin.ac.jp

ORAL PRESENTATIONS:

This symposium has only oral presentation.

Keynote Talk: Speaker has 30 minutes for their presentation. With approximately 20 minutes given for the presentation followed by 10 minutes for questions and answers.

Oral Presentation: Speaker has 15 minutes for their presentation. With approximately 13 minutes given for the presentation followed by 2 minutes for questions and answers.

GUIDELINES:

Abstracts should be prepared according to the abstract template. The abstract should be sent via e-mail (nagai@cc.kogakuin.ac.jp). The deadline for abstract submission would be **February 15, 2021**. The authors are encouraged to submit a camera-ready abstract (A5-size with 25 mm margins on all sides) in Word or PDF format. Use Times New Roman font. In the PDF file case, all fonts should be embedded in the file. The font size should be boldfaced 14 point for the title and 11 point for the remaining. The abstract should be completed within 1 page without figures and tables.

References

[1] A. Author and B. Author: "Title of paper," Journal Name, vol., startpage-endpage (year).

[2] A. Author, Title of book (Publisher), Chapter, (year).

Papers in the form of electronic file should be submitted by **e-mail** to the following address: nagai@cc.kogakuin.ac.jp

March 5

Venue: Online

https://zoom.us/j/97691092331?pwd=VTZ1TmxwOUdBKzVWTVUrV2NpT2x6UT09

Meeting ID: 976 9109 2331

Passcode: 618611

Opening Remarks (JST: 13:20-13:30, SGT: 12:20-12:30)

Prof. Mitsunobu Sato

Keynote lectures (JST: 13:30-14:30, SGT: 12:30-13:30)

Chair; Prof. Toshinori Okura

Keynote 1 Prof. Stefan Adams (NUS)

Tools for accelerated design of ion conducting solids for energy storage applications

Keynote 2 Prof. Takeyoshi Onuma (KUTE)

Developments of Semiconductor-based UVC Emitters and Sensors for Sterilization

Break (JST: 14:30-14:45, SGT: 13:30-13:45)

Oral session 1 (JST: 14:45-16:00, SGT: 13:45-15:00)

Chair; Prof. XXXX

Oral 1 Mr. Linchun He (NUS)

Mechanical-electrochemical Failure of NASICON-type Solid-state Electrolyte Based All-solid-state Li-ion Battery

Oral 2 Mr. Kenta Watarai (KUTE)

High resolution imaging of SSE grain using FIB-TOF-SIMS

Oral 3 Mr. Zhongkai Hao (NUS)

Oxygen-Deficient Blue TiO_2 for Ultra-Stable and Fast Lithium Storage

Oral 4 Mr. Yutaka Suwazono (KUTE)

Water photolysis by an all-solid-state photovoltaic lithium-ion battery using Li_2MnO_3 thin-film as cathode active material

Oral 5 Mr. Akito Taguchi (KUTE)

Impact of Indium Oxide Powder as Source Precursor on α-In_2O_3 Films Grown by Mist CVD

Break (JST: 16:00-16:15, SGT: 15:00-15:15)

Oral session 2 (JST: 16:15-17:30, SGT: 15:15-16:30)

Chair; Prof. XXXX

Oral 6 Mr. Kentaro Sakai (KUTE)

Analysis and classification of aerosol using surface roughness parameter

Oral 7 Ms. Rie Yamada (KUTE)

Impact of hydrochloric acid on the Mist CVD growth of Ga_2O_3

Oral 8 Mr. Jianguo Sun (NUS)

Structure Optimization of Prussian Blue As the Cathode for Full Sodium-ion Battery

Oral 9 Mr. Koji Kawada (KUTE)

Synthesis and characterization of Na^+ conducting glass-ceramic $Na_5FeSi_4O_{12}$ doped with boron, aluminum, and gallium oxides

Oral 10 Mr. Xiaoyu XU (NUS)

Composite Polymer Electrolyte Based on PEO

Break (JST: 17:30-17:45, SGT: 16:30-16:45)

Oral session 11 (JST: 17:45-18:30, SGT: 16:45-17:30)

Chair; Prof. Tomohiro Yamaguchi

Oral 11 Mr. Takumi Umedate (KUTE)

Validation of resonance ionization sputtered neutral mass spectrometry for accurate isotope ratio analysis

Oral 12 Ms. Masaki Matsuda (KUTE)

Characterization of GaInN multi-layers grown on strain-controlled layer by RF-MBE

Oral 13 Mr. Kenta Shirasu (KUTE)

Development of individual cell components analysis method with FIB-TOF-SIMS

Closing Remarks (JST: 18:30-18:45, SGT: 17:30-17:45)

Prof. Li Lu

Time Table (JST)

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14:45-15:00	**Oral 1**	**Mr. Linchun He**	**p. 12**
15:00-15:15	**Oral 2**	**Mr. Kenta Watarai**	**p. 13**
15:15-15:30	**Oral 3**	**Mr. Zhongkai Hao**	**p. 14**
15:30-15:45	**Oral 4**	**Mr. Yutaka Suwazono**	**p. 15**
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17:15-17:30	**Oral 10**	**Mr. Xiaoyu XU**	**p. 21**
17:45-18:00	**Oral 11**	**Mr. Takumi Umedate**	**p. 22**
18:00-18:15	**Oral 12**	**Ms. Masaki Matsuda**	**p. 23**
18:15-18:30	**Oral 13**	**Mr. Kenta Shirasu**	**p. 24**

Time Table (SGT)

12:30-13:00	**Keynote 1**	**Prof. Stefan Adams**	**p. 10**
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16:45-17:00	**Oral 11**	**Mr. Takumi Umedate**	**p. 22**
17:00-17:15	**Oral 12**	**Ms. Masaki Matsuda**	**p. 23**
17:15-17:30	**Oral 13**	**Mr. Kenta Shirasu**	**p. 24**

Keynote 1

Tools for accelerated design of ion conducting solids for energy storage applications

Stefan Adams
NUS Department of Materials Science and Engineering
mseasn@nus.edu.sg

Here we report the progress of our bond-valence-based automated pathway analysis [1,2] (available free for academic use from [3]) that visualizes ion migration pathways and predicts barriers from crystal structures within seconds or minutes. This speeds up shortlisting of promising structures by 4 orders of magnitude compared to DFT-based NEB methods. Thereby it rationally accelerates the design of new materials for energy storage applications. We also integrate the pre-screening into an automated workflow for subsequent DFT characterization [4]. Results are benchmarked against experimental and DFT NEB migration barriers. Our tool comprises an AI-based dopant predictor focusing on bond-valence-based crystal chemical descriptors. In the next step we plan to integrate the prediction of absolute conductivities factoring in the inventory of sites, mobile ions and pathways. Application examples including thiophosphate halides [5], polyanion oxides and pure halides will be discussed to benchmark the findings and illustrate strength and limitations of our approach.

References

[1] H. Chen et al. SoftBV–a software tool for screening the materials genome of inorganic fast ion conductors. *Acta Cryst. B* **75**, 18-33 (2019).

[2] L.L. Wong et al. Bond Valence Pathway Analyzer (BVPA) – An automatic rapid screening tool for fast ion conductors within softBV. *Chem. Mater.* **33**, *in press* (2021).

[3] http://www.dmse.nus.edu.sg/asn/software.html

[4] L. Zhang et al. A database of ionic transport characteristics for over 29000 inorganic vompounds. *Adv. Funct. Mater.* **30** 2003087 (2020).

[5] R. Prasada Rao et al. Stable lithium ion conducting thiophosphate solid electrolytes $Li_x(PS_4)_yX_z$ (X = Cl, Br, I). *Chem. Mater.* **31** 8649-8662 (2019).

Developments of Semiconductor-based UVC Emitters and Sensors for Sterilization

Takeyoshi Onuma, Tomohiro Yamaguchi, and Tohru Honda

Department of Electrical Engineering and Electronics, Graduate School of Engineering, Kogakuin University, Japan

Abstract

UVC light source is attracting explosive attention for sterilization. Recently, the use of 222-nm-UVC-light is proposed to sterilize human skin with suppressing DNA lesions. Effectiveness of 222-nm UVC irradiation on viable SARS-CoV-2 is also demonstrated. Demands are thus increasing for developing semiconductor-based UVC emitters to replace the discharge-type light sources. Present keynote talk includes our recent progress for developing nitride- and oxide-semiconductor-based UVC emitters and sensors.

Keywords: UVC; semiconductor; sterilization

Mechanical-electrochemical Failure of NASICON-type Solid-state Electrolyte Based All-solid-state Li-ion Battery

Linchun He[1,2], Li Lu[2, †], Stefan Adams[1, *]

Department of [1]MSE and [2]ME, NUS, Singapore [†]luli@nus.edu.sg; [*]mseasn@nus.edu.sg

Abstract

Although inorganic-based all-solid-state Li-ion battery (ASSLiB) is considered to be a promising candidate for future energy storage devices, its high impedance due to poor interface bonding and limited contact area results in poor electrochemical performance and fast capacity fading. To understand these issues, we performed Time-of-flight secondary ion mass spectrometry (TOF-SIMS), X-ray photoelectron spectroscopy (XPS), and X-ray Powder Diffraction (XRD) combining with DFT calculated formation energy to explore the decomposition of the LAGP after charge/discharge cycles. Mechanical-electrochemical failure of the LAGP was introduced combined with Finite element method (FEM) simulation SSE.

Keywords: Solid-state Electrolyte; All-solid-state Li-ion Battery; Failure Mechanism; NASICON

Title: High resolution imaging of SSE grain using FIB-TOF-SIMS

Kenta Watarai[1], Akihiro Kawasugi[2], Masato Morita[2], Tetsuo Sakamoto[1, 2, *]

[1]Graduate School of Electrical Engineering and Electrics, Kogakuin University. [2]Department of Applied physics, School of Advanced Engineering, Kogakuin University

**E-mail: ct13087@ns.kogakuin.ac.jp*

Abstract

Focused ion Beam (FIB) attached Time of Flight-Secondary ion Mass Spectrometer (TOF-SIMS) developed by our laboratory [1] is one of the best way to analyze solid state electrolyte (SSE) because it can detect Li ions with high detection sensitively and can microscopic imaging. In this study, charge and discharge cycled LAGP ($Li_{1.5}Al_{0.5}Ge_{1.5}(PO_4)_3$) grains were measured with high magnification by FIB-TOF-SIMS to clarify its degradation mechanism. Morphological and elemental degradation of LAGP grains was directly confirmed for the first time.

Keywords: FIB-TOF-SIMS, high magnification analysis, LAGP (solid state electrolyte)

Reference: [1] T. Sakamoto *et al.*, *Appl. Surf. Sci.*, 255, 1617-1620 (2008).

Title: Oxygen-Deficient Blue TiO_2 for Ultra-Stable and Fast Lithium Storage

Zhongkai Hao[1], Guo Qin Xu[1] *

[1] *Department of Chemistry, National University of Singapore, Singapore 117543, Singapore*

Abstract

Developing titanium dioxide (TiO_2)-based anode with superior high-rate capability and long-term cycling stability is important for efficient energy storage. Herein, a simple one-step approach for fabricating blue TiO_2 nanoparticles with primitive oxygen vacancies is reported. Oxygen vacancies can enlarge lattice spaces, lower charge transfer resistance, and provide more active sites. As a result, this blue TiO_2 electrode exhibits a highly reversible capacity of 50 mAh g^{-1} at 100 C even after 10 000 cycles, which is attributable to the combination of surface capacitive process and remarkable diffusion-controlled insertion. The strategy of employing oxygen-deficient nanoparticles may be extended to the design of other robust semiconductor materials as electrodes for energy storage.

Keywords: Titanium dioxide; Oxygen vacancies; Electrochemical energy storage; Li-ion batteries.

Water photolysis by an all-solid-state photovoltaic lithium-ion battery using Li_2MnO_3 thin-film as cathode active material

Yutaka Suwazono, Gen Nakayama, Kazuma Aochi, Hiroki Nagai, Mitsunobu Sato*

Kogakuin University, Tokyo, Japan

Abstract

An all-solid-state photovoltaic lithium-ion battery (ASS-PV-LIB) using anatase thin-film of 120 nm thickness and Li_2MnO_3 (LMO) one of 80 nm thickness as the active materials, whose areas are both 90 cm^2, respectively for anode and cathode was fabricated on an FTO glass substrate. An organic-inorganic hybrid film involving $LiClO_4$ was newly prepared and sandwiched between each thin film of both active materials, as a solid-state electrolyte with a thickness of 110 μm. A device assembled with three ASS-PV-LIBs in series were connected to platinized-Ti electrodes immersed in a 30% NaOH aqueous solution. At approximately 2:1 volume ratio, gases from each electrode connected to the anode and cathode respectively of the device occurred by irradiation with UV light irradiation (16 mW cm^{-2} at 365 nm). The H_2 gas of 90 μL was obtained from the anode side after 6-h irradiation.

Keywords: Li_2MnO_3 thin film; molecular precursor method; photovoltaic device; water photolysis

Impact of Indium Oxide Powder as Source Precursor on α-In_2O_3 Films Grown by Mist CVD

A. Taguchi[1,*], S. Takahashi[2], T. Yamaguchi[1,2], T. Onuma[1,2], T. Honda[1,2]

[1]Dept. of Electrical Engineering and Electronics, Graduate School of Engineering, Kogakuin University, [2]Dept. of Electrical Engineering and Electronics, Graduate School of Engineering, Kogakuin University, Hachioji, Tokyo, Japan

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Abstract

Single phase α-In_2O_3 films were successfully grown on (0001) α-Al_2O_3 substrates by mist CVD using In_2O_3 powder as a source precursor instead of conventional $In(acac)_3$. The formation of cubic phase was completely suppressed by adjusting the HCl concentration in the source solution. The resultant films showed better electrical properties than those using $In(acac)_3$. The results demonstrate that the use of In_2O_3 powder has potential to grow single crystalline α-In_2O_3 with reduced residual impurities.

Keywords: In_2O_3; Mist CVD; Impurity

Analysis and classification of aerosol using surface roughness parameter

Kentaro Sakai,[1] Ryota Koiwai,[1] Kanae Atari,[2] Masato Morita,[2] Tetsuo Sakamoto[1,2,*]

1.Graduate School of Electric Engineering and Electronics, Kogakuin University

2.Department of Applied physics, School of Advanced Engineering, Kogakuin University

Abstract

Very small particles are suspended in air and they are called aerosol. In our research group, we are noticed that a certain relationship between aerosol type and shape exists when we analyzed particles using an FIB-TOF-SIMS (focused ion beam time-of-flight secondary ion mass spectrometry). Hereby, we proposed a shape analysis method to perform classification of aerosol analysis by employing the information on particle shapes obtained from SEM images. However, in previous work, shape analysis uses only contours. In this study, surface roughness of each particle was included in the parameter in order to improve accuracy of the classification.

Keywords: Aerosol; Individual analysis; Cluster analysis; SEM image; FIB-TOF-SIMS.

Impact of hydrochloric acid on the Mist CVD growth of Ga_2O_3

R. Yamada[1,*], S. Takahashi[2], T. Yamaguchi[1,2], T. Onuma[1,2], T, Honda[1,2]

[1] Department of Applied Physics, School of Advanced Engineering, Kogakuin University, Hachioji, Tokyo 192-0015, Japan, [2]Department of Electrical Engineering and Electronics, Graduate School of Engineering, Kogakuin University, Tokyo 192-0015, Japan,

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Abstract

A small amount of hydrochloric acid (HCl) is usually added to an aqueous solvent to dissolve the source precursor in the growth of mist chemical vapor deposition (Mist CVD) method. However, the effect of adding HCl on the crystal growth has not been fully clarified yet. In this study, the impact of HCl in the mist CVD growth of Ga_2O_3 was investigated. The effect of adding HCl on the crystal growth is discussed based on the results of grain size and film thickness of the obtained Ga_2O_3 films, involving the growth temperature dependence.

Keywords: Ga_2O_3; Mist CVD; hydrochloric acid

Structure Optimization of Prussian Blue As the Cathode for Full Sodium-ion Battery

Jianguo Sun[1], Jin An Sam Oh[1], Kaiyang Zeng[1], Li Lu[1, 2, *]

[1] *Department of Mechanical Engineering, National University of Singapore, Singapore 117575, Singapore*

[2] *National University of Singapore Chongqing Research Institute, Chongqing, 401123, P.R. China*

Abstract

Low-cost Prussian blue has attracted lots of attention as a promising cathode for sodium-ion batteries (SIBs). Herein, a unique discharging plateau elevation was firstly determined in the iron hexacyanoferrate (NFFCN). Furthermore, we induced a stable NNiFCN out layer to lock the sodium ion (Na^+) intercalation induced lattice strain in NFFCN, so as to alleviate the mechanical degradation of NFFCN and improve the electrochemical performance. As expected, the assembled full cell achieves an outstanding rate performance and cycling stability over 3000 cycles at 500 mA g^{-1}.

Keywords: Prussian Blue; Sodium-Ion Battery; Intercalation Capacitance

Synthesis and characterization of Na^+ conducting glass-ceramic $Na_5FeSi_4O_{12}$ doped with boron, aluminum, and gallium oxides

Koji Kawada[1], Kimihiro Yamashita[1,2,3], Toshinori Okura[1*]

[1] *Department of Applied Chemistry, School of Advanced Engineering, Kogakuin University*

[2] *Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University*

[3] *Strategic Innovation and Research Center of Material and Science, Teikyo University*

Abstract

This study has focused on the effect of Si-substitution with boron, aluminum, and gallium on sodium-ion conduction properties of the developed glass-ceramic $Na_5FeSi_4O_{12}$. To improve the conductivity with a small amount of Si-substitutes, $Na_5FeSi_4O_{12}$-isostructural derivatives containing such as B, Al, and Ga were prepared according to the crystallization process of glasses with the composition $Na_{5.1}FeM_{0.1}Si_{3.9}O_{12}$ (M=B, Al, Ga). Without phase separation, the ionic conductivities of glass-ceramics were enhanced up to 1.69×10^{-3} at 300°C on $Na_{5.1}FeB_{0.1}Si_{3.9}O_{12}$, whereas decreased down to 1.30×10^{-3} and 1.12×10^{-3} S cm^{-1} at 300°C on $Na_{5.1}FeAl_{0.1}Si_{3.9}O_{12}$, and $Na_{5.1}FeGa_{0.1}Si_{3.9}O_{12}$, respectively.

Keywords: Solid electrolyte; NASICON; Glass-ceramics; $Na_5FeSi_4O_{12}$.

Title: Composite Polymer Electrolyte Based on PEO

Xiaoyu XU[1], Yumei WANG[1,2], Li LU[1,2,3,*]

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Abstract

All-solid-state sodium-ion batteries are supposed to be the next generation batteries due to the high-safety and low price. Composite polymer electrolytes are promising materials for its high flexibility, which helps maintain a good electrolyte-electrode interface during battery cycling. However, the low ionic conductivity limits its wide application. In this work, a composite electrolyte thin film which is made up of Poly(ethylene oxide), $Na_3Zr_2Si_2PO_{12}$ and $NaClO_4$ has been successfully developed. It is expected to be commercialized because of its facile preparation process and low fabrication cost.

Keywords: Sodium-ion battery; Polymer composite electrolyte; ionic conductivity; interface

Title: Validation of resonance ionization sputtered neutral mass spectrometry for accurate isotope ratio analysis

Takumi Umedate[1], Takeru Yoshida[2] Masato Morita[2], Tetsuo Sakamoto[1, 2, *]

[1] *Department of Applied physics, School of Advanced Engineering, Kogakuin University*

[2] *Graduate School of Electrical Engineering and Electrics, Kogakuin University.*

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Abstract

Time-of-flight secondary ion mass spectrometry with focused ion beam (FIB-TOF-SIMS) developed in our laboratory is effective for isotope ratio analysis of small parts of a solid sample without complicated pretreatment. However, it has a problem of isobaric interference due to non-selective ionization. The laser resonance ionization sputtering neutral mass spectrometry (R-SNMS) developed in our laboratory can overcome this problem. In this study, the accuracy of isotope ratios of FIB-TOF-SIMS and R-SNMS was validated by obtaining the isotope ratios of actual samples under various measurement conditions.

Keywords: FIB-TOF-SIMS**;** R-SNMS**;** isotope.

Characterization of GaInN multi-layers grown on strain-controlled layer by RF-MBE

M. Matsuda[1, *], R. Yoshida[2], K. Tahara[2], T. Yamaguchi[1, 2], T. Onuma[1, 2], T. Honda[1, 2]

[1]Department of Applied Physics, Faculty of Advanced Engineering, Kogakuin University, Tokyo, Japan [2]Department of Electric Engineering and Electronics, Graduate School of Engineering, Kogakuin University, Tokyo

Abstract

The piezoelectric fields in $Ga_{1-x}In_xN/Ga_{1-y}In_yN$ (x>y) Multiple Quantum Wells (MQWs) reduce the radiative recombination rate. We propose the insertion of $Ga_{1-y}In_yN$ layer under $Ga_{1-x}In_xN/Ga_{1-y}In_yN$ MQWs grown by radio-frequency plasma assisted molecular beam epitaxy (RF-MBE) to enhance the optical emission, which alleviates strain in $Ga_{1-x}In_xN$ wells. Strong PL emission peak at 576 nm was observed from $Ga_{1-x}In_xN/Ga_{1-y}In_yN$ MQWs with $Ga_{1-y}In_yN$ layer compared to broad PL emissions at 550~800 nm from those without $Ga_{1-y}In_yN$ layer. We attributed the increased emission to an improved electron and hole wave function overlap due to decreased piezoelectric fields in wells.

Keywords: RF-MBE; GaInN; MQWs; photoluminescence.

Development of individual cell components analysis method with FIB-TOF-SIMS

K. Shirasu[1], K. Tamura[1], M. Morita[2], T. Sakamoto[1,2,*]

[1]Graduate School of Electric Engineering and Electronics, Kogakuin University, [2]Department of Applied physics, School of advanced Engineering, Kogakuin University, *ct13087@ns.kogakuin.ac.jp

Abstract

Cancer cells have different characteristics even if they have the same onset site, and the need for treatment methods that take into account the diversity of cancer has been advocated. In addition, Inorganic elements in cells are closely related to the behavior of cancer cells, and also interact with each other and are active in cells. Therefore, an analysis techniques for the inorganic elements of individual cells will be important for a deep understanding of cancer. In this study, we extracted the information of the components of each cells with FIB-TOF-SIMS, and component data was analyzed by cluster analysis. Hereby we have linked the inorganic elements with the characteristics of cells.

Keywords: TOF-SIMS; Biological; Cluster analysis