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How Chemistry Brings in New Physics Problems: Stabilizing OBDD Structure of Block Copolymers by Configurational Regularity

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Abstract

Block copolymers constitute a fascinating class of soft materials, whose remarkable features lie in their capability of self-assembling into a broad spectrum of nanostructures. It is believed that the physics of block copolymer is well understood. In the theoretical framework of block copolymers, the constituent blocks are normally coarse-grained into Gaussian chains with the segmental interactions lumped into an interaction parameter; in this case, the chemical details of the polymers are lost. In recent years, new complex structures have been disclosed in block copolymers possessing specific chemical characteristics, including chirality, tacticity and conformational asymmetry. These findings point out a direction that chemistry can play an active role to bring in new intriguing problems in the physics of block copolymers.

Here I would like to demonstrate that the introduction of configurational regularity into one of the constituent blocks in a di-block copolymer can stabilize the ordered bi-continuous double diamond (OBDD) morphology, which was commonly considered to be unstable relative to ordered bi-continuous double gyroid (OBDG) structure. We discovered that OBDD existed as the thermodynamically equilibrium bi-continuous structure temperature in a block copolymer composed of a stereoregular block, syndiotactic polypropylene-*block*-polystyrene (sPP-*b*-PS). A thermally-induced transition from OBDD to OBDG occurred upon heating, signifying that OBDD and OBDG represent the stable structure at lower and higher temperature, respectively. The role of configurational regularity was further consolidated via isotactic polypropylene-*block*-polystyrene (iPP-*b*-PS) system, where the di-block was also found to exhibit OBDD morphology and OBDG-OBDD transition. I will address the significance of the release of enthalpy via the helical segment formation and its resultant inter-helix association by the stereoregular block for stabilizing the OBDD structure.

Biography

Dr Chen Hsin-Lung is a Tsing Hua Chair Professor at the Department of Chemical Engineering in National Tsing-Hua University, Taiwan. He also holds the Associate Dean appointment at College of Engineering in National Tsing-Hua University since 2016. Dr Chen received his PhD and MS degree in Polymer Science and Engineering from University of Massachusetts Amherst in 1994 and 1990. He joined Chang Gung University as an Associate Professor in 1995. Thereafter, he moved on to National Tsing Hua University as Associate Professor in 1997 and was promoted to Full Professor in 2001.

He has received prestigious awards in recognition of innovative achievements including Academic Award by Ministry of Education Taiwan in 2015, Outstanding Academic Polymer Research Award by the Society of Polymer, Taipei in 2010. He is mainly engaged in research on polymer physics, small angle X-ray, neutron scattering and nanostructure of soft matter.

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