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Interview

# An Interview with Prof. Mikihiro Hayashi

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## CV

2015. Mar.: Ph.D. of engineering, Graduate school of Engineering, Applied chemistry, Nagoya University, Japan.
2015. Apr.–2016. Mar.: Postdoctoral Fellow, L'École supérieure de physique et de chimie industrielles de la ville de Paris, France.
2016. Apr.–2017. Feb.: Postdoctoral Fellow, Tokyo institute of technology, Japan.
2017. Mar.–present: Assistant professor, Nagoya institute of technology
2023. Oct.–present: JST PRESTO Researcher

## Honors:

- Selected as Rising starts, *Progress in Polymer Science* special issue, 2025
- Encouragement award, The Society of Rheology Japan, 2024.
- Selected as Emerging Investigators, *Polymer Chemistry* special issue, 2024
- Selected as Young star researcher, *Polymer Journal* special issue, 2022
- Award for Encouragement of Research in Polymer Science, The Society of Polymer Science Japan, 2020

## Interview

### Could You Please Tell Us Your Scientific Background and Main Research Area?

I received the B.Eng., M.Eng., and Ph.D. degrees from Nagoya University, where I worked in Prof. Yushu Matsushita's group. There I studied block copolymer-based elastomers using supramolecular interactions, including hydrogen bonds and metal-ligand coordination bonds. During my Ph.D., I served as a visiting researcher at ESPCI Paris Tech (France; Prof. Ludwik Leibler) and at Shanghai Jiao Tong University (China; Prof. Xinyuan Zhu). After earning my Ph.D., I returned to ESPCI Paris Tech as a postdoctoral researcher, and subsequently experienced a second postdoc at Tokyo Institute of Technology (Science Tokyo) in Prof. Masatoshi Tokita's group. In 2017, I began my career as an assistant professor at Nagoya Institute of Technology in Prof. Akinori Takasu's group. Since 2021, I have led my own group as a principal investigator. My current research focuses on vitrimer materials, which are recyclable and healable cross-linked polymers enabled by associative bond exchange mechanisms[1,2]. As a fundamental research, I have identified key factors that regulate relaxation properties governed by bond exchange reactions in networks, thereby influencing recycling and healing efficiency. Additionally, I have conducted application-oriented studies based on bond exchange concept, developing upcycling strategies and novel adhesion techniques[3,4].

### What Got You Interested in This Research in the First Place?

Vitrimers were first reported by Prof. L. Leibler's group in 2011.[5] Although I studied in L. Leibler's group from 2014 to 2016, my research at that time focused on supramolecular semicrystalline polymers rather than vitrimers. Discussions of vitrimers were frequently circulated in group meetings, and when I first encountered the concept, I recognized its substantial potential for sustainable functionality in current and future society. Since the establishment of the Sustainable Development Goals, the development of sustainable polymers has become increasingly important in both academia and industry. Today, cross-linked polymers are considered as non-recyclable. Moreover, more stringent recycling regulations for cross-linked polymers are likely to be implemented in the coming decades. In this context, identifying fundamental techniques for sustainable cross-linked polymers is of great significance. Given that the history of vitrimers is relatively brief, there remain many open questions from the perspec-

tive of polymer physics, and I enjoy working on these remaining puzzles.

### Would You Like to Share with Us What Impressed You Most in Your Career Development and Research Life?

During my master's course, I had the opportunity to attend a lecture by Prof. L. Leibler at Nagoya University. Although the lecture did not focus on vitrimers, it was highly engaging in terms of polymer physics and sparked my interest in joining his group. My supervisor, Prof. Y. Matsushita, had a long-time friendship with Prof. Leibler, which facilitated my visits as a Ph.D. student (three months). Studying in Leibler's group with other researchers and students was a precious experience, and I was continually impressed by their research acumen and rigorous discussions. I subsequently returned for a second visit (two months) and then a third (one year), the latter as a postdoctoral researcher. After securing a position at Nagoya Institute of Technology, Prof. Leibler visited Japan for a conference, where I discussed my aspiration to start vitrimer research in Japan. This conversation marked the start of my engagement with vitrimer science. Thanks to the opportunity to engage with vitrimers during visiting researcher and postdoctoral experiences, I maintain strong motivation to contribute as a vitrimer researcher.

### Where Do You Get the Latest News about Your Research Area, or Where Do You Take Inspiration From?

Research articles on vitrimer science are published in many journals every week. I follow a personal rule to review the weekly updates from major polymer- and materials-science journals every Friday. From these updates, I select a subset of articles for deeper study. I read roughly 200–300 articles per year, which helps me stay informed about trends in the field. The information from these papers is organized by topic and annotated with key notes for quick reference. However, information from academic journal alone do not convey the "real-world" industrial problems. Therefore, engaging in discussions with industrial researchers provides a valuable opportunity to understand practical challenges.

### Considering the Progress in Your Research Area, Could You Please Share with Us What Challenges and/or Developments You Think May Be Encountered in the Coming Years?

Although the recyclability of vitrimers is attractive, a major barrier to realizing this potential is the difficulty of collecting used products. Building social infrastructure to collect different types of vitrimers may be impractical, and this challenge applies to any new types of recyclable polymers more generally. Even when used vitrimers are collected, high viscosities of cured vitrimers present another problem. Conventional recycling processes typically rely on injection or extrusion molding, which makes reprocessing high viscosity vitrimers into recycled products with desired shapes difficult. Although compression molding could be applied, it is largely suitable only for producing film-shaped products. Consequently, we must explore new functional opportunities for vitrimers that do not rely solely on recyclability.

### What Attracts You to Join the Editorial Board of the e-JSM?

The editorial board comprises outstanding researchers from the younger generation who specialize in rubbers and cross-linked polymers. Working with them could be a valuable experience, providing opportunities to create new professional friendships throughout the project, which is a key attraction of serving as a member.

### What Do You Think of the Future of the e-JSM?

A critical issue in rubber materials is their non-sustainability due to permanent cross-links, despite the expanded range of applications. This challenge is now recognized as an important topic in both academia and industry. I envision e-JSM as a platform for advanced rubbers and cross-linked polymers with sustainable functionalities. A deep understanding of the fundamental physics governing sustainable functions is essential, and thus this topic should be addressed within the journal as well.

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