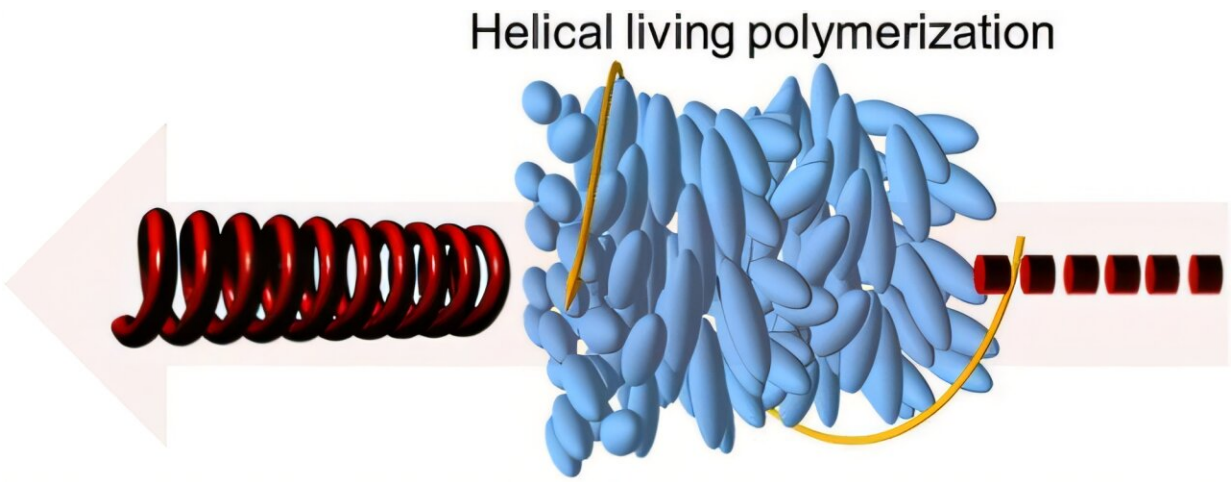
Biomimetic polymerization: Liquid crystals enable chiral polymer synthesis

January 28 2025



Graphical abstract. Credit: *Macromolecules* (2025). DOI: 10.1021/acs.macromol.4c01017

By using optically active liquid crystals as reaction sites, researchers at University of Tsukuba have successfully achieved the living polymerization of polymers with aligned helical structures. In this process, optically inactive monomers adopt the chiral (mirror-image) structure in liquid crystals as they grow, resulting in optically active polymers.

The paper is published in the journal *Macromolecules*. This advance represents a pioneering achievement in both asymmetric chemistry and

polymer chemistry.

Polyisocyanides are polymers distinguished by their helical structures, where the helix's winding direction (right- or left-handed) can be controlled through catalysts designed for synthesizing chiral molecules. This feature allows the exhibiting of optical properties such as circular dichroism and optical rotation in polyisocyanides, making them stable, optically active polymers.

In their study, the research team synthesized optically active conducting polymers from non-optically active monomers through physical rather than chemical methods using a liquid crystal reaction field as an external environment.

For the first time, they achieved asymmetric (chiral) living polymerization of optically active polyisocyanides using liquid crystals with chiral (mirror-image isomer) structures as a solvent.

Circular dichroism measurements of the resulting polyisocyanides confirmed their optical activity, which can be attributed to their helical structures. Additionally, the liquid crystal used in the reaction exhibited properties of the twisted-bend nematic phase—a recently discovered phase that has been attracting considerable attention in liquid crystal research.

The identification of a twisted-bend nematic liquid crystal within a polymer is a notable finding in liquid crystal science.

This reaction is analogous to the enzymatic growth of amino acids with chiral structures in vivo, which leads to the synthesis of proteins with helical structures. As such, it holds promise as a biomimetic technology—a field that mimics and leverages the functional principles of living organisms.

More information: Hiromasa Goto et al, Asymmetric Synthesis of Chiral Polyisocyanides from Achiral Monomers with Living Polymerization in a Liquid Crystal Reaction Field, *Macromolecules* (2025). DOI: 10.1021/acs.macromol.4c01017

Provided by University of Tsukuba