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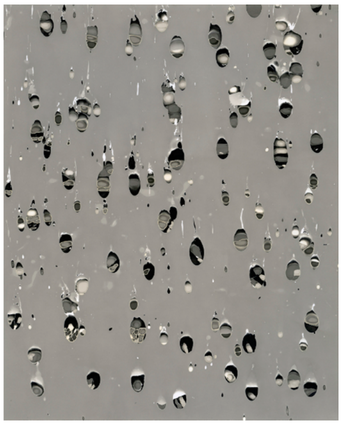
EDITORIAL

Imaging Art and Facts

The Capsule Museum in Houston, Texas, recently featured the work of Caleb Charland, an artist who sets up intricate physical experiments and records the results onto film or photographic paper. I participated in a panel discussion at the museum about his exhibition titled *Shadows of the First Law*. The images were formed by several unusual techniques. For *Pouring Light*, phosphorescent dust was funneled against photographic paper. *Theory of Shadows* featured intricate patterns formed with shadows cast by translating opaque baffles. *Solar Plexus* was a long-exposure image of the night sky shot with the camera strapped to the artist's chest. However, it was *The Artifacts of Fire and Wax*, pictured below, that most piqued the panel's interest. The image was created by a candle that dripped hot wax onto photographic paper while swinging on a pendulum. The strong and variable contrast brings several questions to mind. Are the wax drops opaque, or do they focus the light? How does their effect change as the wax cools from melted liquid to polycrystalline solid? How does the wax generate fringes within a drop? We ultimately concluded that most of the contrast is not due to light at all but to chemical interactions between the wax and photographic paper that occur during the iterative development process used by Mr. Charland.



Artifacts of Fire and Wax by Caleb Charland. Image Courtesy of Caleb Charland.

The panel's considerations of *The Artifacts of Fire and Wax* illustrate an important point in microscopic imaging. When we look at an image from a new microscopic technique, our natural inclination is to ask "What is the resolution?" as our eyes wander to the lower right corner in search of a scale bar. The resolution of small features is, after all, the main point of microscopy. However, the resolved features are not so valuable if we do not know the meaning of the image. We must also ask, "What is the contrast mechanism?", which is an equally important question.

Microscopic images are formed by recording the spatial variations of some physical interaction between a sample and the microscope, resulting in a map of some property of the sample. For example, in optical microscopy, bright-field images map optical absorption, while phase-contrast images map the index of refraction. The more advanced the microscope, the more complicated the contrast may become. Scanning electron microscopy (SEM) maps the propensity of a sample to emit electrons upon stimulation by a focused electron beam. However, different emission mechanisms send electrons in different directions with different energies carrying different information. So whether SEM contrast indicates topography (secondary electron emission) or composition (backscattered electrons) depends on the location and sensitivity of the detector within the chamber. To properly interpret an SEM image therefore requires some knowledge of the detector settings, not just the final magnification.

> At *ACS Nano*, we are interested in manuscripts that further microscopy through careful considerations of contrast mechanisms.

Microscopes do not always map a simple, unambiguous property of the sample. In atomic force microscopy (AFM), many different force interactions can affect the probe tip and therefore contribute to the image contrast. In the early days of AFM, the images sometimes were referred to as "molecular topography", but great strides have been made in the analytical interpretation of AFM images since then. Electric forces, magnetic forces, dissipative forces, chemical forces, and even protein unfolding forces can be mapped. At *ACS Nano*, we are interested in manuscripts that further microscopy through careful considerations of contrast mechanisms. In our June issue, Lai *et al.* showed how to mathematically transform multifrequency AFM data sets into parameter spaces that reflect physical properties of interest.[1] In an upcoming article, Amo and Garcia consider the conditions under which hydrodynamic and inertial effects will influence AFM contrast and force measurements. Their theory and simulations predict an upper limit to how fast AFM measurements can be reliably recorded, at least using current contrast interpretations.[2] Careful attention to image contrast, experimentally, theoretically, and in simulations, can help guide the development of new microscopic techniques, help avoid misinterpretation of image artifacts, and help make sure our results, like Mr. Charland's images, are more than just pretty pictures!

Announcements. We are pleased to announce the three winners of the 2016 *ACS Nano* Lectureship Awards. The winners are Prof. Lifeng Chi for the Asia/Pacific region, Prof. Christopher Murray for the Americas, and Prof. Andrea Ferrari for Europe/Africa/Middle East. All are frequent contributors and advisors to *ACS Nano*.

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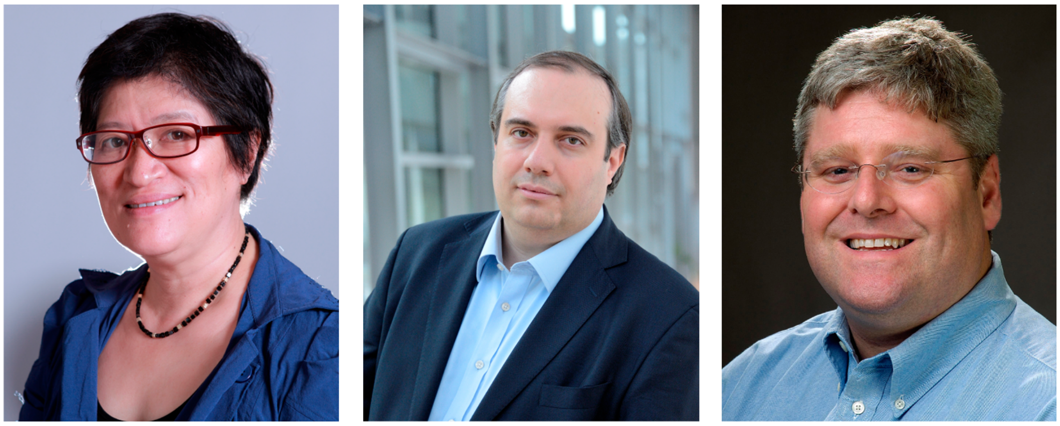

The winners of the 2016 *ACS Nano* Lectureship Awards are (left) Prof. Lifeng Chi of Soochow University, (center) Prof. Andrea Ferrari of the University of Cambridge, and (right) Prof. Christopher Murray of the University of Pennsylvania. Photo images courtesy of Lifeng Chi, University of Cambridge, and Cherie Kagan, respectively.

Prof. Lifeng Chi is a professor at Soochow University. Her research focuses on supramolecular chemistry on surfaces, in particular, molecular assembly and reactions, molecular patterning, and structured functional surfaces.[3−12] Prof. Andrea Ferrari is Professor and Director of the Cambridge Graphene Centre at the University of Cambridge. His research focuses on carbon nanomaterials, and he is a pioneer in the study of two-dimensional materials.[13−19] He leads the graphene flagship initiative of the European Union. Prof. Christopher Murray is a Penn Integrates Knowledge Professor at the University of Pennsylvania. His research focuses on the integration of precise nanocrystals into devices and technologies.[20−29] He is a pioneer in the area of hierarchical assembly of materials.

The lectureships and companion lectures will be presented on August 30 at the European Conference on Surface Science (ECOSS) 2016 meeting in Grenoble, France. Please join me in congratulating our lecturers, and we look forward to seeing you in Grenoble!

Jason Hafner, Associate Editor

AUTHOR INFORMATION

Notes

Views expressed in this editorial are those of the author and not necessarily the views of the ACS.

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