CURRICULUM VITAE (CV)

Dr. Shigeo Maruyama is the distinguished Professor at the University of Tokyo, a faculty member of the Department of Mechanical Engineering, School of Engineering and a Director of Collaborative Research Organization for Micro and Nano Multifunctional Devices, which integrates and coordinate research activities across all 9 Schools and Institutes at the University of Tokyo.

Professor Shigeo Maruyama has invented the Alcohol Catalytic Chemical Vapor Deposition (ACCVD) technique for growth of high-purity single-walled carbon nanotubes (SWCNTs) at relatively low temperature in 2002. Later, by ACCVD technique, he realized the vertically aligned growth of SWCNTs for the first time in the world. These techniques and idea of adding controlled amount of oxygen are well accepted in the field and widely applied. At the same time, he has been the leading researcher of characterization methodology of SWCNTs such as resonant Raman spectroscopy, near infra-red photoluminescence spectroscopy and absorption spectroscopy. Through these studies of growth and characterization of SWCNTs along with the unique studies of chemical reaction on metal clusters in mass spectroscopy, he is well recognized as the most important successor of the legacy of late Professor Richard E. Smalley, Nobel Laureate of Chemistry in 1996, at Rice University.

In parallel to those experimental works, he pioneered the molecular dynamics simulation of catalytic growth of SWCNTs. Hundreds of simulation studies following his work have paved the theoretical background of the nucleation and growth of SWCNT, and chirality (geometric structure) controlled growth of SWCNT.

In research field of application of SWCNT, he has worked on growth of horizontally aligned SWCNTs on crystal quartz substrate. His proposal of employing r-cut crystalline quartz is now recognized to be the essential for such aligned growth. He also developed the full-length selective removal technique of metallic SWCNTs in the array of grown SWCNTs, which is also an essential technique for the scaled up design of field effect transistors (FET) using semiconductor SWCNT as channels. Another important application he has developed are next generation solar cells such as organic and organic-inorganic Perovskite solar cells. A film of high-quality SWCNTs is probed to be the practical flexible/foldable transparent-conductive electrode through his EU-Japan international project, called IRENA. The demonstrated solar cells employing the SWCNT films are remarkable for replacement of Indium-Tin-Oxide (ITO) in the early stage. The unique flexible and foldable solar cells are proposed. However, recent design of SWCNTs fully replacing and out-performing metal electrode as the transparent electrode extruding organic hole transport layer has proved that SWCNT is not simply the replacement of ITO, but turned out to be the essential material for practical cost efficient tandem solar cells. With the near-infra red transparent nature of SWNCTs, it will be the only acceptable design of top cell of Perovskite-Silicon tandem solar cells with power conversion efficiencies of above 30%.

Finally, his unique proposal of one-dimensional van der Waals hetero structure based on SWCNT published in Science in 2020 is expected to be the land-mark of development of one-dimensional materials. He has synthesized a new coaxial nanotube structure, in which mono- or few-layer hexagonal boron nitride nanotube (BNNT) seamlessly wrapped around a SWCNTs. He further developed the 1D coating CVD of transition metal dichalcogenide nanotubes (TMD-NT), such as MoS2 nanotubes. The 1D research field and 2D research field will be combined to the new physics and applications of low-dimensional materials.

Professor Shigeo Maruyama is the current co-chair of steering committee of Carbon Nanotube conferences (International Conference on Science and Application of Nanotubes and Low-Dimensional Materials) since 2016. His leadership is essential for the growing research field of low-dimensional materials such as carbon nanotubes through annual international conferences. For 9 years, he was the president of 'The Fullerenes, Nanotubes and Graphene Research Society' (FNTG) based in Japan, during 2011-2020. Because of the multi-disciplinary nature of the emerging material research, those activities are combining researchers from chemistry, physics, and various engineering fields. The collaboration with industries and society are also essential for the research society of emerging materials. He has co-organized or contributed in the industry-society actives such as Nano-Carbon-Application Forum, Future Technology Symposia of NBCI (Nanotechnology Business Creation Initiative), Graphene Consortium of NBCI, Four University Nano-Micro fabrication consortium, and others.

He worked as a cross-appointment fellow for Advanced Industrial science and technology (AIST) in Japan for 5 years during 2015-2020. And, he is working as the director of University-wide Collaborative Research Organization for Micro and Nano Multifunctional Devices at the University of Tokyo since 2019. He is now the research supervisor of JST-CREST research area, "Creation of Innovative Core Technologies for Nano-enabled Thermal Management" since 2018. Combining all these multi-disciplinary research and innovation activities, his main target is bridging the science and engineering research to industrial innovations.

Along with the innovative research works on growth, characterization, and applications of SWCNTs, Professor Shigeo Maruyama is well known as the pioneer of the unique interdisciplinary research field, Nanoscale Thermal Engineering. He is the inventor of molecular dynamics simulations for nucleation, phase interface phenomena, phase change phenomena, and phonon transport for thermo-fluid engineering and material engineering filed. His multiscale simulations based on density functional theory (DFT) is extended to molecular dynamics simulations and dynamics with Boltzmann equations, and continuum. This concept is now a kind of common-sense in different engineering fields. Combined with the innovative chemistry and physics with these engineering, he had made a strong bridge of the nano-science to the industry level applications.

	Name	Shigeo Maruyama		
	Date of Birth	1960/03/01	Age	61
	Research Institution, Academic Unit (School, Faculty, etc.) & Position	School of Engineering, The University of Tokyo, Distinguished Professor		
	Academic Degree	Doctor of Engineering		

Education

1983 Department of Mechanical Engineering, The University of Tokyo, Bachelor of Engineering

1985 Department of Mechanical Engineering, The University of Tokyo, Master of Engineering

1988 Department of Mechanical Engineering, The University of Tokyo, Doctor of Engineering

Profession

1988-1989 **Research Associate**, School of Engineering, the University of Tokyo,
Studied heat transfer of turbulent and boiling fluid with Professor Masahiro Shoji

1989-1991 **Visiting Scholar and Visiting Fellow,** Department of Chemistry, Rice University, USA,
Studied the carbon, silicon, metal nanoclusters with Professor Richard E. Smalley

1991-1993 **Lecturer**, School of Engineering, the University of Tokyo,
Synthesis and molecular dynamics simulation of fullerene

1993-2004 **Associate Professor,** School of Engineering, the University of Tokyo,
CVD synthesis of single-walled CNT and MD simulation of its formation mechanism

2004-2014 **Professor**, School of Engineering, the University of Tokyo,
CVD synthesis, photoluminescence, heat transfer of SWCNT; metal cluster; field effect transistors (FET) and solar cells using SWCNT.

2014-present **Distinguished Professor,** School of Engineering, the University of Tokyo,
CVD synthesis of SWCNT and graphene; solar cells using SWCNT and graphene
Synthesis and application of one-dimensional hetero-nanotubes

2015-2020 **Cross-Appointed Fellow,** Energy NanoEngineering Lab., National Institute of Advanced Industrial Science and Technology (AIST), Perovskite solar cell using nanocarbon materials.

2019-present **Director**, Collaborative Research Organization for Micro and Nano Multifunctional Devices, UTokyo

Recent Journal publications

1. S. Cambre*, M. Liu, D. Levshov, K. Otsuka, S. Maruyama*, R. Xiang*, Nanotube-based one-dimensional heterostructures coupled by van der Waals forces, *Small*, **17**, 2102585. (2021).
2. Y. Zheng, A. Kumamoto, K. Hisama, K. Otsuka, G. Wickerson, Y. Sato, M. Liu, T. Inoue, S. Chiashi, D.-M. Tang, Q. Zhang, A. Anisimov, E. I. Kauppinen, Y. Li, K. Suenaga, Y. Ikuhara, S. Maruyama*, R. Xiang*, One-dimensional van der Waals Heterostructures: Growth Mechanism and Handedness Correlation Revealed by Non-destructive TEM, *P. Natl. Acad. Sci.*, **118**, e2107295118. (2021).
3. J. Yoon, U. Kim, Y. Yoo, J. Byeon, Q. Zhang, E. I. Kauppinen, M. Choi, S. Maruyama*, P. Lee*, I. Jeon*, Foldable Perovskite Solar Cells using Carbon Nanotube-Embedded Ultrathin Polyimide Conductor, *Adv. Sci.*, **8**, 2004092, (2021).
4. Y. Feng*, H. Li, T. Inoue, S. Chiashi, S. V. Rotkin, R. Xiang, S. Maruyama*, One-dimensional van der Waals heterojunction diode, *ACS Nano*, **15**, 5600-5609, (2021).
5. M. Liu, K. Hisama, Y. Zheng, M. Maruyama, S. Seo, A. Anisimov, T. Inoue, E. I. Kauppinen, S. Okada, S. Chiashi, R. Xiang, S. Maruyama*, Photoluminescence from Single-Walled MoS2 Nanotubes Coaxially Grown on Boron Nitride Nanotubes, *ACS Nano*, **15**, 8418-8426. (2021).
6. *R. Xiang, T. Inoue, Y. Zheng, A. Kumamoto, Y. Qian, Y. Sato, M. Liu, D. Tang, D. Gokhale, J. Guo, K. Hisama, S. Yotsumoto, T. Ogamoto, H. Arai, Y. Kobayashi, H. Zhang, B. Hou, A. Anissimov, M.

Maruyama, Y. Miyata, S. Okada, S. Chiashi, Y. Li, J. Kong, E. I. Kauppinen, Y. Ikuhara, K. Suenaga, *S. Maruyama, One-dimensional van der Waals heterostructures, *Science* **367**, 537-542 (2020).

7. P. Wang, Y. Zheng, *T. Inoue, R. Xiang, A. Shawky, M. Watanabe, A. Anisimov, E. I. Kauppinen, S. Chiashi, *S. Maruyama, Enhanced In-Plane Thermal Conductance of Thin Films Composed of Coaxially Combined Single-Walled Carbon Nanotubes and Boron Nitride Nanotubes, *ACS Nano* **14**, 4298-4305 (2020).
8. Y. Qian, *I. Jeon, Y.-L. Ho, C. Lee, S. Jeong and C. Delacou, S. Seo, A. Anisimov, E. I. Kaupinnen, Y. Matsuo, Y. Kang, H.-S. Lee, D. Kim, J.-J. Delaunay, *S. Maruyama, Multifunctional Effect of p-Doping, Anti-Reflection, and Encapsulation by Polymeric Acid for High Efficiency and Stable Carbon Nanotube-based Silicon Solar Cell, *Adv. Energy Mater.* **10**, 1902389 (2020).
9. I. Jeon, R. Xiang, A. Shawky, Y. Matsuo, *S. Maruyama, Single-Walled Carbon Nanotubes in Emerging Solar Cells: Synthesis and Electrode Applications, *Adv. Energy Mater.* **9**, 1801312 (2019).
10. R. Yoshikawa, K. Hisama, H. Ukai, Y. Takagi, T. Inoue, *S. Chiashi, *S. Maruyama, Molecular Dynamics of Chirality Definable Growth of Single-Walled Carbon Nanotubes, *ACS Nano* **13**, 6506-6512 (2019).
11. H. An, A. Kumamoto, *R. Xiang, T. Inoue, S. Chiashi, C. Bichara, A, Loiseau, Y. Li, Y. Ikuhara, *S. Maruyama, Atomic Scale Structural Identification and Evolution of Co-W-C Ternary SWCNT Catalytic Nanoparticles: HR-STEM imaging on SiO_2, *Sci. Adv.* **5**, eaat9459 (2019).
12. J.-W. Lee, I. Jeon, H. Lin, S. Seo, T.-H. Han, A. Anisimov, E. I. Kauppinen, *Y. Matsuo, *S. Maruyama, *Y. Yang, Vapor-Assisted Ex-Situ Doping of Carbon Nanotube towards Efficient and Stable Perovskite Solar Cells, *Nano Lett.* **19**, 2223-2230 (2019).
13. K. Otsuka, S. Yamamoto, *T. Inoue, B. Koyano, H. Ukai, R. Yoshikawa, R. Xiang, S. Chiashi, *S. Maruyama, Digital isotope coding to trace growth process of individual single-walled carbon nanotubes, *ACS Nano* **12**, 3994-4001 (2018).
14. K. Otsuka, T. Inoue, E. Maeda, R. Kometani, S. Chiashi, *S. Maruyama, On-chip sorting of long semiconducting carbon nanotubes for multiple transistors along an identical array, *ACS Nano* **11**, 11497-11504 (2017).
15. *K. Cui, Y. Qian, I. Jeon, A. Anisimov, Y. Matsuo, E. I. Kauppinen, *S. Maruyama, Scalable and Solid-State Redox Functionalization of Transparent Single-Walled Carbon Nanotube Films for Highly Efficient and Stable Solar Cells, *Adv. Energy Mater.* **7**, 1700449 (2017).

Highly Cited Journal Publications

1. S. Maruyama*, R. Kojima, Y. Miyauchi, S. Chiashi and M. Kohno, Low-Temperature Synthesis of High-Purity Single-Walled Carbon Nanotubes from Alcohol, *Chem. Phys. Lett.*, (2002), **360**, 229-234. (Times Cited: 890)
2. Y. Murakami, S. Chiashi, Y. Miyauchi, M. Hu, M. Ogura, T. Okubo, S. Maruyama*, Growth of vertically aligned single-walled carbon nanotube films on quartz substrates and their optical anisotropy, *Chem. Phys. Lett.*, (2004), **385**, 298-303. (Times Cited: 471)

3. S. Yamashita*, S. Maruyama, Y. Murakami, Y. Inoue, H. Yaguchi, M. Jablonski, S. Y. Set, Saturable absorbers incorporating carbon nanotubes directly synthesized onto substrates/fibers and their applications to mode-locked fiber lasers, *Opt. Lett.*, (2004), **29**, 1581-1583. (Times Cited: 347)
4. Y. Miyauchi, S. Chiashi, Y. Murakami, Y. Hayashida and S. Maruyama*, Fluorescence spectroscopy of single-walled carbon nanotubes synthesized from alcohol, *Chem. Phys. Lett.*, (2004), **387**, 198-203. (Times Cited: 285)
5. S. Maruyama*, A Molecular Dynamics Simulation of Heat Conduction of Finite Length SWNTs, *Physica B*, (2002), **323**, 193-195. (Times Cited: 275)
6. P. T. Araujo, S. K. Doorn, S. Kilina, S. Tretiak, E. Einarsson, S. Maruyama, H. Chacham, M. A. Pimenta, A. Jorio, The third and fourth optical transitions in semiconducting carbon nanotubes, *Phys. Rev. Lett.*, (2007), **98**, 067401. (Times Cited: 258)
7. Y. Murakami, E. Einarsson, T. Edamura and S. Maruyama*, Polarization dependence of the optical absorption of single-walled carbon nanotubes, *Phys. Rev. Lett.*, (2005), **94**, 087402. (Times Cited: 210)
8. Y. Shibuta and S. Maruyama*, Molecular dynamics simulation of formation process of single-walled carbon nanotubes by CCVD method, *Chem. Phys. Lett.*, (2003), **382**, 381-386. (Times Cited: 207)
9. J. Shiomi and S. Maruyama*, Non-Fourier heat conduction in a single-walled carbon nanotube: Classical molecular dynamics simulations, *Phys. Rev. B*, (2006), **73**, 205420. (Times Cited: 206)
10. S. Maruyama, L. R. Anderson and R. E. Smalley*, Direct Injection Supersonic Cluster Beam Source for FT-ICR Studies of Clusters, *Rev. Sci. Instrum.*, (1990), **61**, 3686-3693. (Times Cited: 203)
11. C. Kramberger*, R. Hambach, C. Giorgetti, M. H. Rummeli, M. Knupfer, J. Fink, B. Buchner, L. Reining, E. Einarsson, S. Maruyama, F. Sottile, K. Hannewald, V. Olevano, A. G. Marinopoulos, T. Pichler, Linear plasmon dispersion in single wall carbon nanotubes and the collective excitation spectrum of graphene, *Phys. Rev. Lett.*, (2008), **100**, 196803. (Times Cited: 202)
12. Y. Murakami, Y. Miyauchi, S. Chiashi and S. Maruyama*, Direct synthesis of high-quality single-walled carbon nanotubes on silicon and quartz substrates, *Chem. Phys. Lett.*, (2003), **377**, 49-54. (Times Cited: 192)

Full list: Researcher ID: B-1848-2008, https://publons.com/researcher/1474698/shigeo-maruyama/

Books and chapters

- Ed Y. Li, S. Maruyama, Single-Walled Carbon Nanotubes: Preparation, Property and Application, Topics in Current Chemistry book series, Springer, (2019).

Invited Lectures and Talks

1. S. Maruyama, R. Xiang, T. Inoue, Y. Zheng, M. Liu, Y. Sato, A. Kumamoto, Y. Li, S. Chiashi, E. I. Kauppinen K. Suenaga, Y. Ikuhara, 'One-Dimensional Van der Waals Heterostructures Coaxially Wrapped Around Single-Walled Carbon Nanotubes', *14th Asia Pacific Physics Conference*, Kuching (2019).

2. S. Maruyama, '1D van der Waals hetero-nanotubes based on single-walled carbon nanotubes ', *10th A3 Symposium on Emerging Materials: Nanomaterials for Electronics, Energy and Environment*, Suwon (2019).
3. S. Maruyama, '(Keynote) One-dimensional van der Waals heterostructures coaxially synthesized on single-walled carbon nanotubes', *ChinaNANO 2019*, Beijing (2019).
4. S. Maruyama, '(Keynote) Synthesis and Solar Cell Applications of Single-Walled Carbon Nanotubes Co-Axially Wrapped with Mono- and Few-Layer Boron Nitride Nanotubes', *6th ASME International Conference of Micro/Nanoscale Heat and Mass Transfer*, Dalian, (2019).
5. A. Shawky, I. Jeon, R. Xiang, T. Inoue, Y. Matsuo, S. Maruyama, 'High Performance Carbon Nanotube- Laminated Perovskite Solar Cells', *235th ECS Meeting*, Dallas, (2019).
6. S. Maruyama, R. Xiang, T. Inoue, Y. Zheng, M. Liu, Y. Sato, A. Kumamoto, Y. Li, S. Chiashi, E. I. Kauppinen K. Suenaga, Y. Ikuhara, 'One-dimensional van der Waals heterostructures coaxially wrapped around single-walled carbon nanotubes', *Guadalupe Workshop IX*, Fredericksburg, (2019).
7. R. Xiang, T. Inoue, Y. Zheng, M. Liu, J. Guo, Y. Li, S. Chiashi, S. Maruyama, 'Single-Walled Carbon Nanotubes Co-Axially Wrapped with Mono- and Few-Layer Boron Nitride Nanotubes', *2018 MRS Fall Meeting & Exhibit*, Boston, (2018).
8. S. Maruyama, '(Keynote) Synthesis of One Dimensional van der Waals Heterostructures Wrapped around Single-Walled Carbon Nanotube', *Asian Conference on Nanoscience and Nanotechnology*, Qingdao, (2018).
9. S. Maruyama, 'Synthesis and properties of one dimensional van der Waals heterostructures wrapped around single-walled carbon nanotubes', *The 9th A3 Symposium on Emerging Materials: Nanomaterials for Energy and Electronics*, Kyoto, (2018).
10. R. Xiang, T. Inoue, Y. Zheng, M. Liu, J. Guo, Y. Li, S. Chiashi, S. Maruyama, 'Synthesis and properties of SWCNT@FWBNNT', *Nanocarbon Photonics and Optoelectronics (NPO2018)*, Huhmari, (2018).

Fellowships and Awards/Prizes:

- 2019, Fellow of the Royal Society of Chemistry (FRSC)
- 2008, Chemical Physics Letters Most Cited Paper 2003-2007 Award (Elsevier)
- 2007, Fellow, The Japan Society of Mechanical Engineers
- 2006, Thermal Engineering Contribution Award, The Japan Society of Mechanical Engineers
- 2004, Gold Medal, Tokyo Technology Forum 21, for the "development of ACCVD synthesis of SWCNT"

Others Activities

- 2011-2020, President of The Fullerenes, Nanotubes and Graphene Research Society, Japan
- 2014-present, Steering Committee Co-Chair of International Conferences on Science and Application of Nanotubes and Low-Dimensional Materials (NT conference series)
- 2018-present, Research Supervisor of JST Creation of Innovative Core Technologies (CREST) project, Research Area: Creation of Innovative Core Technologies for Nano-enabled Thermal Management.