Breakthrough Effect Created by a Micelle with Ring Polymer Topology

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"Topology-Directed Control on Thermal Stability: Micelles Formed from Linear and Cyclized Amphiphilic Block Copolymers"
Satoshi Honda, Takuya Yamamoto, Yasuyuki Tezuka, J. Am. Chem. Soc. 2010, 132, 10251-10253, DOI: 10.1021/ja104691j.
Research Highlight "MATERIALS SCIENCE: Shape shifts heat tolerance"
Nature 2010, 466, 534

The thermal stability of a self-assembled micelle was significantly improved by a topology effect. Linear poly(butyl acrylate)-*b*-poly(ethylene oxide)-*b*-poly(butyl acrylate) (**1**) and the cyclized product, poly(butyl acrylate)-*b*-poly(ethylene oxide) (**2**), were self-assembled to form flower-like micelles (Figure 1). The CMCs were determined to be 0.13 and 0.14 mg/mL for **1** and **2**, respectively, by viscometry. DLS, AFM (Figure 2), and TEM studies revealed that both micelles are spherical with approximately 20 nm in diameter. Despite no distinctive change in the chemical composition or structure of the micelle, the cloud point (T_c) was increased by more than 40 °C through the linear-to-cyclic topological conversion of the polymer amphiphile (Figures 3a and 3b). Furthermore, the T_c was controlled by coassembly of **1** and **2** (Figure 3c).

The topology-based control of the stabilization may provide new developments for supramolecular chemistry. The present methodology is ideal for human body-related applications such as drug delivery system, food, and cosmetics, which require great care on the modification of the chemical and self-assembled structures, concerning for toxicity and biocompatibility.

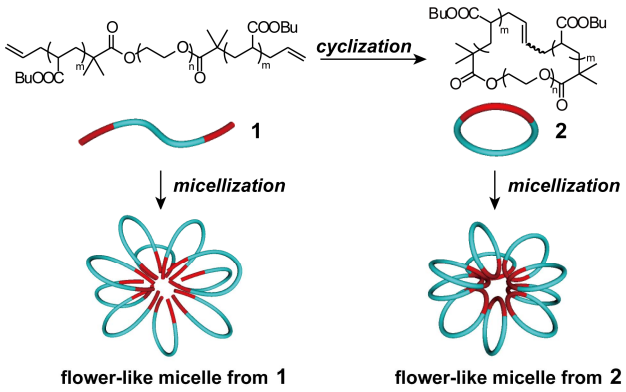

Figure 1. Chemical structures of **1** and **2** and schematic representation for the formation of flower-like micelles.

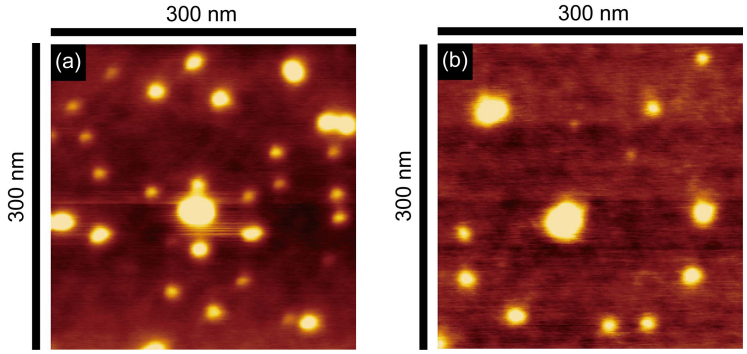

Figure 2. AFM images of spin-coated aqueous solutions of micelles from (a) **1** and (b) **2**.

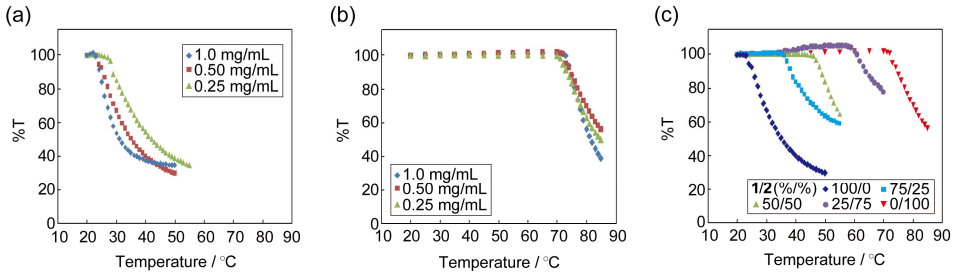

Figure 3. Turbidity measurements of micellar solutions. Temperature-dependence of (a) **1** and (b) **2** (1.0, 0.50, 0.25 mg/mL). (c) Temperature-dependence of homoassemblies and coassemblies (25%/75%, 50%/50%, and 75%/25%). The total concentration of **1** and **2** in a solution was 0.50 mg/mL.