# Existence of Frank-Kasper Sigma phase in conformationally symmetric block copolymer/homopolymer blend

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## Abstract

Soft quasicrystal has emerged as an exciting field driven by the recent discovery of quasicrystalline order and quascrystal approximants known as the Frank-Kasper (FK) in soft matters including block copolymers (bcps), dendrimers, surfactants and shape amphiphiles. In the case of linear bcps, it was believed that FK phase is stable in the conformationally asymmetric system with significant disparity in Kuhn lengths of the constituent blocks. Nevertheless, recent studies on the blends of two conformationally symmetric bcps with different chain lengths unveiled the opportunity of generating FK phase in bcps irrespective of the conformational symmetry. In this study, we revealed the formation of FK σ phase in a conformationally symmetric bcp blended with the corresponding homopolymer using synchrotron small angle X-ray scattering (SAXS) conducted at TLS 23A1 and TPS25A. A compositionally asymmetric poly(ethylene oxide)-*block*-polybutadiene (PEO-*b*-PB) bearing the conformational asymmetry parameter ε of 1.15 was blended with a small amount of PB homopolymer (h-PB) to yield the spherical micelles composed of PEO core domain and the corona containing PB block and h-PB. The micelles were found to organized in the canonical lattices including BCC and HCP when the PEO composition was distant from the phase boundary between sphere and HEX morphology. Once the PEO volume fraction (= 0.24) was very close to the boundary, the SAXS profile was found to display a large number of diffraction peaks that could be indexed by FK $\sigma$ phase. Our results demonstrated that the phase window of FK phase located in the vicinity of HEX phase, and its formation required the microdomain to retain sphere or sphere-like morphology at higher composition of the core block. Blending with the corresponding homopolymer appeared to be a useful approach to broaden the window of sphere morphology by moving the sphere-HEX phase boundary to higher core block composition, so as to make FK phase accessible in conformationally symmetric systems.

***Keywords – block copolymer, Frank-Kasper phase, conformational asymmetry, blend***