Curriculum Vitae



Name (Age) **Masaaki Tanaka**

Date of Birth May 23, 1961

Nationality Japan

Title, Affiliation

- Director, Center for Spintronics Research Network (CSRN), The University of Tokyo
- Professor, Department of Electrical Engineering and Information Systems (EEIS), Graduate School of Engineering, The University of Tokyo
- Professor, Institute for Nano Quantum Information Electronics (NanoQuine), The University of Tokyo

Academic degree Dr. of Engineering (March 1989, The University of Tokyo)

Research and education history

2016 – **present**: Director of the Spintronics Research Network of Japan (Spin-RNJ); 2016 – 2026 Director , Center for Spintronics Research Network (CSRN), Graduate School of Engineering, The University of Tokyo
2006 – **present**: Professor, Institute for Nano Quantum Information Electronics (NanoQuine), The University of Tokyo
2004 – **present**: Professor, Department of Electrical Engineering and Information Systems, Graduate School of Engineering, The University of Tokyo.
2001 – 2007: PRESTO and SORST Researcher, Japan Science and Technology Agency.
1995 – 1998: PRESTO Researcher, Japan Science and Technology Agency.
1994 – 2004: Associate Professor, Dept. of Electronic Engineering, The University of Tokyo.
1992 – 1994: Visiting Research Scientist, Bell Communications Research (Bellcore), USA.
1990 – 1994: Lecturer, Dept. of Electrical Engineering, The University of Tokyo.
1989 – 1990: Research Associate, Dept. of Electronic Engineering, The University of Tokyo.
1989: Doctor of Engineering, The University of Tokyo
1986: Master of Engineering, The University of Tokyo
1984: Bachelor of Engineering, The University of Tokyo

Achievements and highlights of past research activities

Prof. Masaaki Tanaka started his research in 1984 on molecular beam epitaxy and optical/electronic properties of GaAs/AlGaAs quantum heterostructures as a graduate student at the University of Tokyo. Since early 1990s, when he set up his own group, he has extended research activities to a new field of epitaxial synthesis of semiconductor-based magnetic/spintronic materials and their heterostructures, containing either ferromagnetic metals or magnetic impurities to demonstrate their novel spin-related properties and functionalities. More specifically, he succeeded in growing ferromagnetic metals (MnGa and MnAs) on III-V semiconductors and MnAs on III-V and on Si, by which large spin-dependent transport and magneto-optic effects were demonstrated. He also established ways to grow ferromagnetic semiconductors, such as (III,Mn)As and (III,Fe)V, by which he not only demonstrated novel magnetic tunnel junctions and other spintronic devices with unprecedented performances, but also showed for the first time that the Curie temperature (T_C) can exceed 300 K in (III,Fe)V with both n-type and p-type conduction. Furthermore, he has proposed, fabricated, and demonstrated new devices, such as spin transistors and spin-MOSFETs using spin degrees of freedom, contributing significantly to the exploration and development of a field of

"semiconductor spintronics".
The followings are more specific description of his major achievements:

(1) Epitaxial growth of (Ga,Mn)As/AlAs/(Ga,Mn)As magnetic tunnel junction devices, containing ferromagnetic semiconductor (GaMn)As and the first demonstration of large tunneling magnetoresistance (about 75%) in semiconductors [major paper (1) Phys. Rev. Lett. (2001)].

(2) Proposal and analysis of spin MOSFETs, which are compatible with Si CMOS technology and usable in reconfigurable logic circuits; fabrication of spin MOSFET and investigation of its device physics. [major paper (2) Appl. Phys. Lett. (2004)] and [(3) (*invited paper*) IEEE Trans. Electron Devices. (2007)].

(3) Synthesis of granular MnAs nanoparticles embedded in GaAs and demonstration of giant magneto-optical effect and giant magnetoresistance. [major paper (4) (*invited review*) Semiconductors and Semimetals (2008)].

(4) Discovery of electromotive force induced by a static magnetic field and huge magnetoresistance exceeding 10^6 % in magnetic tunnel junctions containing MnAs nanoparticles. [major paper (5) Nature (2009)].

(5) Fabrication of double-barrier resonant-tunneling devices, where a ferromagnetic semiconductor GaMnAs quantum well is embedded; demonstrated enhanced TMR [major paper (6) Phys. Rev. Lett. (2010)], and clarified the Fermi level position and valence band structure of GaMnAs [(7) Nature Physics (2011)].

(6) Epitaxial synthesis of a new n-type electron-induced ferromagnetic semiconductor (In,Fe)As [major paper (8) (*invited review paper*) Applied Physics Reviews (2014)].

(7) Epitaxial synthesis of a ferromagnetic semiconductor (Ga,Fe)Sb and demonstration of a Curie temperature T_C of 340 K [major paper (9) Appl. Phys. Lett. (2016), Cover and Feature Article].

(8) Fabrication of a bilayer semiconductor heterostructure consisting of nonmagnetic InAs and ferromagnetic (Ga,Fe)Sb, and discoveries of new giant magnetoresistance and odd-parity magnetoresistance, and their successful control by a gate electric field [major paper (10) Nature Physics (2019); major paper (15) Nature Comm. (2022)]. Ultrafast (sub-ps) control of magnetization in a (In,Fe)As based quantum well by wavefunction engineering. [major paper (16) Advanced Materials (2023)]

(9) Highly efficient control of magnetization reversal in perpendicularly magnetized (Ga,Mn)As by spin-orbit torque by an extremely low current density J_C of about 3.4×10^5 Acm^{-2}, a factor of 100 lower than that in normal metallic systems [major paper (11) Nature Communications (2019)]. Later, J_C is further lowered to 4.6×10^4 Acm^{-2} by suppressing the field-like torque [major paper (12) Nature Electronics (2020)].

(10) Successful epitaxial growth of high-quality single-crystal α-Sn thin films, having both the ultimate narrow-gap semiconductor properties and topological material properties, with a diamond-type crystal structure, on (In,Fe)Sb and InSb (001) substrates. Reported the highest mobility (30,000 cm^2/Vs) in α-Sn at the time [major paper (14) Advanced Materials (2021)]

(11) Establishing a new technique to induce the phase transition of α-Sn thin films to the superconducting β-Sn at arbitrary positions by irradiating them with FIB. This opens the possibility of creating composite structures and quantum devices that combine dissimilar materials and properties, such as semiconductor / ferromagnet / topological material / superconductor structures [major paper (17) Nature Comm. (2024)].

In summary, **Dr Masaaki Tanaka played both pioneering and leading roles in opening a new research field of semiconductor-based spintronics, where semiconductor physics, materials science, magnetism, and electronics overlap.** Since the early 1990s, well before this field has become a hot area, **Dr. Tanaka initiated exploratory and pioneering research activities on epitaxial synthesis of semiconductor-based spintronic materials and structures, where both "magnetism and spin" and "semiconductors" play key roles**. In particular, he and his team have recently synthesized a set of Fe-doped ferromagnetic semiconductors; (In,Fe)As, (In,Fe)Sb and (Ga,Fe)Sb, that show not only both n- and p-type conduction, but also exhibit very high Curie

temperatures (T_C) above 300 K. These achievements have resolved most of longstanding problems that conventional Mn-doped III-V and group-IV ferromagnetic semiconductors had been faced with; namely, in the past, 1) ferromagnetic semiconductors were available only in p-type, because Mn atoms work only as acceptors in III-V and group IV semiconductors, 2) T_C was much lower than room temperature, 3) no unified understanding was available, concerning the band structure and mechanism of ferromagnetism. A series of outstanding achievements have solved these problems and played key roles in developing this exciting field.

Achievements

(1) International influence/contribution

a) Organizer, invited speaker or chair of related international conferences (etc.), and/or director or chairman of a major international academic society in the subject field

- Over 190 plenary/invited/keynote presentations at international conferences/symposia/meetings.
- Program Committee Chair, 4th International Conference on the Physics and Application of Spin-related Phenomena in Semiconductors (PASPS-IV), Sendai, August 15-18, 2006.
- Subcommittee Chair, "Spintronic Materials and Devices", International Conference on Solid-State Devices and Materials (SSDM), 2007 – 2008.
- Organizer and Co-chair, Advanced Heterostructures and Nanostructures Workshop (AHNW) 2006 and 2008, Hawaii.
- Organizer, Focus Session "Spin-dependent Phenomena in Semiconductors", American Physical Society 2010 March Meeting, Portland, USA, March 15-19, 2010.
- Conference Chair, 6th International Conference on the Physics and Application of Spin-related Phenomena in Semiconductors (PASPS-VI), Tokyo, Japan, August 1 - 4, 2010.
- Program Chair, International Conference on Molecular Beam Epitaxy (ICMBE) 2012, Nara, September 23-28, 2012.
- Program Chair, 46th International Conference on Compound Semiconductors (ISCS 2019), Compound Semiconductor Week 2019 (CSW2019) in Nara, May 19-23, 2019.
- Conference Chair, 24th International Conference on Electronic Properties of Two-Dimensional Systems (EP2DS-24) and 20th International Conference on Modulated Semiconductor Structures (MSS-20), online, Aug 31 - Nov 5, 2021.
- Conference Chair, International on Molecular Beam Epitaxy (ICMBE 2024), Matsue Japan, September 8 – 13, 2024.
- Steering Committee Chair, International on the Physics of Semiconductors (ICPS 2026), Tokyo, August 16 – 21, 2026.
- Scientific Advisory Committee Member of Paul Drude Institute, Berlin, Germany, 2026 – present.

b) Member of a scholarly academy in a major country

- Chair, International Advisory Committee, International Conference on Molecular Beam Epitaxy, 2024 – present; Member, 2012–present
- Fellow, Japan Society of Applied Physics, 2015–present.
- Member, International Advisory Committee of the 9th SPINTECH. Fukuoka, Japan, June 4-8 2017.
- Member, Science Council of Japan, 2017 – present; Cooperation Member 2017 – 2023;
- Council Member, Association of Asia and Pacific Physics Societies (AAPPS), January 2017 - June 2020.

- Director, Spintronics Research Network of Japan, 2016 – present.
- Vice Chair, International Union of Pure and Applied Physics (IUPAP), Commission 8 (Semiconductor Physics), 2024 – present; Member, 2021 – present.

c) Recipient of prestigious awards

- Takei Award, the Magnetics Society of Japan in 1997.
- Yazaki Award, the Yazaki Science and Technology Foundation in 1999.
- Marubun Award, the Marubun Research Collaboration Foundation in 2002.
- IBM Japan Prize, IBM Japan in 2003.
- JSPS Prize, the Japan Society for the Promotion of Science in 2007.
- Education, Culture, Sports, Science Minister's Commendation of the Field of Science and Technology in 2012.
- Fellow, Japan Society of Applied Physics since 2015.
- Ichimura Academic Award, Ichimura Foundation for New Technology in 2019.
- Yazaki Academic Award, Yazaki Memorial Foundation for Science and Technology in 2021.
- ISCS (International Symposium on Compound Semiconductors) Quantum Devices Award in 2022.

d) Editor of an influential journal, etc.

- AIP Advances, Executive Editor, January 2011– 2017; Deputy Editor, January 2018 – present.
- AAPPS Bulletin Editor, January 2014 – June 2017.
- AAPPS Bulletin Scientific Committee member, July 2019 – June 2022.

(2) Receipt of large-scale competitive funds (over past 5 years)

- 2016 – 2021 Budget request funding for CSRN and Spin-RNJ, PI, ¥738,258,000
- 2017 – 2023 Core Research for Evolutional Science and Technology (CREST), JST, PI, ¥210,000,000
- 2017 – 2021 Grant-in-Aid for Exploratory Research, JSPS, PI, ¥19,800,000
- 2020 – 2025 Grant-in-Aid for Scientific Research (S), JSPS, PI, ¥197,340,000
- 2025 – 2028 Grant-in-Aid for Scientific Research (A), JSPS, PI, ¥35,700,000
- 2022 – 2027 Funding from the MEXT Budget Request for CSRN and Spin-RNJ, PI, ¥503,352,000

(3) Major papers

(1) M. Tanaka and Y. Higo, “Large tunneling magnetoresistance in GaMnAs/AlAs/GaMnAs ferromagnetic semiconductor tunnel junctions”, Phys. Rev. Lett. **87,** pp.026602/1-4 (2001).

(2) S. Sugahara and M. Tanaka, "A spin metal-oxide-semiconductor field-effect transistor using half-metallic-ferromagnet contacts for the source and drain", Appl. Phys. Lett. **84**, pp.2307-2309 (2004).

(3) M. Tanaka and S. Sugahara (***Invited paper***) "Metal-oxide-semiconductor based spin devices for reconfigurable logic", IEEE Trans. Electron Devices **54**, pp.961-976 (2007).

(4) M. Tanaka, M. Yokoyama, Pham Nam Hai, and S. Ohya (***Invited review paper***), "Properties and functionalities of MnAs/III-V hybrid and composite structures", *Semiconductors and Semimetals*, Vol. **82**, pp.455-485 (Academic Press, New York, Nov. 2008).

(5) P. N. Hai, S. Ohya, M. Tanaka, S. E. Barnes, S. Maekawa, "Electromotive force and huge magnetoresistance in magnetic tunnel junctions", Nature **458**, pp.489-492 (2009).

(6) Pham Nam Hai, Shinobu Ohya, and Masaaki Tanaka, "Long spin-relaxation time in a single

metal nanoparticle", Nature Nanotechnology **5**, pp.593-596 (2010).

(7) S. Ohya, I. Muneta, P. N. Hai, and M. Tanaka, "Valence-Band Structure of the Ferromagnetic Semiconductor GaMnAs Studied by Spin-Dependent Resonant Tunneling Spectroscopy", Phys. Rev. Lett. **104**, 167204 (2010).

(8) Shinbu Ohya, Kenta Takata, and Masaaki Tanaka, "Nearly non-magnetic valence band of the ferromagnetic semiconductor GaMnAs", Nature Physics **7**, pp.342-347 (2011).

(9) Masaaki Tanaka, Shinobu Ohya, and Pham Nam Hai ***(Invited review paper***), "Recent progress in III-V based ferromagnetic semiconductors: band structure, Fermi level, and tunneling transport", Appl. Phys. Rev. **1**, pp.011102/1-26 (2014). Full text viewed 4177 times (Dec 2016 – July 2025).

(10) N. T. Tu, P. N. Hai, Le Duc Anh, and M. Tanaka, "High-temperature ferromagnetism in heavily Fe-doped ferromagnetic semiconductor (Ga,Fe)Sb", Appl. Phys. Lett. **108**, pp.192401/1-4 (2016). ***Cover and Featured Article*** of Applied Physics Letters (May 2016), and one of the most read papers in 2016.

(11) K. Takiguchi, Le Duc Anh, T. Chiba, T. Koyama, D. Chiba, and M. Tanaka, "Giant gate-controlled proximity magnetoresistance in semiconductor-based ferromagnetic/nonmagnetic bilayers", Nature Physics **15**, pp.1134-1139 (2019).

(12) M. Jiang, H. Asahara, S. Sato, T. Kanaki, H. Yamasaki, S. Ohya, and M. Tanaka, "Efficient full spin–orbit torque switching in a single layer of a perpendicularly magnetized single-crystalline ferromagnet", Nature Commun. **10**, pp.2590/1-6 (2019).

(13) M. Jiang, H. Asahara, S. Sato, S. Ohya, and M. Tanaka, "Suppression of the field-like torque for efficient magnetization switching in a spin–orbit ferromagnet", Nature Electronics **3**, pp.751–756 (2020).

(14) Masaaki Tanaka (***Invited Review Paper)***, "Recent Progress in Ferromagnetic Semiconductors and Spintronics Devices ", Jpn. J. Appl. Phys. **60**, pp.010101/1-15 (2021).

(15) L. D. Anh, K. Takase, T. Chiba, Y. Kota, K. Takiguchi, and M. Tanaka, "Elemental topological Dirac semimetal α-Sn with high quantum mobility", Advanced Materials **33**, pp.2104645/1-9 (2021).

(16) K. Takiguchi, L. D. Anh, T. Chiba, H. Shiratani, R. Fukuzawa, T. Takahashi, and M. Tanaka, "Giant gate-controlled odd-parity magnetoresistance in one-dimensional channels with a magnetic proximity effect", Nature Commun. **13**, pp.6538/1-7 (2022).

(17) L. D. Anh, M. Kobayashi, T. Takeda, K. Araki, R. Okano, T. Sumi, M. Horio, K. Yamamoto, Y. Kubota, S. Owada, M. Yabashi, I. Matsuda, and M. Tanaka, "Ultrafast subpicosecond magnetisation of a two-dimensional ferromagnet", Advanced Materials **35**, pp.2301347/1-8 (2023).

(18) L. D. Anh, K. Ishihara, T. Hotta, K. Inagaki, H. Maki, T. Saeki, M. Kobayashi, and M. Tanaka, "Large superconducting diode effect in ion-beam patterned Sn-based superconductor nanowire / topological Dirac semimetal planar heterostructures", Nature Commun. **15,** pp.8014/1-8 (2024).

(19) Le Duc Anh, Takahiro Saeki, Keita Ishihara, D. Nishigaki, Hideki Maki, and Masaaki Tanaka, "Non-destructive laser nanopatterning of superconducting heterostructures in topological Sn thin films", Advanced Materials **38**, e12571/1-9 (2026).

(20) Shinobu Ohya, Le Duc Anh, and Masaaki Tanaka (***Invited paper, Topical Review***), "Spin-dependent Tunnelling in Semiconductor-based Heterostructures", *Special Issue on the 50th Anniversary of the Tunnelling Magnetoresistance Effect*, Journal of Physics D: Applied Physics **59**, pp.243001/1-37 (2026).

Including the papers listed above, **Dr. Masaaki Tanaka published more than 350 refereed papers in international journals and presented more than 190 invited/plenary/keynote talks at international conferences/symposia/meetings.**

(4) Others

A community of researchers in the field of spintronics in Japan, represented by Dr. Masaaki

Tanaka, has proposed “Spintronics Research Network of Japan, Spin-RNJ”. This has been consecutively selected under the Science Council of Japan, Master Plan Priority Large-Scale Research Programs in 2014, 2017, 2020, 2023, and 2026, as well as the Ministry of Education, Culture, Sports, Science and Technology's ”Basic Plan for Promoting Large-Scale Academic Research Projects – Roadmap 2014, 2020, 2023, and 2026", despite stringent selection criteria. Based on this plan, the “Center for Spintronics Research Network (CSRN)” was established in five core universities (The University of Tokyo, Tohoku University, Osaka University, Kyoto University, and Keio University) starting in fiscal year 2016. Since then Dr. Masaaki Tanaka has served as the director of CSRN at the University of Tokyo, which is the core hub, and he has been playing a leading role as the representative of the national collaboration network hub (Spin-RNJ) since its inception.