Colloidal Glyco-Cubosomes from the Self-Assembly of a Carbohydrate Block Copolymer

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Complex bicontinuous structures abound in Nature and have previously been observed in the self-assembly of lipids and, recently, in the self-assembly of amphiphilic block copolymers (BCPs) into colloidal cubosomes. Micelles with bicontinuous phases retain nanostructured internal networks of water channels arranged in regular patterns. However, the employed BCPs are difficult to synthetize and usually require high concentration and mixtures of organic solvents to form bicontinuous structures.

Here we report, for the first time, the existence of cubosomes made from carbohydrate-based copolymer, namely poly(styrene-b-xyloglucan) (PS4.5k-b-XGO1.3k), where the sugar blocks were oligosaccharides extracted from tamarind seeds. This bio-sourced BCP self-assembled in water to form vesicles, when highly diluted, and glyco-cubosomes at higher concentrations. The proposed mechanism for this morphological transition is based on the unique properties of XGO: the short and bulky branched oligomer induced negative averaged surface curvatures, leading to stalks between adjacent membranes and then to cubosomes.

The addition of salt, cellulose or the enzymatic cleavage of XGO branches prevented this transition. This study reveals a green opportunity towards highly ordered nanoporous architectures with bio-based polymers, which is a great concern for the potential applications in the food, pharmaceutical and cosmetic industries.