Skimming the Surface

Soft materials science, which traditionally encompasses polymers, liquid crystals, and aggregating systems such as micelles and vesicles, presents not only a number of interesting analytical challenges but also technological opportunities. The challenges arise because the materials are often solution-based, have low inherent contrast between the different phases, or are fragile and easily damaged by physical probes or energy beams. The opportunities arise because these systems are governed by weak forces, so small changes in chemistry or external conditions can cause large changes in the system properties.

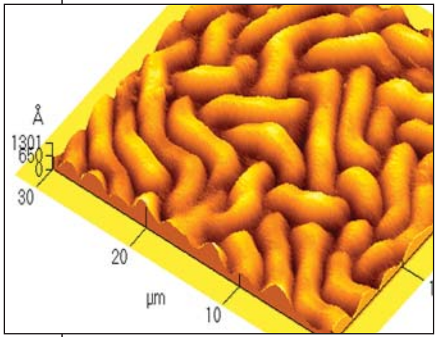
All of this is magnified when considering soft surfaces and interfaces. The analytical challenges are greater, because the amount of material being probed is quite small, especially in comparison to a signal from the bulk that may overshadow surface phenomena. The opportunities for interesting chemistry, though, are similarly magnified, because surface properties can be tweaked through postprocessing or by designing the chemistry to be responsive to external stimuli.

Starting with a very interesting thought experiment, Russell (p. 964) wonders what happens to molecules that are attached to a surface when the surface area changes. Clearly these molecules must migrate into or out of the surface, thus allowing for changes in the surface properties. Hydrophobic materials can become hydrophilic, and tacky materials can lose their stickiness, with only mild changes in temperature or humidity.

In a News report (p. 962), Service describes how critical these surface properties are for implantable sensors. These devices are still limited because of the response of the body's immune system, which tends to recognize the material as a foreign body and thus attack or immobilize it. Researchers are now beginning to have some success at avoiding this immune response or manipulating it to their advantage.

Soft interfaces also play a key role in biology, where vesicles are one of the transport capsules used by cells. Discher and Eisenberg (p. 967) review the world of polymer vesicles, where advances in synthetic chemistry have widened the potential for creating these bilayer sacs of weakly associating molecules, which have potential as drug-delivery vehicles.

The surface of a material can also have a substantial impact on the bulk properties, particularly in the areas of optics and tribology. Assender *et al.* (p. 973) discuss the advances that have been made in correlating surface topography to the macroscopic properties.



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Soft materials science also plays an important role in the coatings industry, even if the final product proves to be harder than the substrate it is applied to. This industry is one of specialization, because for each application there is often a unique recipe. Despite this, it is also an industry that can create tremendous added value by the addition of a very small amount of material. Matheson (p. 976) discusses how soft coatings have always slowly evolved with the discovery of new materials, but the industry now faces a number of new challenges, as commonly used solvents and heavy metals have been forced out of existing formulations because of environmental and toxicity concerns.

As the techniques to probe and control the chemistry of soft materials improve, the potential for tailored and adaptable surfaces and interfaces will continue to expand. Whether in drug-delivery applications, packaging, value-added coatings, or futuristic medical probes, there are clearly many industries driving these technologies. This special issue is intended to skim the surface and present just a few of the advances that are being made in all areas of soft surfaces and interfaces. —DAN CLERY AND MARC LAVINE

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