【Grant-in-Aid for Specially Promoted Research】

Science and Engineering

Title of Project : Development of Ultimate Functions Based on Helical Polymers with Helicity Memory

Eiji Yashima
(Nagoya University, Graduate School of Engineering, Professor)

Research Project Number : 18H05209 Researcher Number : 50191101
Keyword : Helical polymer, helical structure, chirality, asymmetric catalysis, chiral separation

【Purpose and Background of the Research】

Mother nature applies the one-handed helical structure in biological systems at the macromolecular and supramolecular levels, which links to their sophisticated functions. Chemists have been challenged to develop artificial helices to mimic such biological helices and functions. Apart from the previous studies, the present project aims to develop ultimate functions based on synthetic helical polymers with a unique "static memory of helicity" that cannot be achieved by the biological helical systems. Our helical polymers possess outstanding exclusive features, such as (1) remarkable chiral amplification of the helical chirality, (2) ultrafast helicity induction and subsequent memory of the helicity, (3) spring-like motion accompanied by a significant visible and fluorescence color change, (4) flexible and adaptable helical cavity, and (5) easy modification of the pendant groups. With these key features in hand, we will establish rational strategies for developing helical polymers with a unique static memory of the helicity and then develop [1] an ultimate chirality detection system for the extremely small chirality, [2] practically useful switchable chiral stationary phases (CSPs) for HPLC and asymmetric catalysts, [3] an in-situ colorimetric/fluorescence sensing system, and [4] enantioseparation and asymmetric catalysis within a helical cavity of the helical polymers.

【Research Methods】

Taking advantage of the outstanding features of the helical polymers with the static helicity memory, the structure-property relationships of the helical polymers will be explored to realize the ultimate functions. The unique and versatile static helicity memory strategy makes it possible to further modify the side groups with the desired functional groups, while maintaining their static helicity memory, leading to the developments of the ultimate functions.

【Expected Research Achievements and Scientific Significance】

While a huge number of studies on helical systems have been reported, our helical polymers are unique and exclusive among those prepared before because of their unique static memory of the helicity with a remarkable amplification of the helical chirality. Therefore, making the best use of our helical polymers enables to develop innovative chiral materials with specific functions that cannot be achieved by the biological helical systems. The fundamental knowledge gained from this project will also contribute to understanding the origin of the biomolecular homochirality.

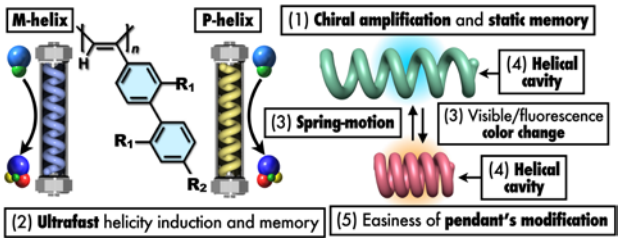

Figure Outstanding properties of helical polymers with a static memory of helicity.

【Publications Relevant to the Project】

・E. Yashima, N. Ousaka, D. Taura, K. Shimomura, T. Ikai, K. Maeda, Supramolecular Helical Systems: Helical Assemblies of Small Molecules, Foldamers, and Polymers with Chiral Amplification and Their Functions, *Chem. Rev.* **116**, 13752-13990 (2016).
・K. Shimomura, T. Ikai, S. Kanoh, E. Yashima, K. Maeda, Switchable Enantioseparation Based on Macromolecular Memory of a Helical Polyacetylene in the Solid State, *Nature Chem.* **6**, 429-434 (2014).

【Term of Project】 FY2018-2022

【Budget Allocation】 457,300 Thousand Yen

【Homepage Address and Other Contact Information】

http://helix.mol.nagoya-u.ac.jp/e/index.html
yashima@chembio.nagoya-u.ac.jp