

Takashi ONAYA, Ph.D.

Assistant Professor

1st April 2024

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Nano-Space Function Design Group (Prof. Kita Research Group),
Group of Materials Design and Processing,
Department of Advanced Materials Science,
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RESEARCH EXPERIENCES

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| Dec. 2022 – Present | Assistant Professor (The University of Tokyo Excellent Young Researcher)
Prof. Kita Research Group,
Department of Advanced Materials Science,
Graduate School of Frontier Science, The University of Tokyo, Japan |
| Dec. 2022 – Present | Leading Initiative for Excellent Young Researcher (LEADER)
The Ministry of Education, Culture, Sports, Science and Technology
(MEXT), Japan |
| Apr. 2018 – Present | Visiting Researcher
International Center for Materials Nanoarchitectonics (WPI-MANA),
National Institute for Materials Science (NIMS), Japan |
| Apr. 2021 – Nov. 2022 | Research fellow of Japan Society for the Promotion of Science (JSPS), PD
Japan Society for the Promotion of Science (JSPS), Japan
(Affiliation: National Institute of Advanced Industrial Science and
Technology (AIST), Japan) |
| Apr. 2018 – Mar. 2021 | Research fellow of Japan Society for the Promotion of Science (JSPS), DC1
Japan Society for the Promotion of Science (JSPS), Japan
(Affiliation: Meiji University, Japan) |
| Apr. 2019 – Apr. 2020 | Visiting Researcher / Research Assistant (RA)
Prof. Jiyoung Kim Research Group,
Department of Materials Science and Engineering,
The University of Texas at Dallas, United States |
| Apr. 2016 – Mar. 2018 | NIMS Junior Researcher
International Center for Materials Nanoarchitectonics (WPI-MANA),
National Institute for Materials Science (NIMS), Japan |
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EDUCATION

Apr. 2018 – Mar. 2021 Ph.D. in Engineering

Supervisor: Prof. Atsushi Ogura

Department of Electrical Engineering, Meiji University, Japan

Apr. 2016 – Mar. 2018 M.S. in Engineering

Supervisor: Prof. Atsushi Ogura

Department of Electrical Engineering, Meiji University, Japan

Apr. 2012 – Mar. 2016 B.S. in Engineering

Supervisor: Prof. Atsushi Ogura

Department of Electronics and Bioinformatics, Meiji University, Japan

AWARDS and HONORS

■ The 15th Silicon Technology Division Paper Award

Silicon Technology Division, The Japan Society of Applied Physics, 2024.

■ IWDTF Young Researcher Award

2023 International Workshop on Dielectric Thin Films for Future Electron Devices –Science and Technology– (IWDTF 2023), Thin Film and Surface Physics Division, The Japan Society of Applied Physics (JSAP), 2023.

■ Featured Article

APL Materials, AIP Publishing, 2022.

■ Excellent Poster Presentation Award

The 14th MANA International Symposium 2021, International Center for Materials Nanoarchitectonics (WPI-MANA), National Institute for Materials Science (NIMS), 2021.

■ Best Poster Award

The 19th Annual Non-Volatile Memory Technology Symposium (NVMTS 2019), 2019.

■ The 44th JSAP Young Scientist Presentation Award

The 65th Japan Society of Applied Physics (JSAP) Spring Meeting, 2018.

■ Yasuda Award

The 23rd Workshop on Symposium on Electron Device Interface Technology (EDIT23), 2018.

■ Young Award

2017 International Workshop on Dielectric Thin Films for Future Electron Devices –Science and Technology– (IWDTF 2017), Thin Film and Surface Physics Division, The Japan Society of Applied Physics (JSAP), 2017.

RESEARCH INTERESTS

- Ferroelectric HfO₂-based thin films and high dielectric constant (high-*k*) insulating thin films (HfO₂, ZrO₂, Al₂O₃, TiO₂, etc.) for future memory device applications.
 - Fabrication techniques of ferroelectric HfO₂-based thin films and high-*k* insulating thin films using an atomic layer deposition (ALD) technique.
 - Interface engineering in ferroelectric HfO₂-based non-volatile memory devices.
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PUBRICATIONS

- [1] **T. Onaya**, and K. Kita, "Role of Oxidant Gas for Atomic Layer Deposition of Hf_xZr_{1-x}O₂ Thin Films on Ferroelectricity of Metal-Ferroelectric-Metal Capacitors", *ECS Transactions*, In press, May 2024. **(Invited paper)**
- [2] T. Inoue, **T. Onaya**, and K. Kita, "Enhancement of remnant polarization in ferroelectric HfO₂ thin films induced by mechanical uniaxial tensile strain after crystallization process", *Applied Physics Express*, In press, March 2024.
- [3] Y. Morita, **T. Onaya**, S. Asanuma, H. Ota, and S. Migita, "Development of ferroelectricity with crystallographic phase transformation in Hf_{0.5}Zr_{0.5}O₂ thin films upon initial stimulation of an electric field exceeding the coercive field", *Japanese Journal of Applied Physics*, In press, March 2024.
- [4] **T. Onaya**, T. Nabatame, T. Nagata, K. Tsukagoshi, J. Kim, C.-Y. Nam, E. H. R. Tsai, and K. Kita, "Effects of oxidant gas for atomic layer deposition on crystal structure and fatigue of ferroelectric Hf_xZr_{1-x}O₂ thin films", *Solid-State Electronics*, Vol. 210, pp. 108801 1–4, October 2023.
- [5] **T. Onaya**, "Fabrication Technique of Ferroelectric Hf_xZr_{1-x}O₂ Thin Films Using ALD-ZrO₂ Nucleation Layers", *ECS Transactions*, Vol. 112, No. 1, pp. 75–88, October 2023. **(Invited paper)**
- [6] J.-H. Kim, **T. Onaya**, H. R. Park, Y. C. Jung, D. N. Le, M. Lee, H. Hernandez-Arriaga, Y. Zhang, E. H. R. Tsai, C.-Y. Nam, T. Nabatame, S. J. Kim, and J. Kim, "Toward Low-Thermal-Budget Hafnia-Based Ferroelectrics via Atomic Layer Deposition", *ACS Applied Electronic Materials*, Vol. 5, No. 9, pp. 4726–4745, September 2023.
- [7] **T. Onaya**, T. Nabatame, M. Inoue, T. Sawada, H. Ota, and Y. Morita, "Wake-up-free properties and high fatigue resistance of Hf_xZr_{1-x}O₂-based metal-ferroelectric-semiconductor using top ZrO₂ nucleation layer at low thermal budget (300°C)", *APL Materials*, Vol. 10, No. 5, pp. 051110 1–7, May 2022. **(Featured Article & The 15th Silicon Technology Division Paper Award)**
- [8] J. Mohan, Y. C. Jung, H. Hernandez-Arriaga, J.-H. Kim, **T. Onaya**, A. Sahota, S. M. Hwang, D. N. Le, J. Kim, and S. J. Kim, "Relaxation Induced by Imprint Phenomena in Low-Temperature (400 °C) Processed Hf_{0.5}Zr_{0.5}O₂-Based Metal-Ferroelectric-Metal Capacitors" *ACS Applied Electronic Materials*, Vol. 4, No. 4, pp. 1405–1414, February 2022.
- [9] T. Nabatame, E. Maeda, M. Inoue, M. Hirose, Y. Irokawa, A. Ohi, N. Ikeda, **T. Onaya**, K. Shiozaki, R. Ochi, T. Hashizume, and Y. Koide, "Influence of HfO₂ and SiO₂ interfacial layers on the characteristics of n-GaN/HfSiO_x capacitors using plasma-enhanced atomic layer deposition", *Journal of Vacuum Science & Technology A*, Vol. 39, No. 6, pp. 062405 1–7, October 2021.

- [10] **T. Onaya**, T. Nabatame, M. Inoue, T. Sawada, H. Ota, and Y. Morita, "Study of SiO₂ Interfacial Layer Growth during Fabrication Process of Ferroelectric Hf_xZr_{1-x}O₂-Based Metal-Ferroelectric-Semiconductor", *ECS Transactions*, Vol. 104, No. 4, pp. 129–135, October 2021.
- [11] T. Nabatame, E. Maeda, M. Inoue, M. Hirose, R. Ochi, T. Sawada, Y. Irokawa, T. Hashizume, K. Shiozaki, **T. Onaya**, K. Tsukagoshi, and Y. Koide, "Study of HfO₂-based High-k gate Insulators for GaN Power Device", *ECS Transactions*, Vol. 104, No. 4, pp. 113–120, October 2021. (*Invited paper*)
- [12] T. Sawada, T. Nabatame, **T. Onaya**, M. Inoue, A. Ohi, N. Ikeda, and K. Tsukagoshi, "Importance of Annealing Step on Dielectric Constant of ZrO₂ Layer of MIM Capacitors with Al₂O₃/ZrO₂ and ZrO₂/Al₂O₃ Stack Structures", *ECS Transactions*, Vol. 104, No. 4, pp. 121–128, October 2021.
- [13] **T. Onaya**, T. Nabatame, Y. C. Jung, H. Hernandez-Arriaga, J. Mohan, H. S. Kim, N. Sawamoto, C.-Y. Nam, E. H. R. Tsai, T. Nagata, J. Kim, and A. Ogura, "Correlation between ferroelectricity and ferroelectric orthorhombic phase of Hf_xZr_{1-x}O₂ thin films using synchrotron x-ray analysis", *APL Materials*, Vol. 9, No. 3, pp. 031111 1–7, March 2021.
- [14] J. Mohan, H. Hernandez-Arriaga, Y. C. Jung, **T. Onaya**, C.-Y. Nam, E. H. R. Tsai, S. J. Kim, and J. Kim, "Ferroelectric polarization retention with scaling of Hf_{0.5}Zr_{0.5}O₂ on silicon", *Applied Physics Letters*, Vol. 118, No. 10, pp. 102903 1–6, March 2021.
- [15] R. Kobayashi, T. Nabatame, K. Kurishima, **T. Onaya**, A. Ohi, N. Ikeda, T. Nagata, K. Tsukagoshi, and A. Ogura, "Influence of adsorbed oxygen concentration on characteristics of carbon-doped indium oxide thin-film transistors under bias stress", *Japanese Journal of Applied Physics*, Vol. 60, No. SC, pp. SCCM01 1–5, March 2021.
- [16] R. Kobayashi, T. Nabatame, K. Kurishima, **T. Onaya**, A. Ohi, N. Ikeda, T. Nagata, K. Tsukagoshi, and A. Ogura, "Comparison of characteristics of thin film transistor with In₂O₃ and carbon-doped In₂O₃ channels by atomic layer deposition and post-metallization annealing in O₃", *Japanese Journal of Applied Physics*, Vol. 60, No. 3, pp. 030903 1–5, February 2021.
- [17] **T. Onaya**, T. Nabatame, M. Inoue, Y. C. Jung, H. Hernandez-Arriaga, J. Mohan, H. S. Kim, N. Sawamoto, T. Nagata, J. Kim, and A. Ogura, "Improvement in ferroelectricity and breakdown voltage of over 20-nm-thick Hf_xZr_{1-x}O₂/ZrO₂ bilayer by atomic layer deposition", *Applied Physics Letters*, Vol. 117, No. 23, pp. 232902 1–5, December 2020.
- [18] **T. Onaya**, T. Nabatame, M. Inoue, Y. C. Jung, H. Hernandez-Arriaga, J. Mohan, H. S. Kim, N. Sawamoto, T. Nagata, J. Kim, and A. Ogura, "Improvement of Ferroelectricity and Fatigue Property of Thicker Hf_xZr_{1-x}O₂/ZrO₂ Bi-layer", *ECS Transactions*, Vol. 98, No. 3, pp. 63–70, September 2020.
- [19] R. Kobayashi, T. Nabatame, K. Kurishima, **T. Onaya**, A. Ohi, N. Ikeda, T. Nagata, K. Tsukagoshi, and A. Ogura, "Characteristics of Oxide TFT Using Carbon-Doped In₂O₃ Thin Film Fabricated by Low-Temperature ALD Using Ethylcyclopentadienyl Indium (In-EtCp) and H₂O & O₃", *ECS Transactions*, Vol. 92, No. 3, pp. 3–13, July 2019.
- [20] **T. Onaya**, T. Nabatame, N. Sawamoto, A. Ohi, N. Ikeda, T. Nagata, and A. Ogura, "Improvement in ferroelectricity of Hf_xZr_{1-x}O₂ thin films using top- and bottom-ZrO₂ nucleation layers", *APL Materials*, Vol. 7, No. 6, pp. 061107 1–7, June 2019.

- [21] **T. Onaya**, T. Nabatame, N. Sawamoto, A. Ohi, N. Ikeda, T. Nagata, and A. Ogura, "Ferroelectricity of $\text{Hf}_x\text{Zr}_{1-x}\text{O}_2$ thin films fabricated by 300 °C low temperature process with plasma-enhanced atomic layer deposition", *Microelectronic Engineering*, Vol. 215, pp. 111013 1–5, July 2019.
- [22] **T. Onaya**, T. Nabatame, T. Sawada, K. Kurishima, N. Sawamoto, A. Ohi, T. Chikyow, and A. Ogura, "Improved leakage current properties of $\text{ZrO}_2/(\text{Ta/Nb})\text{O}_x\text{-Al}_2\text{O}_3/\text{ZrO}_2$ nanolaminate insulating stacks for dynamic random access memory capacitors", *Thin Solid Films*, Vol. 655, pp. 48–53, June 2018.
- [23] **T. Onaya**, T. Nabatame, N. Sawamoto, K. Kurishima, A. Ohi, N. Ikeda, T. Nagata, and A. Ogura, "Ferroelectricity of $\text{Hf}_x\text{Zr}_{1-x}\text{O}_2$ Thin Films Fabricated Using TiN Stressor and ZrO_2 Nucleation Techniques", *ECS Transactions*, Vol. 86, No. 6, pp. 31–38, September 2018.
- [24] K. Kurishima, T. Nabatame, **T. Onaya**, K. Tsukagoshi, A. Ohi, N. Ikeda, T. Nagata, and A. Ogura, "Reliability of $\text{Al}_2\text{O}_3/\text{In-Si-O-C}$ Thin-Film Transistor with an Al_2O_3 Passivation Layer under Gate-Bias Stress", *ECS Transactions*, Vol. 86, No. 11, pp. 135–145, September 2018.
- [25] **T. Onaya**, T. Nabatame, N. Sawamoto, A. Ohi, N. Ikeda, T. Chikyow, and A. Ogura, "Improvement in ferroelectricity of $\text{Hf}_x\text{Zr}_{1-x}\text{O}_2$ thin films using ZrO_2 seed layer", *Applied Physics Express*, Vol. 10, No. 8, pp. 081501 1–4, July 2017.
- [26] T. Sawada, T. Nabatame, T. D. Dao, I. Yamamoto, K. Kurishima, **T. Onaya**, A. Ohi, K. Ito, M. Takahashi, K. Kohama, T. Ohishi, A. Ogura, and T. Nagao, "Improvement of smooth surface of RuO_2 bottom electrode on Al_2O_3 buffer layer and characteristics of $\text{RuO}_2/\text{TiO}_2/\text{Al}_2\text{O}_3/\text{TiO}_2/\text{RuO}_2$ capacitors", *Journal of Vacuum Science & Technology A*, Vol. 35, No. 6, pp. 061503 1–7, July 2017.
- [27] **T. Onaya**, T. Nabatame, T. Sawada, K. Kurishima, N. Sawamoto, A. Ohi, T. Chikyow, and A. Ogura, "Role of High- k Interlayer in $\text{ZrO}_2/\text{high-}k/\text{ZrO}_2$ Insulating Multilayer on Electrical Properties for DRAM Capacitor", *ECS Transactions*, Vol. 75, No. 8, pp. 667–674, September 2016.

INVITED TALKS

- [1] °**T. Onaya**, and K. Kita, "Role of Oxidant Gas for Atomic Layer Deposition of $\text{Hf}_x\text{Zr}_{1-x}\text{O}_2$ Thin Films on Ferroelectricity of Metal-Ferroelectric-Metal Capacitors", 245th ECS Meeting, D02-1303, San Francisco, California, USA, Marriott Marquis San Francisco, May 2024.
 - [2] °**T. Onaya**, T. Nabatame, M. Inoue, T. Sawada, H. Ota, and Y. Morita, "Fabrication technique of ferroelectric $\text{Hf}_x\text{Zr}_{1-x}\text{O}_2$ thin films using ALD- ZrO_2 nucleation layers and its application to MFS structures", The 71st JSAP Spring Meeting 2024, 23p-12J-2, Tokyo, Japan, Setagaya Campus, Tokyo City University & Online, March 2024.
 - [3] °**T. Onaya**, "Fabrication Technique of Ferroelectric $\text{Hf}_x\text{Zr}_{1-x}\text{O}_2$ Thin Films Using ALD- ZrO_2 Nucleation Layers", 244th ECS Meeting, G02-1525, Gothenburg, Sweden, Swedish Exhibition & Congress Centre and Gothia Towers Hotel, October 2023.
 - [4] °**T. Onaya**, T. Nabatame, N. Sawamoto, A. Ohi, N. Ikeda, T. Nagata, and A. Ogura, "Fabrication technique of ferroelectric $\text{Hf}_x\text{Zr}_{1-x}\text{O}_2$ thin films using nano- ZrO_2 nucleation layer", The 79th JSAP Autumn Meeting 2018, 21a-145-6, Aichi, Japan, Nagoya Congress Center, September 2018.
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ASSOCIATION MEMBERSHIPS

Jan. 2015 – Present The Japan Society of Applied Physics (JSAP)

PROFESSIONAL ACTIVITIES

Apr. 2024 – Present Committee Member
Microprocesses and Nanotechnology Conference (MNC), Atomic Layer
Processing (ALP) session
