Thursday Morning, November 13, 2014

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

Conservation Studies of Heritage Materials

Moderator: David S. McPhail, Imperial College London, UK, Naoko Sano, NEXUS, Newcastle University, UK

8:00am **CS-ThM1 Complementary Ion and Electron Microscopy Studies for Heritage Conservation**, ***Barbara Shollock***, Imperial College, London **INVITED**

Heritage conservation is an ever-growing discipline, fuelled by factors such as environmental pollution, and the issues surrounding conservation are not always clear. Defining the conservator's needs and the information required to address them can stimulate scientists to apply analytical techniques to new and unconventional challenges.

In this presentation, we will review some of the key issues faced in heritage conservation and the boundaries imposed by the ethics of conservation. Understanding these ethical considerations can guide the dialogue between conservator and analytical scientist to form a research approach that can satisfy both the scientific questions and the ethics of conservation. The application of electron and ion beam techniques will be considered in terms of conservation studies, and case studies will be used to illustrate the advantages and limitations of these techniques.

8:40am **CS-ThM3 Conservation Science at the National Archives: Science in Support of the Preservation of the Records of the Federal Government**, ***Jennifer Herrmann***, National Archives and Records Administration **INVITED**

The National Archives and Records Administration (NARA) is the repository of the permanently valuable records of the United States Government, including the Charters of Freedom, and a wide range of records that document the working of federal agencies and the rights and privileges of citizens. These materials range from Civil War-era pension files to immigration records and from homestead records to logs of Navy ships. NARA has the mission of preserving all of these records for future generations to access. Conservators and conservation scientists work together at NARA to support this dual mission of preservation and access. The Research and Testing Lab (R&T) works closely with the exhibits program and facilities across NARA to ensure that the products and materials used to display and store records will not contribute to their deterioration. In order to answer these questions as well as help preserve individual NARA holdings, R&T uses many standard analytical techniques. FTIR is the first non-destructive analytical technique we use to identify unknowns in the laboratory, including deteriorating films which could be cellulose nitrate or acetate. If FTIR cannot give us enough information, we often rely on the non-destructive XRF and also SPME-GC-MS, which is useful for monitoring off-gassing of records or materials used around records. For example, XRF has been useful in determining if a forgery of a date on a Lincoln Pardon could be reversed safely. This technique has also been used to study platinum photographs of different known recipes and processing conditions to see if the ghost image phenomenon that often occurs with historic platinum images could be better understood. DART MS, XPS, SEM, and FTIR have all been attempted for this photographic research project, as well as accelerated aging tests, microfading experiments, and fiber and paper analysis. The most visible R&T project that supports the dual mission has been the re-encasement and monitoring of the Charters of Freedom (the Declaration of Independence, Constitution, and Bill of Rights) and the Rubenstein Magna Carta. Instrumentation to monitor leaks and oxygen content, as well as air tight connections and plumbing are required in order to determine the conditions within these high tech encasements. As can be seen, the field of conservation science has many great tools from analytical chemistry to help preserve our important records and art.

9:20am **CS-ThM5 Advanced Spectroscopy for Traditional and Modern Heritage Materials**, ***Fenella France***, Library of Congress **INVITED**

The conservation of art and cultural heritage objects requires advances in non-invasive, non-destructive analytical techniques to characterize cultural heritage materials, including substrates (paper, parchment) and media (inks, pigments, colorants). Spectral imaging systems developed for astronomical imaging and remote sensing have been adapted and customized for libraries and museums. T he Library of Congress LC) is using hyperspectral imaging to support preservation of cultural heritage materials with a range of capabilities. With an integrated 39 MegaPixel camera and LED illumination panels to capture high-resolution images in ultraviolet, visible and near infrared spectrum, researchers can create a spectral map of a manuscript or object that can be linked with other non-invasive analyses. Hyperspectral imaging captures non-visible and visible information in registered high resolution digital images, with further capabilities including identification of materials through spectral response, and monitoring of degradation or changes due to environmental conditions and conservation treatments.

The Library utilizes this system to address challenges associated with characterizing manuscript materials, including: early Portolan (nautical) Charts, L'Enfant Plan of Washington D.C., Jefferson's handwritten draft of the Declaration of Independence, and Herblock political cartoons. It has been used to illustrate non-invasive characterization of materials, deterioration, and detection of non-visible changes due to exhibition and storage. Assessing the long-term effects of treatments on collection materials is a growing area of research at LC. The conservation of a 1513 hand-colored Ptolemy Geographia posed interesting challenges in terms of the treatment of select maps in poor condition, due to the presence of verdigris, and a later restoration treatment. Analysis for treatment to stabilize these seven maps included a combination of quantitative X-ray fluorescence, spectral imaging, and Raman spectroscopy. Development of reference databases and integration of data from other analytical techniques allows a more complete mapping of collection materials. Linking this mapping data with other spectroscopic techniques allows for more data from single-point analyses, and provides a greater depth of information. Scriptospatial mapping of data enables direct sharing and visualization of data, with capture of standardized instrumentation parameters and object metadata. The scriptospatial interface enhances interaction between a range of professions, allowing multidisciplinary collaboration for integration of preservation, scientific and cultural information.

11:00am **CS-ThM10 Building a Case for the Future: Design and Construction of an Encasement and Monitoring System to Protect the US Bill of Rights for the Next 100 Years**, ***Jacob Ricker***, *J.H. Hendricks, N.J. Brandenberg, G.F. Strouse*, NIST

NIST has been working to revolutionize the way we monitor and protect our historical documents by designing and constructing the next generation of document encasement. While the encasement "operates" at atmospheric pressure, to protect important documents it must perform like an ultra-high vacuum (UHV) system in terms of purity requirements, outgassing rate, permeation and leak rates. It has long been known that documents degrade overtime, but archivists and historians have been working to slow this process down through limiting exposure to damaging agents (oxygen, dust, excess humidity, mold, etc.) while still allowing visibility of the document for the public. NIST's design is innovative due to its ability to seal the document in a humidified Argon environment using a custom designed chamber with a double o-ring seal to reduce oxygen permeation through the second viton o-ring seal. This system required several innovative solutions to reduce differential pressure on the display glass and to improve and leak test the o-ring sealing.

The Encasement also features a custom designed sensor suite to monitor the status of the internal environment. The NIST design monitors and wirelessly transmits differential pressure, barometric pressure, temperature, humidity, oxygen content, and GPS location. All of the sensors were designed to be vacuum compatible with metal seals to ensure integrity of the encasement. The talk will feature discussions on oxygen permeation rates and measurement along with monitoring sensor performance.

11:20am **CS-ThM11 Parylene Coating for Paper/Book Strengthening**, ***Lei Pei***, *M. Pollei, S. Jordan-Mowery, J. Baty*, Johns Hopkins University

Parylene, the generic name for a class of polymers with the base monomer para-xylylene, has been used to strengthen papers via chemical vapor deposition. The deposited monomers polymerize *in situ*, forming a thin conformal coating that adds strength. Compared to other paper strengthening techniques, such as lining and paper splitting, which are mostly based on individual sheet treatment, parylene coating has the unique ability to treat all the pages of a book simultaneously. Parylene as a paper strengthening technique, however, has had limited recognition within the conservation community since the pioneering research was completed in the 1990s. The major conservation concerns centered at that time on how well Parylene coatings improve the durability of brittle papers and how well the treatment would enable future conservation intervention. One of the earliest criticisms revolved around reversibility of the treatment. No one would reasonably argue that it is desirable to return an embrittled book back to a state of embrittlement, which prevents its being used and/or its ability to accept other traditional repair techniques. Given that we cannot readily correct depolymerization of cellulose at this stage, the real value in parylene is the extent to which it will impart adequate material strength and be

receptive to the range of traditional repair techniques as would be used on a non-embrittled book, and all other things being equal, how long the strength will last.

To answer these concerns and highlight the potential of this paper strengthening technique, we present the results obtained from mechanical testing and the behavior of parylene coated paper in standard paper conservation treatments. These results show that Parylene-treated groundwood pulp book papers from 1951 reveal many of the characteristics of a new wood pulp paper, in term of rattle, turn radius, and general tactile experience. The treated paper has over 30% improvement in tear resistance and more than three times higher folding endurance (based on a log scale of the number of double folds via an MIT folding endurance tester). Additionally, parylene treated paper is receptive to conventional paper conservation treatments such as traditional wheat starch paste and Japanese paper tear mending, guarding, washing and resizing. We will also discuss moisture content measurements to clarify concerns about the vacuum treatment involved in the Parylene coating process and its effect upon the treated paper.

11:40am **CS-ThM12 Iron Gall Ink Chemistry and Corrosion of Historical Documents Probed by XPS and Raman**, ***Karen Gaskell***, *A.A. Ponce, S. Gibbons, P. Zavalij*, University of Maryland, College Park, *L. Brostoff*, Library of Congress, *B. Eichhorn*, University of Maryland, College Park

Iron gall inks were the major writing medium from the middle ages through the 19th Century in the Middle East and Europe, and are present in hundreds of thousands of important cultural heritage objects worldwide, including books, manuscripts and artistic drawings. Iron gall ink depending on its preparation is well known for its potentially corrosive effect on paper or other writing medium, over time, changes in temperature and humidity can accelerate this degradation resulting in the worst case, complete loss of documents. The major ingredients of ion gall ink are iron salts, most often iron sulfate, tannic acids derived from vegetable sources such as gall nuts and gum arabic used as a binder. In this study, X- Ray Photoelectron Spectroscopy (XPS), is used to probe the chemistry of iron gall ink and to study the effect of common preservation techniques such as deacidification and phytate treatment. Despite much research in this area the chemistry of iron gall ink is still poorly understood, including the structure of the complex itself, resulting from the reaction between iron sulfate and gallic acid. The two most widely accepted structures in literature have been proposed by Krekel and Wunderlich, these structures will be discussed and compared to XPS, Raman, FTIR and X-ray crystallography data obtained from model compounds.

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