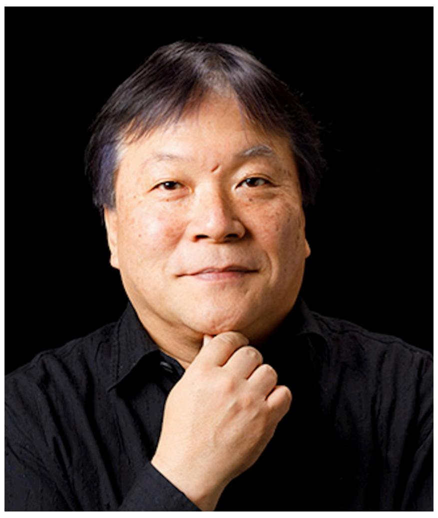
Curriculum Vitae



Affiliation:

(1) The University Distinguished Professor, Tokyo College, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan.
(2) Group Director, Riken Center for Emergent Matter Science, 2-1 Hirosawa, Wako, Saitama 251-0198, Japan.

Education:

BS: Faculty of Engineering, Yokohama National University (1979)
MS: School of Engineering, The University of Tokyo (1981)
PhD: School of Engineering, The University of Tokyo (1984)

Professional Appointments:

1984–1989: Assistant Professor, The University of Tokyo
1989–1991: Lecturer, The University of Tokyo
1991–1996: Associate Professor, The University of Tokyo
1996–2022: Professor, The University of Tokyo
2022–Now: University Distinguished Professor, The University of Tokyo

1996–1999: Researcher, Japan Science & Technology Agency, PRESTO Project
2000–2005: Director, Japan Science & Technology Agency, ERATO Nanospace Project
2005–2010: Director, Japan Science & Technology Agency, EARTO–SORST Project on Electronic Nanospace
2008–2012: Director, RIKEN Advanced Science Institute
2013–2013: Deputy Director, Riken Center for Emergent Matter Science
2004–2006: Associate Editor, *Journal of Materials Chemistry* (RSC)

2014– Advisory Board, *Journal of the American Chemical Society* (ACS)
2009– Board of Reviewing Editors, *Science Magazine* (AAAS)

Selected Awards and Honors:

(1) The Chemical Society of Japan Award for Young Chemists (1988)
(2) Award of the Society of Polymer Science, Japan (1993)
(3) SPACC Award (1998)
(4) Wiley Polymer Chemistry Award (1999)
(5) IBM Science Award (1999)
(6) Nagoya Medal Seminar Silver Medal (2000)
(7) Tokyo Techno Forum Gold Medal (2001)
(8) Arthur K. Doolittle Award (American Chemical Society, PMSE Division) (2005)
(9) Inoue Prize for Science (2005)
(10) Molecular Chirality Award (2008)
(11) Award for the Contribution to Coordination Chemistry (2008)
(12) American Chemical Society Award in Polymer Chemistry (2009)
(13) Chemical Society of Japan Award (2009)
(14) Purple Ribbon (2010)
(15) Alexander von Humboldt Research Award (2011)
(16) Fujihara Prize (2011)
(17) Arthur K. Doolittle Award (American Chemical Society, PMSE Division) (2013)
(18) Van't Hoff Award Lecture (2013)
(19) Leo Esaki Prize (2015)
(20) 1st University of Tokyo Engineering Faculty Award (2016)
(21) Chirality Medal (2017)
(22) Japan Academy Prize (2018)
(23) The Ichimura Prize in Science for Excellent Achievement (2020)
(24) Ryoji Noyori ACES Award (2020)
(25) The Netherlands Award for Supramolecular Chemistry (2021)

(26) Honorary Fellow of the Chemical Research of India (2013)
(27) Member of the Royal Netherlands Academy of Arts and Science (2020)
(28) Member of the US National Academy of Engineering (2023)
(29) Member of the American Academy of Arts and Sciences (2023)
(30) Kao Executive Fellow

Biosketch

Takuzo Aida is one of five University Distinguished Professors at the University of Tokyo, Japan, and serves as the group director of the RIKEN Center for Emergent Matter Science (CEMS). After earning his PhD in Polymer Chemistry under the supervision of Prof. Shohei Inoue at the University of Tokyo in 1984, he began his research career in the same laboratory, focusing for nearly a decade on developing "precision polymerization using metalloporphyrins as initiators.” In 1996, at the age of 40, Aida became an independent full professor at the University of Tokyo. In 2008, he was invited to RIKEN, a prestigious national institute in Japan with a rich history of over 100 years, where he served as the director of the RIKEN Advanced Research Institute prior to the establishment of RIKEN CEMS, his current affiliation. Aida's scientific achievements include the discovery and development of supramolecular polymers, which have significant applications in innovative functional materials. Notably, he reported the first prototype of supramolecular polymers in 1988, which directly led to his receipt of the Netherlands Award for Supramolecular Chemistry in 2021. Supramolecular polymers are now recognized to provide a potential breakthrough in addressing the pressing issue of global warming. With over 400 publications mostly in high-impact journals, Aida has trained nearly 80 PhD students and 50 postdoctoral researchers, resulting in more than 90 alumni now working globally in academia. His accolades include the Chemical Society of Japan Award and the American Chemical Society Award in Polymer Chemistry in 2009, the Purple Ribbon in 2010, the Alexander von Humboldt Research Award and the Fujihara Prize in 2011, the Leo Esaki Prize in 2015, the Chirality Medal in 2017, the Japan Academy Prize in 2018, and the Ryoji Noyori ACES Award in 2020, as well as the Netherlands Award for Supramolecular Chemistry in 2021. Aida has been elected as a member of the Royal Netherlands Academy of Arts and Sciences in 2020, the United States National Academy of Engineering in 2021, and the American Academy of Arts and Sciences in 2023.

List of Key Achievements

1. **Prototype of Supramolecular Polymerization:** Found that an amphiphilic porphyrin carrying four poly(ethylene glycol) side chains in aqueous media cofacially assembles into a noncovalent 1D polymer chain with a dynamic nature (*Chem Commun.* **1988**).
2. **Light-Harvesting Dendritic Antennae:** Found that dye-appended dendritic antennae funnel photoexcitation energy from the periphery to the core. This periphery-to-core energy transfer occurs efficiently when the dendritic scaffold adopts a spherical shape (*Nature* **1997**; *JACS* **1999**; *Angew. Chem.* **2003**).
3. **Extrusion Polymerization:** Discovered that polymerizing ethylene using mesoporous silica-supported polymerization catalysts results in tough fibers composed of "extended-chain crystals" instead of conventional "folded-chain crystals," a process named "extrusion polymerization" (*Science* **1999**).
4. **Supramolecular Copolymerization with CNTs:** Found that carbon nanotubes (CNTs) form supramolecular copolymers with ionic liquids, leading to a physical gel with high CNT dispersion (*Science* **2003**). This gel can be utilized for developing "air-driven actuators," which facilitate the creation of "portable braille devices". By using the same gel, we collaboratively developed stretchable conductors (*Science* **2008**; *Nature Materials* **2009**). Also succeeded in exfoliating graphite to achieve high-yield monolayer graphene production (*Nature Chemistry* **2015**).
5. **Nanotube Drug Delivery System for Cancer:** Successfully synthesized nanotubes through supramolecular polymerization of the molecular chaperone (*Nature* **2003**). These nanotubes selectively release drugs in cancerous tissues, where ATP is overexpressed at levels 10,000 times higher than in normal tissues (*Nature Chemistry* **2012**). The technology is also being developed for selective RNA transport.
6. **Conductive Nanotubes via Supramolecular Polymerization:** Synthesized the first conductive nanotube through supramolecular polymerization of molecular graphene (*Science* **2004**), which leads to the advancement in unidirectional helical structures (*PNAS* **2005**), photoconductive devices (*Science* **2006**; *Science* **2011**), and solar cell elements (*PNAS* **2009**).
7. **Security Inks via Supramolecular Polymerization:** Developed the first security ink based on supramolecular polymerization via metallophilic interaction (*Nature Materials* **2005**).
8. **Molecular Machine for Non-Covalent Capture and Photochemical Bending:** Designed the first molecular machine capable of non-covalently capturing guest molecules and bending them using light energy (*Nature* **2006**).
9. **Non-Crosslinked Light-Driven Actuator:** Developed the first non-crosslinked, light-driven actuator using a two-dimensionally aligned azobenzene polymer brush (*Science* **2010**).
10. **Supramolecular Polymers Responsive to Audible Sound:** Created supramolecular polymers that respond to sound in the audible range (*Nature Chemistry* **2010**).
11. **"Aqua Materials" – Highly Robust Hydrogels:** Developed a highly robust material composed of 98% water through supramolecular copolymerization of clay nanosheets and molecular adhesives in water. This research paved the way for a new era of environmentally friendly materials (*Nature* **2010**).

12. **Ferroelectric Columnar Liquid Crystals:** Successfully synthesized the first ferroelectric columnar liquid crystal, which can switch and retain columnar polarity by applying an electric voltage. This was achieved by solid-phase supramolecular polymerization of fan-shaped motifs with hydrogen bonding units (*Science* **2012**).

13. **Redox-Responsive Metal–Organic Nanotubes:** Developed metal–organic nanotubes that depolymerize in response to redox stimuli (*Science* **2014**).

14. **Salt Bridge Effects on Molecular Binding:** Demonstrated that the binding constant of a guest molecule to a single-molecule membrane surface via salt bridge formation varies by two orders of magnitude due to neighboring hydrophobic units (*Science* **2015**).

15. **Highly Anisotropic "Aqua Materials":** Discovered that titanium oxide nanosheets dispersed in water align perpendicular to magnetic field lines, causing parallel alignment among the nanosheets and generating extraordinarily strong electrostatic repulsion. This led to the synthesis of ultra-anisotropic "aqua materials" with unprecedented mechanical properties (*Nature* **2015**; *Nature Materials* **2015**).

16. **Living Chain-Growth Supramolecular Polymerization:** Developed a unique monomer that preferentially forms intramolecular hydrogen bonds, preventing spontaneous supramolecular polymerization. Using this monomer, we achieved the first living chain-growth supramolecular polymerization, previously deemed impossible (*Science* **2015**; *Nature Chemistry* **2017**).

17. **Carbon Nitride Films that Hop in Response to Humidity:** Developed the first carbon nitride material in film form that hops in response to humidity changes (*Science* **2016**).

18. **Self-Healing Resin Glass:** Challenged the conventional belief that rigid resins with frozen molecular motion cannot self-heal. Developed a resin glass that autonomously repairs fractures simply by pressing the broken surfaces together (*Science* **2018**). This discovery received widespread media coverage, including an interview with CNN.

19. **Porous Organic Crystals with Self-Healing and High Thermal Stability:** Successfully synthesized the first porous organic crystal based on "CH•••N bonding" through supramolecular polymerization of pyridyl-functionalized organic molecules (*Science* **2018**). This material uniquely combines high thermal stability with excellent self-healing capabilities.

20. **AND Logic Circuit in Columnar Liquid Crystals:** Developed the first columnar liquid crystal system where discotic molecules undergo supramolecular polymerization within a nematic liquid crystalline phase. This system enables data rewriting and recording only when both electrical and optical signals are applied simultaneously, acting as an AND logic circuit (*Science* **2019**).

21. **Solvent-Free Autocatalytic Supramolecular Polymerization:** Discovered a solvent-free supramolecular polymerization, in which monomers are autocatalytically generated in a template-assisted manner from raw materials simply by heating, leading to the growth of supramolecular polymers (*Nature Materials* **2021**).

22. **Elastic Metal–Organic Frameworks (MOFs):** Developed the first stretchable metal–organic framework (MOF) that behaves like an elastomer. This was achieved using a catenane-based ligand, a key mechanical interlocking structure (*Nature* **2021**).

23. **Ultrafast Desalination Using a Fluorous Nanochannel Formed by Supramolecular Polymerization:** Developed a fluorous nanoring that self-assembles in a lipid bilayer to afford a nanochannel with a fluorous interior wall. This particular self-assembled

nanochannel allows ultrafast permeation of water via breaking down its clusters, where the permeation rate of water is nearly 500 times larger than that through a channel constructed by aquaporin (*Science* **2022**). Since this fluorous nanochannel can exclude electrolytes, one may potentially realize rapid desalination of seawater, thereby addressing the shortage of drinkable water.

24. **Mechanically Robust yet Readily Metabolizable Supramolecular Plastics:** Developed unprecedented plastics that are mechanically strong yet metabolizable under biologically relevant conditions owing to their dissociative nature with electrolytes (*Science* **2024**). Salt-bridging sodium hexametaphosphate with di- or tritopic guanidinium sulfate in water forms a cross-linked supramolecular network, which is stable unless electrolytes are resupplied. This unusual stability is caused by a liquid-liquid phase separation that expels sodium sulfate, generated upon salt bridging, into a water-rich phase. This approach can be extended to polysaccharide-based supramolecular plastics that are applicable for 3D printing.

25. **Near-identical Macromolecules Spontaneously Partition into Concentric Circles:** Found a particular liquid–liquid phase separation (LLPS) at a solid–liquid interface that lead to the partitioning of DNAs with nearly identical structures into concentric circles (*Nature* **2024**) . We noticed this intriguing phenomenon when we drop-cast onto a glass plate an aqueous ammonium sulfate dispersion of phase-separated droplets comprising a homogeneous mixture of poly(ethylene glycol) (PEG) samples with different termini. This partitioning is as a result of the competitive spreading induced by an ammonium sulfate layer spontaneously formed on the glass surface. We successfully extended the above mechanism to partitioning a mixture of nearly identical DNAs into concentric circles followed by their selective extraction using the salting-in effect.