could also form. In this study, a steel sample was annealed at 900°C for 10 min to form the austenite phase and then continuously cooled to 600°C for 1 h. X-ray diffraction data was obtained in the synchrotron source with a typical time resolution of 10 s. The growth behavior of individual ferrite grains and pearlite colonies were monitored using the diffraction spot intensities.

The results indicated that the activation energy for ferrite grain nucleation was at least two orders of magnitude smaller than that predicted by the thermodynamic models. The growth curves of the grains appear to confirm the parabolic growth model but also show three fundamentally different and distinct types of growth. The researchers were able to distinguish between the four types of grain growth which are (in order of reducing temperature): grains not interacting with neighboring grains, grains continuing to grow with the same crystallographic orientation into another phase, grains that indirectly interact, and grains that directly interact with neighboring grains.

This innovative experimental technique and the resulting insights can be incorporated into nucleation and growth models for the processing of steels in order to tailor the properties of the final product. A detailed knowledge of austenite decomposition kinetics in steel can lead to the development of new steel grades and optimization of processing conditions to yield high-quality steels with superior properties.

Gopal R. Rao

Dolphin Skin Offered as Model for Nanoparticle Coating

Karen L. Wooley, professor of chemistry at Washington University in St. Louis, has noted how the shape and texture of dolphin skin prevents marine creatures from clinging. The observation fits into her study of finding ways to mediate interactions between biological systems and synthetic materials, designing chemical functionalities, or groups of atoms that either promote or discourage binding between them.

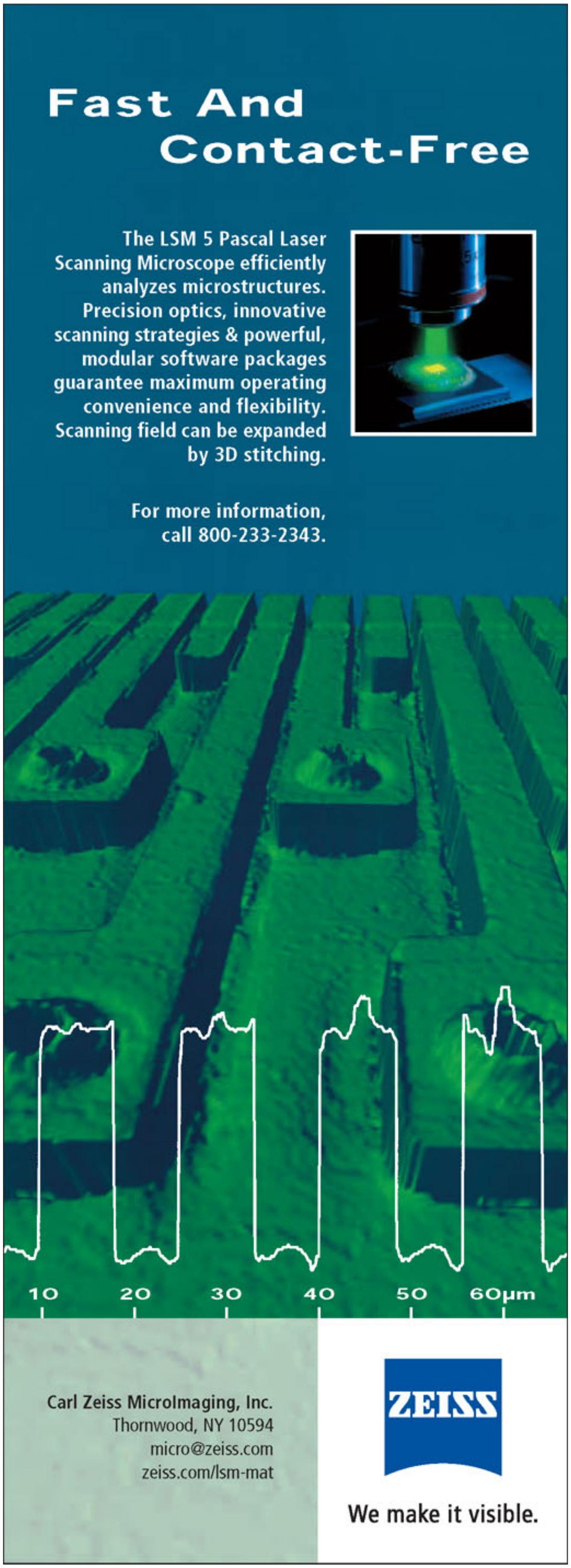
During the Council for the Advancement of Science Writing's New Horizons in Science 40th Annual Briefing, held October 27–30 at Washington University, Wooley said that the key to her antifouling agents is their three-dimensional topography, which mimics such naturally occurring hydrodynamic surfaces as the skin of a dolphin. Using high-powered electron microscopy, researchers have found that dolphin skin, for all its seeming smoothness, is slightly rippled on the nanometer scale. Still, these ripples are not large enough to hinder movement through the water but are small enough that they leave few niches for marine creatures to grip.

"For a long time, antifouling work was geared toward making super-smooth surfaces," Wooley said. "It was thought that if the surfaces were super-smooth and had less surface energy, then the organisms couldn't attach."

Wooley formulated the idea of mixing two normally incompatible polymers—a hyperbranched fluoropolymer and a linear polyethylene glycol—and allowing them to phase-separate into distinct domains, one interspersed in the other. Cross-linking would then solidify the mixture, she said, thus creating a heterogeneous coating that, upon close examination, reveals treacherous nanosized terrain composed of mountains and valleys, ranging from hard to soft, hydrophilic to hydrophobic.

Wooley hypothesizes that if the coating's surface features are in the same size-regime as the secreted adhesive protein put out by marine organisms, then the protein will be unable to bind sufficiently to maintain attachment.

"When the polymer surface is first prepared, it looks like a bunch of submicroscopic mountains, but when it's placed under artificial sea water, the entire surface swells and gives us this inverted structure," Wooley said. With this concept, she said, researchers can control the size of the surface features and determine whether that influences the attachment of marine organisms. Such antifouling coatings may inhibit barnacles and other marine organisms from attaching to, and ultimately corroding, ship hulls. ☐



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