The University of Rochester received an NSF grant in 2010 to research the science and conservation of the daguerreotype, in collaboration with the George Eastman Museum. The extensive study collections of the museum provided source materials for research, and the University of Rochester Integrated Nanosystems Center (URnano) carried out the research, primarily relying on its state-of-the-art SEM and TEM instruments. Detailed analysis of more than fifty daguerreotypes by SEM and TEM has provided an unparalleled resource of the nanostructure of the daguerreotype and documentation of its deterioration pathways.

This research revealed for the first time the complex nano-scale physicochemical phenomena of the first medium of photography. Extensive use of URnano’s focus ion beam (FIB) cross section setup for thin-section preparation and lift-out for TEM analysis has provided the basis to explain both the process and its deterioration.

The daguerreotype was introduced by Louis-Jacques-Mandé Daguerre in 1839. The process entails a highly polished silver plate (silver clad copper), photo-sensitization by iodine vapors, exposure in camera to effect the silver-halide photoreduction reaction, which forms a latent image, and then development of the nanometer grains of silver into light scattering particles on the order of 1–10 microns by a mercury vapor atmosphere. The diffuse scattering of the particles contrasts with the specular reflection of the polished silver, producing a high-resolution, high-dynamic range black-and-white direct positive image. The daguerreotype was the first photographic image process and a world-changing technology, both culturally and scientifically. It was superseded by far more efficient and replicable processes using negatives and paper prints by 1860. The native resolution of the direct positive mercury developed silver particle image has never been improved upon. A well-made daguerreotype from 1850 has an approximate resolution equivalent to 25 MP.

URnano’s use of the FIB and nanoprobe has allowed detailed characterization of the image formation, comparative analysis of different daguerreotype makers’
Figure 17.1. Unidentified man. George Eastman Museum Study collection; 6th plate [2.75” x 3.25”], ca. 1850.

Figure 17.2. Preparation of a thin section in daguerreotype surface; 15 μm x 5 μm.

Figure 17.3. HR TEM image of an image particle at 50,000 x magnification. The full structure of the image surface is revealed. The surrounding matrix is platinum to protect the surface from ion beam damage, and the encompassed particle shows density differences of the silver-mercury-gold complexes that are formed in this iteration of the daguerreotype process. It also reveals the dynamics of mass transfer and formation of Kirkendall voids that research has documented in the image formation.
methods, and most importantly, better understanding of the deterioration mechanisms of the highly reactive metals at the nanoscale.

Thin-section preparations in the SEM chamber by FIB and nanoprobe lift-out for TEM analysis by imaging and energy dispersive X-ray analysis (EDS) has revealed many details of the daguerreotype process at the nanoscale.

A profoundly significant component of the research done at URnano with daguerreotypes has entailed the documentation and description of a susceptibility of the silver-gold-mercury nanostructure to engage with bio-organisms that contact the surface. In the presence of atmospheric moisture, the conditions are ideal for a nano-scale bio-metallic propagation, which has yet to be fully described. In this research, nearly all daguerreotypes researched manifested this phenomenon. This has grave implications for daguerreotype collections around the world, and as a result, a derivative of this research has led to the development of microclimate enclosures and storage systems that can maintain low humidity, or ideally sustain an oxygen-free argon atmosphere.

Figure 17.5 shows the biologically driven growth that reduces the nanometallic metal surface complexes and incorporates them at the molecular level into a dynamic growth pattern. The nanoparticles are being ingested. Numerous FIB analyses show that this mechanism engages metals from the subsurface and

Figure 17.4. Daguerreotype from 1850; red circle shows area analyzed.
disrupts the surface structure. The original biological form becomes increasingly a metallic pseudomorph over time.

This extensive work at URnano has benefited the daguerreotype and its conservation, as well as increasing the capacity of the center through skill development, engagement of students in the NSF Research Experiences for Undergraduates (REU) program in summer internships, and full exploitation of UR’s powerful electron microscopy suite. More of this research is available at http://rochester.edu/college/nod/, and additional material will be added in the near future.
Highlight IV: Colloquia Posters

1. Thomas Baer.

Timing is everything:
Predicting Embryo Viability through Quantitative Imaging of the First Three Days of Human Development

Dr. Thomas Baer
Executive Director
Stanford Photonics Research Center
Stanford University

8:30 am, Tuesday, Dec 7, 2010
Sloan Auditorium, Goergen 101
Refreshments provided.

Co-sponsored by Department of Biomedical Engineering

This talk will describe studies of preimplantation human embryo development that correlate microscopic time-lapse image analysis and gene expression profiling. Our studies indicate that success and failure in human embryo development is largely determined before embryonic gene activation. Our methods and algorithms may provide an improved approach for early diagnosis of embryo potential in assisted reproduction procedures.

2. Robert Greenler.

Reading the Sky's Icy Halos

Robert Greenler
Emeritus Professor of Physics
University Wisconsin - Milwaukee

3:00 pm, Monday, April 21, 2008
Sloan Auditorium, Goergen Building
Refreshments following lecture

This talk reviews the wide variety of sometimes spectacular effects that occur when light interacts with ice particles and water droplets in the sky. Many beautiful pictures of these effects will accompany the lecture.
Starting a Company In Tough Times

Dr. Susan Houde-Walter
CEO, LaserMax, Inc

PhD in Optics, Rochester 1987
Optics faculty, Rochester 1987-2005

This talk will describe the trials and rewards of founding and leading a company in the optics industry in economically challenging times.

3:00 pm, Monday, Jan 31, 2011
Sloan Auditorium, Goergen 101
Refreshments provided.


5. Rosaly Lopes.

Colloquium
UNIVERSITY OF ROCHESTER
THE INSTITUTE OF OPTICS

Unveiling Titan: Results from the Cassini-Huygens Mission to Saturn and its Moons

Rosaly M. C. Lopes
NASA Jet Propulsion Laboratory

BSc and PhD, University College London
AAAS Fellow, 2005 Carl Sagan Medalist

This talk will review data captured by radar, imaging camera and spectrometers that reveal for the first time surface features of the “earth of the outer solar system.”

3:00 pm, Monday, March 19, 2012
Sloan Auditorium, Goergen 101
Refreshments provided.


Colloquium
UNIVERSITY OF ROCHESTER
THE INSTITUTE OF OPTICS

Computer image analysis in the study of art

Dr. David G. Stork
Richoh Innovations

Well known researcher, lecturer and author in the area of computer analysis of art.

In this talk we will learn what computers can reveal about images that even the best-trained connoisseurs, art historians and artist cannot.

Special day and time
3:30-4:30 pm, Thursday
March 27, 2008
Sloan Auditorium, Goergen Building
Refreshments served

Joint colloquium with Electrical and Computer Engineering