Designing Hydrogels for Biomedical Applications

Hydrogels represent a unique class of materials with wide spread application. The use of hydrogels is increasing rapidly especially in regenerative medicine. Hydrogels are an ideal choice for use in biology since many of their properties are similar to natural tissues. However, a limitation of these materials has been the development of high modulus values in the absence of significant chemical cross-linking. Our efforts focus on new polymer architectures and compositions that lead to unique hydrogels. For example, we reported the first hydrogels with modulus greater than 10,000 Pascals from a class of biocompatible ABA triblock copolymers. Figure 1 illustrates the basic nanostructure present in many of the hydrogels we have prepared. The blue spheres are 10-20 nm in diameter and separated by approximately 50 nm.

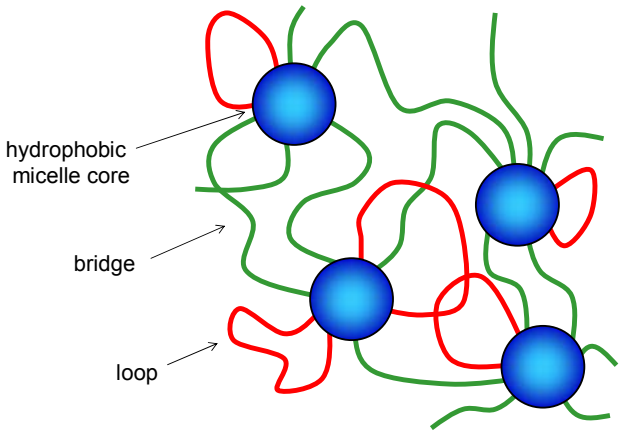

Figure 1. Illustration of the nanostructure present in many of the hydrogels formed by ABA triblock copolymers.

Figure 2 shows the progression of hydrogel formation in an ABA copolymer. Starting at 10 wt%, the material is a viscous solution. As more polymer is added to the solution, percolation is able to form and a strong gel is established above 16 wt%. Three inverted vials are shown on the right containing 16, 18, and 20 wt% polymer, respectively. As you can see, these gels do not flow. They hold their shape over many weeks.

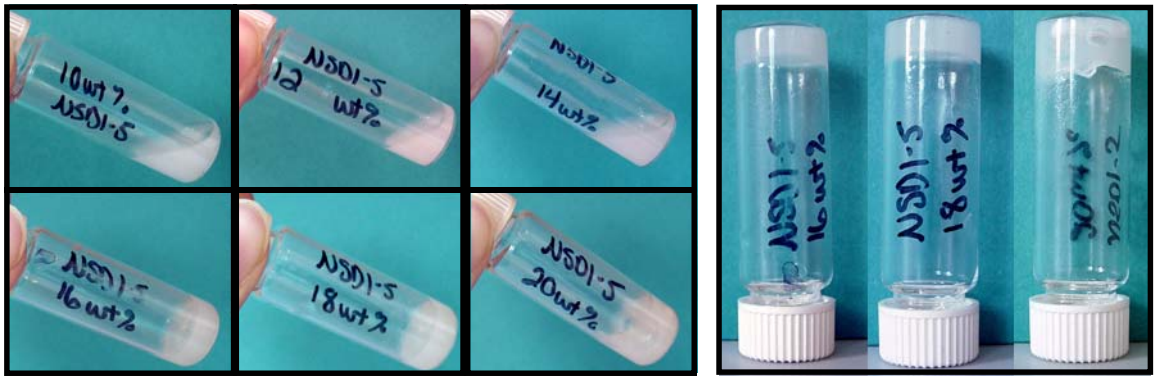

Figure 2. Gel formation in ABA triblock copolymers.

Recently, we have extended our designs to ABC triblock copolymers. These copolymers are built on the same architectural designs as the ABA systems; however, one block is changed from a hydrocarbon to a fluorocarbon. These materials also form nanostructured materials as illustrated in Figure 3. For example, we already know that an ABC triblock copolymer will form a hydrogel while the corresponding ABA does not.

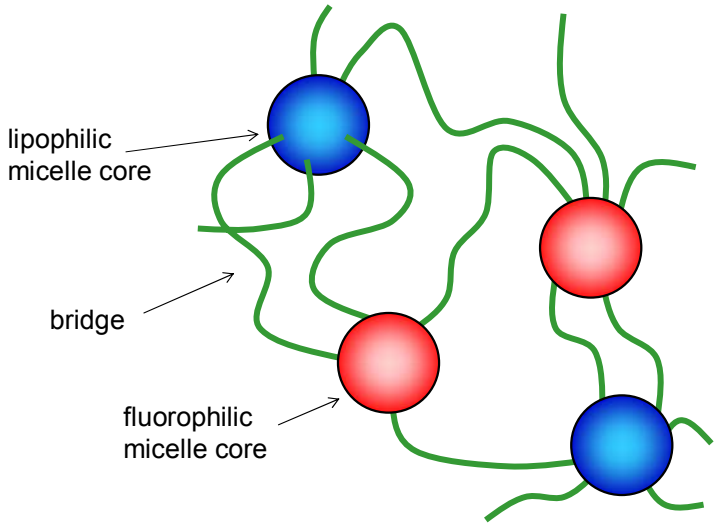

Figure 3. ABC triblock copolymers are likely to result in different nanostructure organization.