Creating more environmentally friendly, heat resistant and transparent plastics

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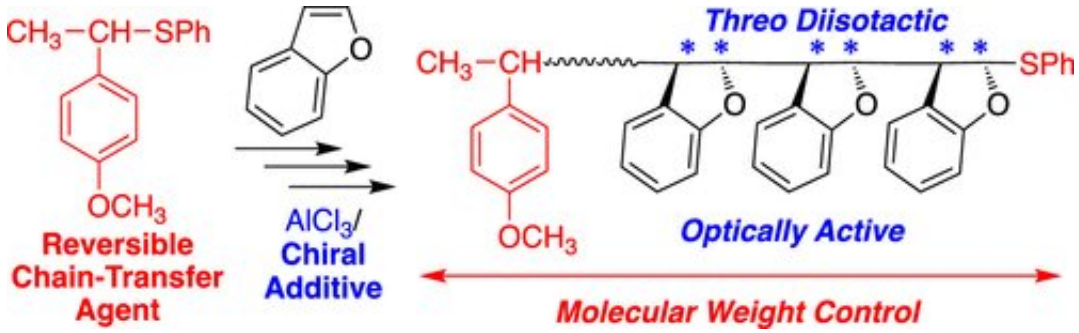

Graphical abstract. Credit: *Journal of the American Chemical Society* (2022). DOI: 10.1021/jacs.2c02569

Researchers in Japan have developed a new technique for creating polymers. This discovery is expected to lead to the development of plastics that are more environmentally friendly, heat resistant, and transparent.

Previous research, such as that performed by Nobel laureate Giulio Natta's group in the 1960s, created polymers using a technique called asymmetric cationic polymerization. However, their group could not control the molecular weight. Controlling the molecular weight of polymers, especially those used in the engineering of plastics, is important because it affects many of the properties of the plastics. Stiffer-flowing, high molecular weight polymers offer the best performance as they are tougher and more resistant to chemical and

environmental damage.

A group that includes Lecturer Mineto Uchiyama and Professor Masami Kamigaito of the Graduate School of Engineering at Nagoya University, and Professor Kotaro Sato of the Tokyo Institute of Technology, has successfully synthesized optically active polymers with controlled molecular weight. To develop the combination technique of asymmetric living cationic polymerization, they combined two existing techniques: their "living cationic polymerization" and Natta's "asymmetric cationic polymerization." This new technique creates polymers with controlled molecular weight and high optical activity that can be chemically controlled. Their findings are reported in the *Journal of the American Chemical Society*.

Monomers are the building blocks of polymers and come from various sources. To test their new technique, the group started with benzofuran, which can be derived from natural resources and is a precursor of the polymer polybenzofuran. Benzofuran forms rigid polymers with a high glass transition temperature and high transparency. It is also chemically recyclable. Its high glass transition temperature means that the polymer maintains its hard shape, even at extreme temperatures. Therefore, benzofuran is useful for the creation of sustainable transparent thermoplastics.

As Lecturer Uchiyama explains, "Our novel polymerization method could control both the chirality and the molecular weight of polybenzofuran, leading to unique optically active polymer materials with highly controlled structures. This research is expected to lead not only to the development of new precision polymerization reactions but also to the development of new functional polymer materials. Since polybenzofuran has the properties of a highly heat resistant plastic, it is expected to become a new material as a heat resistant resin with optical activity."

Furthermore, Uchiyama sees numerous uses for the compound. "Polybenzofuran has a structure similar to polystyrene, which is one of the main plastics used daily for various products, such as plastic containers, cases, and packaging," he says. "While polybenzofuran is not used as a commercially available plastic, it has a stiffer molecular structure and a higher glass transition temperature than polystyrene. We see it being used as a new plastic with good thermal properties. Furthermore, its unique optical properties could give additional functionalities."

More information: Mineto Uchiyama et al, Asymmetric Cationic Polymerization of Benzofuran through a Reversible Chain-Transfer Mechanism: Optically Active Polybenzofuran with Controlled Molecular Weights, *Journal of the American Chemical Society* (2022). DOI: 10.1021/jacs.2c02569

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