2\textsuperscript{nd} International Workshop on 
Ga$_2$O$_3$ and Related Materials

12-15 September 2017, Parma, Italy

Co-organized by:
Dept. of Mathematical, Physical and Computer Sciences, Univ. of Parma 
and 
IMEM-CNR Institute, Parma

With the support of:
Italian Crystallographic Association (AIC)

Sponsored by:
Office of Naval Research 
University of Parma
Dear attendees,

it is my great pleasure to welcome you to the 2\textsuperscript{nd} International Workshop on Ga\textsubscript{2}O\textsubscript{3} and Related Materials. The general interest about wide-bandgap semiconducting oxides has increased enormously in the past two years, as witnessed by the growing number of publications in scientific journals. The original interest on the most studied $\beta$ polymorph has been extended to less known crystallographic phases, which present very attractive properties, although unstable beyond a certain temperature limit. Furthermore, great advancements were made in terms of material quality and doping, so that today the fabrication of transistors and UV detectors with good performance is within reach.

IWGO 2017 is itself a witness of the great success of oxide semiconductors: the number of submissions practically doubled with respect to the first edition in Kyoto. The Workshop in Parma features 12 invited presentations, 43 oral contributions and 101 posters. Characterisation and materials sessions are still dominant, but there is a considerable increase of papers on processing and devices, also a sign of progress and maturity. I am confident that all of you will gain a lot from attending IWGO 2017, and I hope that you will make new friends and pick-up many new ideas. That will reinforce our oxide community and contribute to establishing the IWGO series.

I wish to close this short preface by thanking: the Office of Naval Research and the University of Parma for generously sponsoring IWGO 2017; the members of the International Programme Committee for their valuable suggestions and help in setting-up a first-class technical programme and, last but not least, my colleagues and friends of the Local Organising Committee for their tireless work during all phases of the Workshop organisation.

I wish you a very enjoyable time in Parma!

Sincerely,

Roberto Fornari
Chairman IWGO 2017
Dept. of Mathematical, Physical and Computer Sciences, University of Parma
IWGO 2017

Chair
Roberto Fornari, University of Parma, Italy

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Oliver Bierwagen, PDI Berlin, Germany
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Presentation information

Presentation guidelines
Standard PC and audio-visual equipment are available for oral presentation. Speakers are kindly requested to check their PowerPoint files ahead of their own session. This is even more important if they want to use their personal laptop. Note that the organisers will not provide adapters for power suppliers nor Mac or HDMI connectors.
Allotted times are: 30 minutes for invited talks and 15 minutes for other presentations. In both cases leave at least two minutes for questions.

Poster presentation
We recommend authors to prepare their poster(s) according to the A0 format (about 84 cm wide and 119 cm high). Numbered boards will be available in the large room just above the conference hall. Authors are requested to set-up their poster(s) at the beginning of the meeting and to leave them on display during the entire Workshop. The poster discussion will take place in two separate sessions on Thursday 14th, at 10:30 (posters P1 - P50) and on Friday 15th at 10:30 (posters P51 - P101). Please identify your session and make sure that at least one author is available for discussion.
Workshop Programme

Tuesday September 12\textsuperscript{th}

15:00 – 18:30 Opening Registration desk
18:30 – 19:30 Choir performance & Welcome party

Wednesday September 13\textsuperscript{th}

09:00 – 09:30 Opening Ceremony
09:30 – 11:00 Session Cha1

Chair Martin Albrecht, IKZ Berlin, Germany

09:30 – 10:00 \textbf{I1 Electronic Defects in Epitaxial and Bulk $\beta$-Ga$_2$O$_3$ Characterized by Deep Level Defect Spectroscopy Methods}

S. Ringel
Electrical & Computer Engineering, The Ohio State University, Columbus, OH, USA

10:00 – 10:15 \textbf{O1 Donor states and deep levels in bulk and epitaxial $\beta$-Ga$_2$O$_3$}

M.E. Ingebrigtsen,\textsuperscript{1} L. Vines,\textsuperscript{1} G. Alfieri,\textsuperscript{2} A. Mihaila,\textsuperscript{2} U. Badstübner,\textsuperscript{2}
B.G. Svensson,\textsuperscript{1} and A.Yu. Kuznetsov\textsuperscript{1}

\textsuperscript{1}University of Oslo, Department of Physics, Oslo, Norway
\textsuperscript{2}ABB Corporate Research, Baden-Dättwil, Switzerland

10:15 – 10:30 \textbf{O2 Ozone MBE Growth and Characterization of Nitrogen-Doped $\beta$-Ga$_2$O$_3$ (010) Thin Films}

T. Kamimura,\textsuperscript{1} Y. Nakata,\textsuperscript{1} A. Kuramata,\textsuperscript{2} S. Yamakoshi,\textsuperscript{2} and M. Higashiwaki\textsuperscript{1}

\textsuperscript{1}National Institute of Information and Communications Technology, Tokyo, Japan
\textsuperscript{2}Tamura Corporation, Saitama, Japan

10:30 – 10:45 \textbf{O3 Temperature-dependent thermal conductivity and diffusivity of a Mg-doped insulating-Ga$_2$O$_3$ single crystal along [100], [010] and [001]}

R. Mitdank,\textsuperscript{1} M. Handwerg,\textsuperscript{1,2} Z. Galazka,\textsuperscript{3} and S.F. Fischer\textsuperscript{1}

\textsuperscript{1}Humboldt-Universität zu Berlin, Berlin, Germany
\textsuperscript{2}Helmholtz-Zentrum Berlin, Berlin, Germany
\textsuperscript{3}Leibniz Institute for Crystal Growth, Berlin, Germany

10:45 – 11:00 \textbf{O4 Properties of N-implanted Monoclinic Ga$_2$O$_3$}

J.A. Freitas, Jr., M.J. Tadjer, N.A. Mahadik, J.C. Culbertson, and B.N. Feigelson
U.S. Naval Research Laboratory, Washington DC, USA

11:00 – 11:20 BREAK
11:20 – 11:50

**Recent progress in EFG growth of Ga_2O_3**

A. Kuramata
Tamura Corporation, Sayama, Saitama, Japan
Novel Crystal Technology, Inc., Sayama, Saitama, Japan

11:50 – 12:05

**Czochralski Growth of [010] Semi-insulating β-Ga_2O_3 Crystals**

J.D. Blevins,¹ S. Mou,¹ A. Neal,¹ D. Thomson,¹ G. Foundos,² K. Stevens,² and D. Look³

¹Air Force Research Laboratory (AFRL), Wright-Patterson AFB, USA
²Northrop-Grumman SYNOPTICS, USA
³Wright-State University, USA

12:05 – 12:20

**β-Ga_2O_3 single crystals grown from thin seeds using the vertical Bridgman technique**

E. Ohba,¹,² T. Kobayashi,¹ Y. Nakamura,¹ D. Ichikawa,¹ and K. Hoshikawa²

¹Fujikoshi Machinery Corp., Matsushiro-machi, Nagano, Japan
²Shinshu University, Nagano, Japan

12:20 – 12:35

**Experimental Study and Modeling of Ga_2O_3 Epitaxial Growth by MOCVD in a CCS Reactor**

M. Bogdanov,¹ A. Lobanova,¹ R. Talalaev,¹ A. Galyukov,² F.L. Alema,³ B. Hertog,³ and A. Osinsky³

¹STR Group, Inc. – Soft-Impact, Ltd., St. Petersburg/Russia
²STR US, Inc., Richmond, VA, USA
³Agnitron Technology, Inc., Eden Prairie, MN, USA

12:35 – 12:50

**Surface diffusion and elementary growth process in homoepitaxial growth of β-Ga_2O_3 layers on (100)-oriented substrates**

R. Schewski, D. Meiling, M. Baldini, Z. Galazka, G. Wagner, and M. Albrecht
Leibniz Institute for Crystal Growth, Berlin, Germany

13:00 – 14:30

**LUNCH**

14:30 – 16:00

**Development of Lateral Ga_2O_3 FETs for RF and Switch Applications**

G. Jessen
Air Force Research Laboratory, WPAFB, OH, USA

15:00 – 15:15

**Bipolar heterodiodes comprising n-type β-gallium oxide and p-type zinc cobalt oxide and nickel oxide**

P. Schlupp, D. Splith, H. von Wenckstern, and M. Grundmann
Universität Leipzig, Leipzig, Germany
15:15 – 15:30  O10 Delta-doped β-Ga$_2$O$_3$ Metal Semiconductor Field Effect Transistors with Regrown Ohmic Contacts
Z. Xia,$^{1}$ S. Krishnamoorthy,$^{1}$ C. Joishi,$^{1,3}$ S. Bajaj,$^{1}$ Y. Zhang,$^{1}$ M. Brenner,$^{1}$ S. Lodha,$^{2}$ and S. Rajan$^{1,2}$
$^1$Department of Electrical and Computer Engineering, Ohio State Univ., USA
$^2$Department of Materials Science and Engineering, Ohio State Univ., USA
$^3$Indian Institute of Technology Bombay, Mumbai, India

15:30 – 15:45  O11 Minimized Self-heating Effect of β-Ga$_2$O$_3$ Nano-membrane Field-effect Transistors on Sapphire Substrate
Purdue University, West Lafayette, IN, U.S.A

15:45 – 16:00  O12 Ultra-Low Forward-Voltage Ga$_2$O$_3$ MOSSBDs
K. Sasaki,$^{1,2}$ Q.T. Thieu,$^{1,2}$ D. Wakimoto,$^{1,2}$ A. Kuramata,$^{1,2}$ and S. Yamakoshi$^{1,2}$
$^1$Novel Crystal Technology, Inc., Saitama, Japan
$^2$Tamura Corporation, Saitama, Japan

16:00 – 16:20  BREAK

16:20 – 18:05  Session Cha2
Chair Oliver Bierwagen, PDI Berlin, Germany

16:20 – 16:50  I4 Temperature dependence of the full dielectric tensor of monoclinic Ga$_2$O$_3$
C. Sturm
Felix-Bloch-Institut für Festkörperphysik, Universität Leipzig, Germany

16:50 – 17:05  O13 Optical and electronic properties of monoclinic Ga$_2$O$_3$ unravelled
M. Schubert,$^{1,2,3}$ A. Mock,$^{1}$ R. Korlacki,$^{1}$ S. Knight,$^{1}$ V. Darakchieva,$^{2}$ B. Monemar,$^{2,4}$
H. Murakami,$^{1,5,6}$ Y. Kumagai,$^{1,5,6}$ K. Goto,$^{5,6}$ and M. Higashiwaki$^{7}$
$^1$Univ. of Nebraska-Lincoln, U.S.A.
$^2$Linkoping University, Sweden
$^3$Leibniz Institute for Polymer Research, Dresden, Germany
$^4$Global Innovation Research Organization, Tokyo Univ. of Agriculture and Technology, Japan
$^5$Department of Applied Chemistry, Tokyo Univ. of Agriculture and Technology, Japan
$^6$Tamura Corporation, Sayama, Saitama, Japan
$^7$Nat. Inst. of Information and Communications Technology, Tokyo, Japan

17:05 – 17:20  O14 Photo-assisted capacitance-voltage characterization of interface states in SiO$_2$/β-Ga$_2$O$_3$ (010) MOS capacitors
H. Masten, J. Phillips, and R.L. Peterson
University of Michigan, Ann Arbor, MI, USA

17:20 – 17:35  O15 Bandgap, excitons, phonons, and thermal conductivity of alpha-, beta-, gamma- and epsilon-Ga$_2$O$_3$
N. Jankowski,$^{1}$ R. Gillen,$^{1}$ G. Callsen,$^{1,2}$ C. Nenstiel,$^{1}$ F. Nippert,$^{1}$ A. Hoffmann,$^{1}$
J.S. Reparaz,$^{3}$ P.O. Vaccaro,$^{3,4}$ A.R. Goñi,$^{3,4}$ M. Campoy-Quiles,$^{3}$ M. Bosi,$^{5}$
R. Fornari,$^{6,5}$ J. Schörmann,$^{7}$ M. Kracht,$^{7}$ A. Karg,$^{7}$ M. Eickhoff,$^{7}$ T. Oshima,$^{9}$
F.H. Teherani,$^{10}$ P. Bove,$^{10}$ V.E. Sandana,$^{10}$ D. Rogers,$^{10}$ C. Ton-That,$^{11}$ Z. Galazka,$^{12}$
J. Furthmüller,$^{13}$ F. Bechstedt,$^{13}$ and M.R. Wagner$^{1}$
17:35 – 17:50  O16 Optical properties of metastable α- and ε-Ga$_2$O$_3$

M. Feneberg,¹ A. Karg,²,³ M. Kracht,² J. Schörmann,² M. Eickhoff,²,³ and R. Goldhahn¹

¹Otto-von-Guericke-Universität Magdeburg, Magdeburg, Germany
²Justus-Liebig-Universität Gießen, Gießen, Germany
³University of Bremen, Bremen, Germany

17:50 – 18:05 O17 Impact of Neutron Irradiation on Electronic Defects in β-Ga$_2$O$_3$

A.R. Arehart¹, E. Farzana¹, T.E. Blue², and S.A. Ringel¹

¹Electrical & Computer Engineering, The Ohio State University, Columbus, OH, USA
²Mechanical & Aerospace Engineering, The Ohio State University, Columbus, OH, USA

Thursday September 14th

09:00 – 10:30 Session Cha3

Chair Steven Ringel, Ohio State Univ., USA

09:00 – 09:30 15 Doping and defects in β-Ga$_2$O$_3$

K. Irmscher

Leibniz Institute for Crystal Growth, Berlin, Germany

09:30 – 09:45 O18 Electronic properties of residual donor in unintentionally doped β-Ga$_2$O$_3$

N.T. Son,¹ K. Goto,²,³ R. Togashi,² H. Murakami,² Y. Kumagai,² A. Kuramata,³ M. Higashiwaki,⁴ S. Yamakoshi,³ and B. Monemar¹,²

¹Department of Physics, Chemistry and Biology, Linköping University, Sweden
²Tokyo University of Agriculture and Technology, Tokyo, Japan
³Tamura Corporation, Saitama, Japan
⁴National Institute of Information and Communications Technology, Koganei, Tokyo, Japan

09:45 – 10:00 O19 Reliability Study on Stress-induced Electron Trapping in Al$_2$O$_3$/β-Ga$_2$O$_3$ MOSCAPs

M.S.L. Narayanan,¹ X. Qin,¹ P. Zhao,¹ P. Bolshakov,¹ A. Kuramata,² L. Larcher,³ R.M. Wallace,¹ and C.D. Young¹

¹University of Texas at Dallas, Richardson, TX, USA
²Tamura Corp. and Novel Crystal Technology, Saitama, Japan
³University of Modena and Reggio-Emilia, Modena, Italy
10:00 – 10:15  
O20 Photo- and electroluminescence of chromium doped β-Ga$_2$O$_3$
A. Fiedler, Z. Galazka, and K. Irmscher
Leibniz-Institute for Crystal Growth, Berlin, Germany

10:15 – 10:30  
O21 Luminescence in the bulk and near-surface regions of β-Ga$_2$O$_3$ crystals
C. Ton-That,¹ T. Huynh,¹ L.L. C. Lem,¹ A. Puaud,² N. Jankowski,³ T.P. Nguyen,² A. Hoffmann,³ M.R. Wagner,³ and M.R. Phillips¹
¹University of Technology, Sydney, Ultimo, Australia
²Institut des Matériaux Jean Rouxel, Université de Nantes, France
³Technische Universität Berlin, Berlin, Germany

10:30 – 11:45  
BREAK & POSTER SESSION 1 (Posters P1 – P50)

11:45 – 13:00  
Session Mat2
Chair Shizuo Fujita, Univ. of Kyoto, Japan

11:45 – 12:15  
I6 Development of Amorphous Gallium Oxide Semiconductor and its Application to future Electronic Devices
J. Kim
Materials Research Center for Element Strategy, Tokyo Inst. of Technology, Yokohama, JAPAN

12:15 – 12:30  
O22 Epitaxial Growth and Characterization of α-, β-, and ε-Phases of Ga$_2$O$_3$
Y. Yao,¹ L.A.M. Lyle,¹ S. Okur,² G.S. Tompa,² T. Salagaj,² N. Sbrockey,² R.F. Davis,¹ and L.M. Porter¹
¹Carnegie Mellon University, Pittsburgh, PA, United States.
²Structured Materials Industries, Inc., Piscataway, NJ, United States

12:30 – 12:45  
O23 MBE-Growth and structural properties of ε-Ga$_2$O$_3$
A. Karg,¹,² M. Kracht,² M. Schowalter,¹ B. Gerken,¹ J. Bläsing,³ M. Rohnke,⁴ J. Schörmann,² J. Janek,⁴ A. Rosenauer,¹ and M. Eickhoff¹
¹University of Bremen, Bremen, Germany
²Physical Institute, University Giessen, Giessen, Germany
³Otto-von-Guericke-University Magdeburg, Magdeburg, Germany
⁴Physical-Chemical Inst., University Giessen, Giessen, Germany

12:45 – 13:00  
O24 MOVPE growth of homoepitaxial β-Ga$_2$O$_3$ layers on misoriented (100) and (001)-oriented substrates for power device applications
G. Wagner, M. Baldini, M. Albrecht, A. Fiedler, Z. Galazka, K. Irmscher, and R. Schewski
Leibniz Institute for Crystal Growth, Berlin, Germany

13:00 – 14:30  
LUNCH

14:30 – 15:30  
Session Mod1
Chair Gregg Jessen, Air Force Research Lab., Wright-Patterson AFB, USA

14:30 – 15:00  
I7 First-principles modeling of sesquioxide semiconductors
H. Peerlaers
Materials Department, University of California, Santa Barbara, CA, USA
15:00 – 15:15  O25 Computational Approaches for the High-Throughput Screening and Design of New Transparent Conducting Oxides
C. Sutton, L.M. Ghiringhelli, and M. Scheffler
Fritz Haber Institute, Max Planck Society, Berlin, Germany

15:15 – 15:30  O26 Rigorous modeling of Schottky barrier diode characteristics and its application to Schottky diodes on β-Ga₂O₃ and In₂O₃
D. Splith, H. von Wenckstern, and M. Grundmann
Institut für Festkörperphysik, Universität Leipzig, Leipzig, Germany

15:30 – 16:45  Session Dev2
Chair Marko Tadjer, NRL Washington, USA

15:30 – 16:00  I8 Advances in Ga₂O₃ MOSFETs for Power and Radiation-Hard Electronics
M.H. Wong
National Institute of Information and Communications Technology, Tokyo, Japan

16:00 – 16:15  O27 Normally-off Gallium Oxide MOSFETs formed by BCl₃ Plasma Etching
1Air Force Research Laboratory, WPAFB, OH, USA
2KBRwyle, Dayton, OH, USA
3George Mason University, Fairfax, VA, USA

16:15 – 16:30  O28 Demonstration of β-(AlₓGa₁₋ₓ)₂O₃/β-Ga₂O₃ (010) Modulation Doping Field Effect Transistors with Ge as dopant grown by plasma-assisted molecular beam epitaxy
1Materials Department, University of California Santa Barbara, U.S.A.
2Electrical and Computer Engineering Department, University of California Santa Barbara, U.S.A.

16:30 – 16:45  O29 Extending a (Ferroelectric) Photovoltaic Frontier with Gallium Oxide
1Catalan Institute of Nanoscience and Nanotechnology, Barcelona, Spain
2Nanovation, Châteaufort, France
3GEMaC, UVSQ-CNRS, Paris Saclay University, Versailles, France
4School of Engineering, University of Warwick, Coventry, U.K.
5Univ. of Technology Sydney, Broadway, Australia
6Center for Quantum Devices, ECE Department, Northwestern Univ., USA

16:45  BREAK

17:00  Excursion & Workshop Banquet
Friday September 15th

09:00 – 10:30  Session Mat3

Chair Vladimir Nikolaev, Ioffe Institute, St. Petersburg, Russia

09:00 – 09:30  19 Growth of Different Ga2O3 Polymorphs and Their Applications
S. Fujita
Photonics and Electronics Science and Engineering Center, Kyoto University
Katsura, Kyoto, Japan

09:30 – 09:45  O30 Crystal Structure and Band Gap Variation with Aluminum Content in Pulsed Laser Deposited Aluminum Gallium Oxide Films
B.W. Krueger, F.S. Ohuchi, and M.A. Olmstead
Department of Physics, Univ. of Washington, Seattle, USA
Depts. Materials Science and Engineering, Univ. of Washington, Seattle, USA

09:45 – 10:00  O31 Epitaxial growth of ε-Al3xGa2-2xO3 alloy films on c-plane AlN templates by mist chemical vapor deposition
D. Tahara, H. Nishinaka, S. Morimoto, N. Miyauchi, and M. Yoshimoto
1Dept. Electronic Systems, Kyoto Institute of Technology, Kyoto, Japan
2Faculty of Electrical Engineering and Electronics, Kyoto Institute of Technology, Kyoto, Japan

10:00 – 10:15  O32 Kinetics and thermodynamics of Ga2O3, In2O3, and (InxGa1-x)2O3 during molecular beam epitaxy
P. Vogt and O. Bierwagen
Paul-Drude-Institut für Festkörperelektronik, Berlin, Germany

10:15 – 10:30  O33 Charge transport in highly doped (010) β-Ga2O3 single crystals made by edge-defined film-fed growth
Z. Kabilova, C. Kurdak, and R.L. Peterson
1Electrical Engin. and Comp. Science, University of Michigan, Ann Arbor, MI, USA
2Physics Dept, University of Michigan, Ann Arbor, MI, USA

10:30 – 11:45  BREAK & POSTER SESSION 2 (Posters P51 – P101)

11:45 – 12:15  I10 Pulsed Laser Deposition of Aluminum Gallium Oxides for Deep-UV Detector Applications
D.-S. Wuu
Department of Materials Science and Engineering, National Chung Hsing University, Taichung, Taiwan

12:15 – 12:30  O34 Towards Modulation-doped β-(AlGa)2O3/ Ga2O3 Field Effect Transistors for High Frequency Electronics
S. Krishnamoorthy, Z. Xia, C. Joishi, S. Bajaj, Y. Zhang, M. Brenner, S. Lodha, and S. Rajan
1ECE Department, The Ohio State University, Columbus, USA
2MSE Department, The Ohio State University, Columbus, USA
3Electrical Engineering, Indian Institute of Technology- Bombay, India
12:30 – 12:45  O35 Improved Blocking Voltage and Reduced Reverse Current in Annealed Vertical Homoepitaxial Pt/β-Ga$_2$O$_3$ Schottky Diodes

M.J. Tadjer,¹ B.N. Feigelson,¹ J.A. Freitas Jr.,¹ and A. Kuramata²

¹U.S. Naval Research Laboratory, Washington DC, USA
²Tamura Corporation and Novel Crystal Technology, Inc., Saitama, Japan.

12:45 – 13:00  O36 Carrier transport and spectral responsivity studies in MBE Grown β-Ga$_2$O$_3$ MSM Solar-Blind Deep-UV Photodetector

A.S. Pratiyush,¹ S. Krishnamoorthy,² S.V. Solanke,¹ Z. Xia,² R. Muralidharan,¹ S. Rajan,² and D.N. Nath¹

¹Centre for Nano Science and Eng. (CeNSE), Indian Institute of Science (IISc), Bangalore, India
²Department ECE, The Ohio State University, Columbus, USA

13:00 – 14:30  LUNCH

14:30 – 16:00  Session Mat4

Chair Akito Kuramata, Novel Crystal Technol., Saitama, Japan

14:30 – 15:00  I11 Halide Vapor Phase Epitaxy of β-Ga$_2$O$_3$ Homoepitaxial Layers Using O$_2$ and H$_2$O as Oxygen Sources

K. Konishi

Department of Applied Chemistry, Tokyo University of Agriculture and Technology, Tokyo, Japan

15:00 – 15:15  O37 Growth of Ge-doped (001) β-Ga$_2$O$_3$ on (001) β-Ga$_2$O$_3$ substrate by plasma-assisted molecular beam epitaxy

S.-H. Han, E. Ahmadi, A. Mauze, T. Mates, and J.S. Speck

Materials Department, University of California Santa Barbara, USA

15:15 – 15:30  O38 The Role of Thermal Expansion of β-Ga$_2$O$_3$ On Strain Induced Heteroepitaxial Structures

M.S. Goorsky, C. Li, and E. Rosker

Dept. Mat. Sci. Eng., University of California, Los Angeles, USA

15:30 – 15:45  O39 Metalorganic chemical vapour deposition of thin films of (Ga$_{1-x}$Al$_x$)$_2$O$_3$ using substituted acetylacetonate precursors, (Ga$_{1-x}$Al$_x$)(acac)$_3$

P. Jaiswal and S.A. Shivashankar

Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore, India

15:45 – 16:00  O40 Phase Control of Ga$_2$O$_3$ Films Deposited by Atomic Layer Epitaxy

V. Wheeler,¹ N. Nepal,¹ L. Nyakiti,² D. Boris,¹ S.Walton,¹ D.Meyer,¹ and C. Eddy Jr.¹

¹U.S. Naval Research Laboratory, Washington DC, USA
²Dept. Material Science and Engineering, Texas A&M University, USA

16:00 – 16:20  BREAK

16:20 – 17:35  Session Cha4
I12 Characterization of EFG-grown $\beta$-Ga$_2$O$_3$ single crystal by using Synchrotron X-ray topography, X-ray diffraction and Raman Y. Yao
Japan Fine Ceramics Center, Nagoya, Japan

16:50 – 17:05 O41 Characterization of Defects in EFG-Grown $\beta$-Ga$_2$O$_3$ Single Crystals
O. Ueda,¹ N. Ikenaga,² K. Koshi,³,⁴ K. Iizuka,³,⁴ A. Kuramata,³,⁴ K. Hanada,⁵ T. Moribayashi,⁵ S. Yamakoshi,³,⁴ and M. Kasu⁵
¹Graduate School of Engineering, Kanazawa Institute of Technology, Minato, Tokyo Japan
²Department of Electrical and Electronic Engineering, Kanazawa Institute of Technology, Nonoichi, Ishikawa, Japan
³Tamura Corporation, Sayama, Saitama, Japan
⁴Koha Co., Ltd., Nerima, Tokyo, Japan
⁵Department of Electrical and Electronic Engineering, Saga University, Saga, Japan

17:05 – 17:20 O42 Ga$_2$O$_3$ conductivity anisotropy analysed by van-der-Pauw measurements
C. Golz,¹ V. Santos,¹ F. Hatami,¹ W.T. Masselink,¹ Z. Galazka,² and O. Bierwagen³
¹Physics Institute, Humboldt-Universität zu Berlin, Germany.
²Leibniz Institute of Crystal Growth, Berlin, Germany.
³Paul-Drude-Institut für Festkörperphysik, Berlin, Germany.

17:20 – 17:35 O43 Charge Trapping Processes in Ga$_2$O$_3$ Schottky Diodes
C. De Santi,¹ M. Meneghini,¹ M.H. Wong,² K. Goto,³,⁴ H. Murakami,⁴ Y. Kumagai,⁴ A. Kuramata,³ S. Yamakoshi,³ M. Higashiwaki,² G. Meneghesso,¹ and E. Zanoni¹
¹Department of Information Engineering, University of Padova, Padova, Italy
²Nat. Inst. of Information and Communications Technology, Tokyo, Japan
³Tamura Corporation, Sayama, Saitama, Japan
⁴Department of Applied Chemistry, Tokyo Univ. of Agriculture and Technology, Tokyo, Japan

17:35 – 17:45 Final remarks, farewell
P1 **Pulsed magnetron assisted radio frequency sputter deposition of β-Ga$_2$O$_3**

P. Schurig, F. Michel, M. Becker, A. Polity, and P.J. Klar
Institute of Experimental Physics I and Center for Material Research, Justus Liebig University Giessen, Giessen, Germany

P2 **Structure property relationships in gallium oxide thin films grown by ion beam sputter deposition**

M. Becker, P. Schurig, F. Michel, A. Polity, and P.J. Klar
Institute for Exp. Physics I and Center for Materials Research (LaMa), Justus Liebig University Giessen, Germany

P3 **Electron Spin Resonance study of Sn doped α-Ga$_2$O$_3**

J. Kikawa, M. Becker, P. Schurig, F. Michel, A. Polity, and Y. Nanishi
Ritsumeikan University, Kusatsu, Shiga, Japan

P4 **Study on surface band bending of α-Ga$_2$O$_3$ grown by mist-CVD**

Y. Fujiki, T. Matsuda, T. Shinohe, T. Araki, and Y. Nanishi
Ritsumeikan University, Kusatsu, Shiga, Japan

P5 **Angle-resolved photoemissions spectroscopy on MgGa$_2$O$_4$: band structure, band bending and phase transition**

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P6 **Reversible modulation of the UV band in β-Ga$_2$O$_3**

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P7 **Cathodoluminescence spectra of Si-doped and Si-implanted β-Ga$_2$O$_3$ single crystals**

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P8 **A comprehensive study of lattice dynamics in ε-Ga$_2$O$_3**

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P9 **Bandgap engineering of single phase β-Ga$_2$O$_3$ epilayers grown by laser molecular beam epitaxy**

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P10 Scintillation and optical properties of Sn-doped Ga$_2$O$_3$ single crystals
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P11 Comparative study of scintillation properties of Ga$_2$O$_3$ single crystals and ceramics
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P12 Optical and Electrical Studies of Spray Coated Doped and Undoped β-Ga$_2$O$_3$ Thin Films
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P13 Fabrication of Si-doped α-Ga$_2$O$_3$ and its electrical properties
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P14 The quality improvement of the GaN epi-layer on (-2 0 1) β-Ga$_2$O$_3$ substrate
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P15 Epitaxial growth of β-Ga$_2$O$_3$ and GaN/β-Ga$_2$O$_3$ heterostructures by halide vapor phase epitaxy
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P16 Prospects of Heteroepitaxial beta-Ga$_2$O$_3$ - Extending the Frontier of Power Electronics
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P17 Direct bonding of gallium oxide and polycrystalline silicon carbide substrates using Surface-Activated-Bonding method
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P18 Study on the effect of anneal on the Ga$_2$O$_3$ film grown by MOCVD
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P19 Thermal stability and phase transition of ε-Ga$_2$O$_3$ polymorph
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P20  The real structure of ε-Ga$_2$O$_3$ and its relation to κ-phase

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P21  AC and DC characterization of γ-Ga$_2$O$_3$-containing glassceramic thin films
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P22  Electrical properties of Schottky diodes fabricated on a (001) β-Ga$_2$O$_3$ single crystal substrate having line-shaped voids and small defects
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P23  Nanoindentation Measurements of Mechanical Properties of β-Ga$_2$O$_3$ Epitaxial Layers grown on c- and m-plane Al$_2$O$_3$ Substrates
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P24  Electrical compensation mechanisms in Ga$_2$O$_3$
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P25  Characterization of electrical properties of α-Ga$_2$O$_3$ films on m-plane sapphire substrates

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P26  Shallow and deep trap levels in β-Ga$_2$O$_3$ single crystals
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P27  Characteristics of Mg and Zn doped β-Ga$_2$O$_3$ thin films and their Schottky diodes grown by metal-organic chemical vapor deposition
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P28  High-performance Schottky diodes based on Cr-doped β-Ga$_2$O$_3$
P29  Photoresponsivity of α-Ga$_2$O$_3$-based deep UV photodetector grown by mist CVD
K. Rikitake, T. Kobayashi, T. Yamaguchi, T. Onuma, and T. Honda
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P30  Graphene-β-Ga$_2$O$_3$ heterojunction for highly sensitive deep ultraviolet photodetector application
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P31  Synthesis of Ga$_2$O$_3$ nanowires for solar-blind ultraviolet photodetection
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P32  Investigation of the electronic structure and optical absorption of Sn-doped β-Ga$_2$O$_3$
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P33  Investigation of the structural, anisotropic and electronic properties of β-Ga$_2$O$_3$ and α-Ga$_2$O$_3$ under pressures
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P34  FMO-DFTB study of the electron transfer between Ga$_2$O$_3$ and water
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P35  Theoretical study of the effect of the surface Ga$_2$O$_3$ on the characteristics of the GaN-based chemical sensor
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P36  Intrinsic carrier trapping and luminescence in β-Ga$_2$O$_3$: a theoretical study using an optimized hybrid functional
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P37  Atomic signatures of local environment from core-level spectroscopy in β-Ga$_2$O$_3$
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P38 Band-to-band transitions and hole effective mass anisotropy in $\beta$-Ga$_2$O$_3$
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P39 Magnetic properties of transition metal ion (Mn, Cr) implanted $\beta$-Ga$_2$O$_3$
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P40 The inherent transport anisotropy of rutile tin dioxide (SnO$_2$) and consequences for applications
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P41 Determination of the Raman Tensor of monoclinic Ga$_2$O$_3$
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P42 $\beta$-Ga$_2$O$_3$ Solar-Blind Photodetector with a high light to dark current ratio
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P43 Fabrication of UV Photodetectors Based On $\beta$-Ga$_2$O$_3$ Thin Films Grown by Pulsed Laser Deposition
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P44 (AlGa)$_2$O$_3$ Solar-Blind Photodetectors on Sapphire with Wider Bandgap and Improved Responsivity
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P45 Photoelectric conversion properties of a $\beta$-Ga$_2$O$_3$/c-Se photodiode
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P46 Development of $\beta$-Ga$_2$O$_3$ p-n diode using p-Cu$_2$O
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P48 Thickness Effect on the Characteristics of ZnGa$_2$O$_4$ Transistor
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P49 Metal-assisted chemical etching of β-Ga$_2$O$_3$ for photodetectors
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P50 Deep ultraviolet photodetectors based on Gallium oxide/semiconductor heterojunctions
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2State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Posts and Telecommunications, Beijing, China
P51  **ICP-RIE etching of β-Ga$_2$O$_3$: Comprehensive investigation of plasma chemistry and temperature**
A.P. Shah and A. Bhattacharya
Tata Institute of Fundamental Research, DCMP & MS, Mumbai, India

P52  **Observation of red light-emitting devices from Ga$_2$O$_3$:Eu/GaAs structure**
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P53  **Characteristics of Ultraviolet Photodetectors Based on N-Incorporation Ga$_2$O$_3$ with and without Thermal Annealing**
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P54  **Solar-blind photodetectors based on epitaxial ZnGa$_2$O$_4$ thin film**
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P55  **Oxygen plasma induced performance enhancement of Pt(O$_x$/In$_2$O$_3$ Schottky barrier diodes**
J. Michel,$^1$ T. Berthold,$^1$ S. Krischok,$^1$ M. Himmerlich,$^1$ J. Rombach,$^2$ O. Bierwagen,$^2$ D. Splith,$^3$
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P56  **Investigating β-Ga$_2$O$_3$ thin films grown by PLD on quartz glass**
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P57  **Photo electrical characteristics of Ga$_2$O$_3$-GaAs structures**
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P58  **Strain dynamics of heteropitaxial grown alpha phase Ga$_2$O$_3$ and homoepitaxial growth of beta phase Ga$_2$O$_3$ as studied by synchrotron based x-ray diffraction and RHEED**
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P59  **Optical floating zone growth and characterization of single crystal β-Ga$_2$O$_3$**
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P60  **Growth and Characterization of pure and doped β-Ga$_2$O$_3$ Crystals by EFG method**
Z. Jia,$^{1,2}$ W. Mu,$^1$ Y. Yin, B. Wu, Y. Li, and X. Tao$^1$
P61  **Determination of crystallographic orientation on growth habits of β-Ga$_2$O$_3$ grown by directional solidification method without seed**  
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P62  **Columnar-shaped β-Ga$_2$O$_3$ Crystal Growth by Edge-defined, Film-fed Growth Technique**  
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P63  **Electric properties of β-Ga$_2$O$_3$ single crystals grown by VB technique**  
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3Toyota Motor Corporation, Susono, Shizuoka, Japan  

P64  **Features of β-Ga$_2$O$_3$ single crystal growth by Czochralsky method with NIKA-3 setup**  
P.S. Shirshnev, 1 A.I. Pechnikov, 3 V.I. Nikolaev, 1,2,3 V.M. Krymov, 2 A.V. Kremleva, 1,2  
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3Perfect crystals LLC, Saint-Petersburg, Russia  

P65  **Synthesis of large size phase-pure β-Ga$_2$O$_3$ by edge-defined film-fed growth**  
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P66  **Epitaxial Growth and Characterization of CuGa$_2$O$_4$ Films**  
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P67  **Fe$_2$O$_3$-assisted Al thermal diffusion in Ga$_2$O$_3$ thin film for wide bandgap engineering**  
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P68  **Investigations into a Strong Dependence of Electrical Conductivity Observed for β-Ga$_2$O$_3$ Thin Films on Sapphire Substrate Orientation**  
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V.E. Sandana, 3 P. Bove, 3 T.T. Huynh, 2 M. Phillips, 2 M.J. Sainz, 4 P. Chapon, 5 Y. Dumont, 1  
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P69 \( \varepsilon \)-Ga\(_2\)O\(_3\) epitaxial growth on AlN and GaN templates using GaCl\(_3\) precursor by mist chemical vapor deposition
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P70 Synthesis of GaN by nitridation of \( \varepsilon \)-Ga\(_2\)O\(_3\) film
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P71 Growth of \( \beta \)-Ga\(_2\)O\(_3\) Thin Films on SiC by Molecular Beam Epitaxy
N. Nepal, D.S. Katzer, V. Wheeler, B.P. Downey, D.F. Storm, M.T. Hardy, and D.J. Meyer
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P72 Growth of \( \beta \)-Ga\(_2\)O\(_3\)-based heterostructures by pulsed-laser deposition
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P73 Mechanical exfoliation of \( \beta \)-Ga\(_2\)O\(_3\) and its device applications
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P74 Homoeptaxial Growth on 2-Inch-Diameter (001) \( \beta \)-Ga\(_2\)O\(_3\) Substrates by Halide Vapor Phase Epitaxy
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P75 The role of Mn dopant on the structural and optoelectronic properties of Ga\(_2\)O\(_3\) films
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P76 Solar blind photodetector based on Al-doped spinel gallium oxide
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P77 High-quality, homoeptaxial Si-doped \( \beta \)-Ga\(_2\)O\(_3\) (010) and \( \beta \)-(Al\(_x\)Ga\(_{1-x}\))\(_2\)O\(_3\)/Ga\(_2\)O\(_3\) (010) heterostructures grown by pulsed laser epitaxy
S. Pacely, R. Budhani, S. Mou, K. Leedy, A. Neal, B. Urwin, K. Mahalingam, and B.M. Howe
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P78 Optical and electronic properties of doped \( \beta \)-Ga\(_2\)O\(_3\) micro- and nanostructures
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Indium incorporation into $\varepsilon$-Ga$_2$O$_3$ epitaxial thin films grown by mist chemical vapor deposition
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Temperature-Dependent Growth of Ga$_2$O$_3$ on (0001) Sapphire Substrates by Halide Vapor Phase Epitaxy
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Combinatorial approach to (In, Ga, Al)$_2$O$_3$ – phase diagram, doping and influence of sub-oxide desorption
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Growth and Application of Cr,Mg co-doped β-Ga$_2$O$_3$ Single Crystal As a Saturable Absorber
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Work function study of β-Ga$_2$O$_3$ thin films using KPFM
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Comparison of β-Ga$_2$O$_3$ UVC Photodetectors Fabricated by MOCVD and PLD
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Characteristics β-Ga$_2$O$_3$ Photodetectors on Bulk Substrate and Sapphire
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β-Ga$_2$O$_3$ (100) MISFETs for power electronics applications
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Leakage current mechanisms of Al$_2$O$_3$/Ga$_2$O$_3$MOS capacitors
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Ga$_2$O$_3$ Vertical Power Field-Effect Transistors with On/Off Ratio >10⁹
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Epitaxy of Ga$_2$O$_3$ by O$_2$ Plasma & Ozone MBE (PAMBE & OMBE)
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Characterization of ZrO$_2$ and HfO$_2$ Dielectrics Deposited by Thermal ALD on β-Ga$_2$O$_3$ Substrates
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The effect of growth pressure on epitaxial growing Ga$_2$O$_3$ films by MOCVD
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Deposition of Wide Bandgap Ga$_2$O$_3$ and Related Alloys by MBE and PLD
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Sub-200°C microwave-assisted deposition of β-Ga$_2$O$_3$ thin films on sapphire
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Control of crystallographic structure of Ga$_2$O$_3$ on sapphire
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Growth and Characteristics of (Al$_x$Ga$_{1-x}$)$_2$O$_3$ Films Using High-Oxygen-Pressure Pulsed Laser Deposition
S.-Y. Huang, C.-C. Wang, S.-H. Yuan, C.-M. Chen, and D.-Sing Wu
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Influence of Ga incorporation into bixbyite In$_2$O$_3$ thin films on the performance of Schottky barrier diodes thereon
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Sol-gel deposition and properties of In$_2$O$_3$ thin layers
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Influence of Growth Rate on Halide Vapor Phase Epitaxy of c-In$_2$O$_3$ on c-Plane Sapphire Substrates
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Effect of Metal Additives on the Surface and in the Bulk of Tin Dioxide Thin Films on Characteristics of Resistive Hydrogen Sensors
A. Almaev, N. Maksimova, and E. Chernikov
P100 **Crystal structure and magnetic properties of Ga$_{2-x}$Fe$_x$O$_3$**

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P101 **Stabilizing the metastable cubic $\gamma$ phase Ga$_2$O$_3$ by Cu doping**

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