Polymer Program

INSTITUTE OF MATERIALS SCIENCE

Seminar: 11:10 am Friday, March 22, 2024

Science 1: Room 1002

Host: Luyi Sun

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Slide-Ring Materials for Sustainable Polymers

We have developed a novel type of polymeric materials such as slide-ring (SR) materials and pseudo-polyrotaxane (PPR) nanosheet with cyclodextrins (CyDs) for sustainable engineering. In the SR materials, polymer chains are topologically interlocked by figure-of-eight cross-links.[1)] Hence, these cross-links can pass along the polymer chains freely to equalize the tension of the threading polymer chains similarly to pulleys. Recently, we have just reported the stretch induced crystallization of the SR gel, which leads to extremely high toughness and recoverability.[2)] The concept of the slide-ring gel is not limited to cross-linked gels but also includes elastomer, cross-linked polymeric materials without solvent. Accordingly, it can be applied to wide area such as paints, rubbers, soft actuator, resins and so on.[3)] The slide-ring materials were used as a key technology to create tough and sustainable polymers.[4,5)]

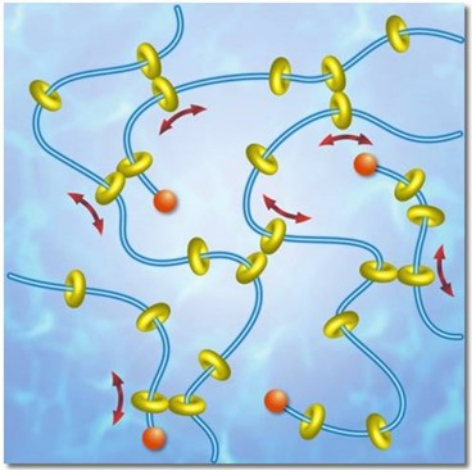

Fig.1. Schematic diagram of Slide-Ring materials.

On the other hand, we have recently developed mass-producing, low-cost, and free-standing nanosheets using topological self-assembly of *β*-cyclodextrins (CDs) and poly(ethylene oxide)$_{75}$-*b*-poly(propylene oxide)$_{29}$-*b*-poly(ethylene oxide)$_{75}$ ($EO_{75}PO_{29}EO_{75}$) triblock copolymer, namely, pseudo-polyrotaxane (PPR) nanosheet by hierarchically ordered supramolecular self-assembly.[6)] The PPR nanosheets were obtained by just mixing triblock copolymer andβ-CD in water at room temperature. β-CDs threaded on poly(propylene glycol) segment of the triblock copolymer to form a monoclinic single crystal with a dimension of 10-20 nm thickness and a few micro meters size. The PPR nanosheet can be applied to a novel drag delivery system with cell adhesiveness and to a new common method to construct polymer brush layer on various kind of materials surfaces.[7)]

1) Y. Okumura and K. Ito, *Adv. Mater.*, **2001**, 13, 485. 2) C. Liu, N. Morimoto, L. Jiang, S. Kawahara, T. Noritomi, H. Yokoyama, K. Mayumi, K. Ito, *Science*, **2021**, 372(6546), 1078. 3) Y. Noda, Y. Hayashi, and K. Ito, *J. App. Polym. Sci.*, **2014**, 131**,** 40509. 4) S. Ando, M. Hirano, L. Wakatabe, H. Yokoyama, K. Ito, ACS Mater. Lett. 2023, 5, *3156*. 5) K. Hashimoto, T. Shiwaku, H. Aoki, H. Yokoyama, K. Mayumi, K. Ito, Sci. Adv. 2023, **9**, 47, *eadi8505*. 6) S. Uenuma, R. Maeda, H. Yokoyama, and K. Ito, *Chem. Commun.*, **2019**, **55**, 4158. 7) S. Uenuma, K. Endo, N. L Yamada, H. Yokoyama, and K. Ito, *ACS Appl. Mater. Interface*, **2021**, 13, 60446.