Tuning the Complex Spherical Phase of Sugar-based Block Co-oligomer via Physical Blending

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Our previous study demonsteated that a full spectrum of Frank-Kasper (FK) phase and dodecagonal quasicrystal (DDQC), previously discovered in different block copolymers, can be accessed in a single sugar-based AB_2 star block co-oligomer (BCO) system composed of an oligosaccharide (Glc_n) block attached with two solanesol (Sol) blocks (denoted as Glc_n-$(Sol)_2$), where a discrete increase of the number of glucose monomer (n) in the Glc_n block led to the transition of the micelle packing from DDQC/body centered cubic (BCC) (n=1) to FK σ (n=2) and then to FK A15 (n=3) phase. Additionally, Laves C15/C14 phase emerged from the high-temperature σ phase in Glc_2-$(Sol)_2$ upon stepwise cooling. While the synthetic approach of tuning the oligosaccharide length can be laborious, this study reveals that these complex spherical phases can also be accessed through binary blending of Glc_n-Sol BCOs. Specifically, blends of Glc_1-$(Sol)_2$ and Glc_4-$(Sol)_2$ exhibited FK phases, including the σ and C14, along with complex phase transition pathways, even though neither individual component exhibited FK phases on its own (Figure 1). Blending Glc_1-$(Sol)_2$ with a $(Glc_2)_2$-$(Sol)_2$ BCO, which bears an A_2B_2 architecture, yielded both the A15 and σ phases (Figure 2). The tuning of micelle packing structures relies on the intimate mixing of BCO molecules within micelles, leading to variable core sizes depending on the overall blend composition and thermal processing conditions. Our findings highlight sugar-based amphiphiles as a promising soft matter system for accessing FK and quasicrystal phases, offering an expandable phase window through binary blending and thermal processing.

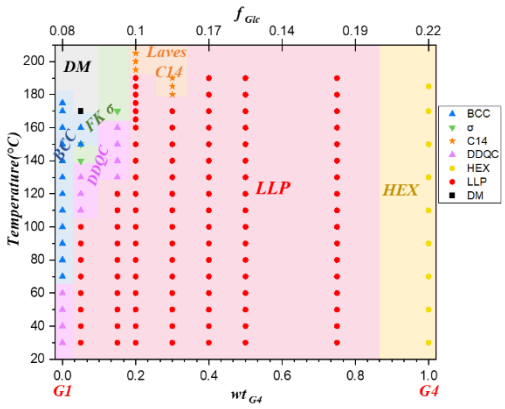

Figure 1. Morpholoical diagram of Glc_1-$(Sol)_2$/ Glc_4-$(Sol)_2$ blend blends

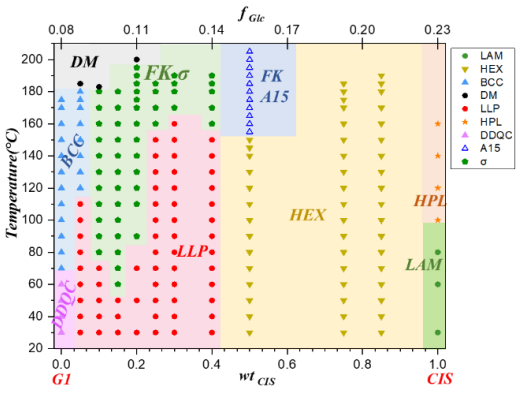

Figure 2. Morpholoical diagram of Glc_1-$(Sol)_2$/ $(Glc_2)_2$-$(Sol)_2$ blend

References

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