Friday Morning, November 14, 2014

Conservation Studies of Heritage Materials Focus Topic
Room: 313 - Session CS-FrM

Conservation Studies of Modern Heritage Materials 3
Moderator: Karen Gaskell, University of Maryland, College Park

9:00am **CS-FrM3 Faces from the Past: Microbeam Imaging and Analysis of Artifacts from ancient Mesoamerica**, ***Timothy Rose***, *J.M. Walsh*, Smithsonian Institution **INVITED**

Working in the analytical laboratories in the Department of Mineral Sciences in the National Museum of Natural History provides plenty of challenging problems just involving geologic materials. Requests from other departments within the museum and elsewhere are growing as the understanding spreads to other disciplines of how our tools can be applied to an even wider variety of materials. Here we provide details about two recent and ongoing studies of cultural artifacts from ancient Mesoamerica. These studies were performed using a variable pressure field emission FEI NovaNanoSEM 600 outfitted with a ThermoFisher silicon drift detector energy dispersive x-ray spectrographic (EDS) analysis system. They were conducted on uncoated whole specimens or fragments and tiny samples removed from the surface or from deep recesses of the objects.

A large collection of spectacular artifacts was delivered to the museum with a request to provide information as to their authenticity. The collection included carved stone figurines and masks and ceramic pieces with various surface coatings. The objects were photographed, measured and placed into groups based on their apparent cultural affinity. Initial observations were made using optical microscopy with particular attention paid to tool marks. In the SEM, some whole artifacts stretched the limits of sample chamber size and geometry. Very few objects showed evidence of modern tools at either the optical or SEM scale. Chemical compositions of minerals in, and surface coatings on, stone artifacts were determined in order to characterize the rock type and other materials. Rock types included jadeitite, serpentinite and syenite. One group of several syenite masks were partially coated with a probable modern tan gypsum plaster. Several ceramic artifacts of unique design have complex surface decorations. A small cross-sectional multi-colored fragment of the coating on one object was studied in detail revealing five chemically distinct layers. We interpret this as original Olmec fresco paint. The results of the ongoing research indicate that the large majority of the artifacts are authentic pre-Columbian objects belonging to the Olmec, Maya, Teotihuacan and Mezcala civilizations which date from 1500BC to 600AD.

In the first comprehensive study of the iconic stone “masks” from Teotihuacan (100 BC to 600AD), we examined nearly 200 masks. Sampling of the artifacts was prohibited however silicone molds taken austensibly to study tool marks and carving methods also removed tiny grains from deep in drill holes. Study of these grains reveal that some are very likely residue from the original carving and polishing of the stone.

9:40am **CS-FrM5 Atomic Layer Deposited Diffusion Barriers on Non-ideal Silver and Bronze Cultural Heritage Objects**, ***Amy Marquardt***, University of Maryland, College Park, *E. Breitung*, E-Squared Art Conservation, *G. Gates, T. Drayman-Weisser*, The Walters Art Museum, *G.W. Rubloff, R.J. Phaneuf*, University of Maryland, College Park

Atomic layer deposited metal oxide diffusion barriers are investigated to better preserve cultural heritage metal objects in museum collections. Recently, the effectiveness and reversibility of ALD films to create diffusion barriers for non-ideal silver and copper alloy (bronze) cultural heritage objects has been studied. Previous results demonstrate the ability of ALD films to protect clean, uniform silver substrates at laest an order of magnitude longer than current silver protection methods. The capability of ALD films to protect surfaces representative of “real” museum metal objects was investigated. These objects included silver surfaces with pre-existing surface treatments, including polishing abrasives, chemical dips or organic lacquers, and patinated copper alloys surfaces with changing chemical composition and topography. The ability of ALD films to uniformly wet non-ideal, chemically varying metal surfaces was investigated under accelerated aging in corrosive gas and acidic aqueous environments. ALD films were structurally engineered through thin film modeling and reflectance spectroscopy measurements to minimize object appearance and color change on patinated or tarnished substrates. Film reversibility was also examined to determine an acceptable technique to remove the ALD films without significantly altering the underlying metal substrate, an important requirement for art conservation practices.

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10:00am **CS-FrM6 Studies of the Effects of Cleaning Protocols on Museum-based Plastics using Advanced Surface Analysis Techniques**, ***Anna Fricker***, *D.S. McPhail*, Imperial College London, UK, *B. Keneghan*, Victoria and Albert Museum, UK

The conservation of plastic artefacts is an area of interest for curators and conservators of cultural heritage. Many museums contain artefacts that are made wholly or partly from plastic and these objects may be present in collections ranging from jewellery to spacesuits. The stability of these polymeric materials is a concern for conservators, particularly as plastic objects can exhibit severe degradation which can occur suddenly and without warning.

The natural soiling of objects in museum collections results in a need to clean plastic artefacts for aesthetic reasons and to maintain artistic integrity. The contamination of plastics with particulate matter may also facilitate degradation. However, the act of cleaning may itself result in damage to an artefact, either immediately after treatment or at a later date. The issue is compounded by the many different types of plastics present in collections: a treatment for one object may be unsuitable for another.

This work examines the physical and chemical changes to the surface of poly (methyl methacrylate) (PMMA) that has been treated with a range of cleaning techniques commonly used in conservation. Methods include the application of solvents and surfactants to the substrate surface. Physical changes to the surface have been examined using microscopy techniques while secondary ion mass spectrometry (SIMS) has been used to characterise the chemical changes to the substrate. The efficacy of these cleaning methods to remove an artificial soil from the polymeric substrate is also discussed.

10:40am **CS-FrM8 Microchemical Characterization of 19th Century Nanotechnology-Daguerreotype Photographs**, ***Edward Vicenzi***, Smithsonian Institution **INVITED**

The daguerreotype photographic process represents the first practical form of photography and was presented to the scientific community in France in 1839. The technology spread rapidly and was widely used for roughly two decades. Image formation can be generalized in four steps: 1) sensitizing a silver-coated copper plate to halogen vapors, 2) exposing the sensitized plate to visible light within a camera, 3) development of an image after the plate is treated with heated mercury vapor, and finally 4) deposition of a gold gilding layer [1,2]. A effort is underway to evaluate several aspects of daguerreotypes including obtaining the composition of the nanoparticles that give rise to image contrast, the protective gilding layer, and corrosion products formed from exposure to atmospheric and other contaminants. A range of scanning and transmission electron- and X-ray-induced spectroscopies have been utilized to characterize these plates on the nano- and submicron- length scales in an effort to inform the long term preservation of these precious objects.

Re fe rence s:

[1] Barger MS and White WB. The daguerreotype: nineteenth-century technology and modern science The Johns Hopkins University Press, ISBN-13: 978-0801864582, 280 pgs (2000).

[2] Swan A, Fiori CE, and Heinrich KFJ. *Scanning electron microscopy* **1**, 411-423 (1979).

11:20am **CS-FrM10 The Application of Advanced Surface Analysis Techniques to the Study of Museum-Based Problems**, ***David S. McPhail***, Imperial College London, UK

Museum materials are often (but not always) relatively stable and inert and the changes that take place to their appearance over time can be so slow as to be essentially imperceptible. For example a materials surface decaying at the rate of 1 nm per day requires approximately three millennia to form a 1 mm crust (assuming linear kinetics). It follows that extremely sensitive analytical instruments with very high sensitivity and resolution are required to measure these ultra-slow surface processes. It is interesting, therefore, that the very latest analytical tools developed primarily to characterise the very latest generation of modern materials such as nanomaterials and semiconductor quantum wells, are also very well suited for the study of the surfaces of historic and pre-historic materials.

In this talk I will show how techniques such as Secondary Ion Mass Spectrometry (SIMS), Focused-Ion Beam SIMS (FIB-SIMS) and Low Energy Ion Scattering (LEIS) can be used to determine the mechanisms and kinetics of processes such as oxidation, diffusion, corrosion and ion exchange at and near the surfaces of a variety of materials from museum

collections. The materials will include glass, metals and ceramics. These analytical techniques can also be used to look at the changes that occur to surfaces as a result of cleaning interventions and can be used to look at how the surfaces becomes re-contaminated over time after cleaning interventions. Being ion-beam based UHV techniques they form the latter parts of any analytical hierarchy. These ion-beam based techniques can exploit stable isotope exchange protocols using ions such as D and O18 to aid the analysis.

There is of course a tension between conservation science and surface analysis as surface analysts like to sample objects and use techniques that consume the object – this is not very welcome by the museum community for obvious reasons. I will discuss this issue and introduce approaches to sampling that might be tolerable.

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