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## Plagiarism: Using Sources Responsibly

Daniel Reardon, Assistant Director, Writing Center, MS&T

**Abstract:** Integrating sources logically and responsibly is the first order of professional research for all scientists and technologists. First, in order to do research, we must thoroughly understand work in our own fields; that work will inform, guide, and direct our own. Researching the ideas of others has become more and more difficult in our present age, however. In our information fluid age, when vast amounts of data are easily accessible and quickly changed, we have now, more than ever, a moral and ethical responsibility to honestly and properly acknowledge the ideas of others that have influenced our own. It is all too easy, however, to copy, whether deliberately or unintentionally, ideas or portions of text without properly citing the sources of this information. This type of copying—plagiarism—demonstrates incompetence. If we fail to record our sources and then later forget that we used those sources, we are still liable and open to the charge of theft of intellectual property. By learning to properly and at all times, regardless of medium, record where we obtain ideas—whether we use them or not—we will maintain professional integrity with everything we write. This presentation will offer several key principles and strategies for responsible research documentation and plagiarism avoidance.

## Investigating Antioxidant Chelation for the Treatment of Lead Poisoning

Weiqing Chen, Dept. of Biological Sciences, East China Normal University, Shanghai, China

**Abstract:** The toxic effects of lead have been manifested as inducements of imbalance between pro-oxidant and antioxidant homeostasis and high affinities for thiol groups in the functional proteins. Prior *in vivo* studies on the treatment of lead poisoning using EDTA, N-acetylcysteine (NAC) and N-acetylcysteine amide (NACA) as chelators showed differences in their ability to decrease both Pb(II) levels and oxidative stress. This present study, performed *in vitro*, was undertaken to further delineate their chelating abilities. Pb-antioxidant complexations were performed at 0-10° C, dissolving antioxidant and Pb acetate in deionized, distilled water. UV-vis spectroscopy was used to investigate the binding interactions of Pb with these antioxidants in solution while X-ray photoelectron spectroscopy (XPS) was used to quantify the amount of Pb bound to the antioxidant. Job's Method plots obtained from UV data revealed 1:1, 1:2.5 and 1:1.5 stoichiometric ratios for EDTA:Pb, NAC:Pb and NACA:Pb coordination, respectively. Deconvolution of the XPS Pb 4f orbitals indicated a greater amount of covalently bound Pb(II) accompanying Pb-NACA complexation as compared to the formation of Pb-NAC and Pb-EDTA. In comparing Pb coordination to NAC and NACA, the increase in the amount of Pb bound to the antioxidant in the XPS data correlated with differences in their point of zero charge (PZC) values. Insights into the binding of Pb to this series of antioxidants will be discussed.

## **NMR Investigations of Hydrothermal Liquefaction of Biomass**

Wenjia Zhang, Dept. of Chem., MS&T

**Abstract:** Hydrothermal liquefaction of cellulosic biomass to synthetic fuel has gained considerable attention for it is conducted in aqueous solution at temperatures and pressures significantly lower compared with biomass pyrolysis or gasification. To elucidate the mechanisms of hydrothermal carbonization, the hydrothermal reaction of D-glucose as a model substrate was examined using quantitative analysis of  $^1\text{H}$ ,  $^{13}\text{C}$  and two-dimensional NMR. For the investigation, we have developed and optimized a new presaturation sequence (EXCEPT = EXponentially Converging Eradication Pulse Train) to suppress the water  $^1\text{H}$ NMR signal. The studies confirm that D-glucose is first dehydrated in aqueous solutions to 5-hydroxymethylfurfural (5-HMF) and subsequently re-hydrated to 4-oxopentanoic acid (levulinic acid). The investigation also reveals the formation of other compounds, some of which are yet unidentified.

## **An Overview of Environmental Regulations for the Chemist**

Dennis L. Whitney, Environmental Engineer, American Airlines, Retired

**Abstract:** Since the National Environmental Policy Act was passed and signed by President Richard Nixon in 1969, a large number of environmental laws have been enacted. The major laws that affect the chemical community are the Resource Conservation and Recovery Act, RCRA, the Clean Water Act, the Comprehensive Environmental Response Comprehensive Liability Act, CERCLA, also known as the Superfund Act, and the Superfund Amendments and Reauthorization Act known as SARA Title III, and the Clean Air Act. There have also been other laws that regulate petroleum spills, asbestos management, toxic chemicals regulated by the Toxic Substances Control Act, the management of nuclear (radioactive) waste, the transportation of hazardous wastes, and the cleanup of hazardous waste spills. There are also regulations concerning the safety of chemical workers published by the Occupational Safety and Health Administration.

Chemical students and professionals at all levels should be aware of the nature of these laws because, in many cases, they may be held personally, and sometimes criminally, liable for damages that may occur due to non-compliance.

## **Oxidative Stress in HIV-Associated Dementia**

Dr. Atrayee Banerjee, Dept. of Chem., MS&T

**Abstract:** An increased risk of HIV-1 associated dementia (HAD) has been observed in patients abusing methamphetamine (METH). Since both HIV viral proteins (gp120, Tat) and METH induce oxidative stress, drug abusing patients are at a greater risk of oxidative stress-induced damage. The objective of this study was to determine if N-acetylcysteine amide (NACA) protects the blood brain barrier (BBB) from oxidative stress-induced damage in animals exposed to gp120, Tat and METH. To study this, CD-1 mice pre-treated with NACA/saline, received injections of gp120, Tat, gp120 + Tat or saline for 5 days, followed by three injections of METH/saline on the fifth day, and sacrificed 24 h after the final injection. Various oxidative stress parameters were measured, and animals treated with gp120+Tat+Meth were found to be the most challenged group, as indicated by their GSH and MDA levels. Treatment with NACA significantly rescued the animals from oxidative stress. Further, NACA-treated animals had significantly higher expression of tight junction (TJ) proteins and BBB permeability as compared to the group treated with gp120+Tat+METH alone, indicating that NACA can protect the BBB from oxidative stress-induced damage in gp120, Tat and METH exposed animals, and thus could be a viable therapeutic option for patients with HAD.

## **HAART Drugs Induce Cytotoxicity Via Oxidative Stress and Mitochondrial Dysfunction in Blood-Brain Barrier Cells**

Kalyan Manda, Dept. of Chem., MS&T

**Abstract:** The blood–brain barrier (BBB) is a diffusion barrier which selectively regulates the flow of molecules from blood to the brain. Dysfunction of the BBB that was observed in the course of HIV infection has been confirmed by variety of pathological studies. Alterations in the barrier function of the brains endothelium have also been implicated in HIV-1-associated neurocognitive disorders (HAND) as well as other neurological disorders like multiple sclerosis and Alzheimer’s disease.

The era of highly active antiretroviral therapy (HAART) has led to a considerable decline in new cases of a severe form of HAND, called HIV-1-associated dementia (HAD). However there has been a significant increase in the number of existing cases with a milder form of HAND. In view of these developments, we hypothesized that HAART drugs may induce oxidative stress in the BBB thereby exacerbating the condition. Exposure of human blood brain endothelial cells (hCMEC/D3) to a combination of two HAART drugs, Zidovudine (3'-azido-2',3'-deoxythymidine; AZT) and indinavir (IDV) significantly reduced viability after a 72 hr treatment, in a dose-dependent manner. Oxidative stress parameters like glutathione (GSH) and malondialdehyde (MDA) were found to be significantly altered after exposure. Loss of mitochondrial membrane potential ( $\Psi_m$ ) assessed using fluorescent microscopy and decreased

ATP levels revealed that cytotoxicity was mediated through mitochondrial dysfunction. Permeability of dextran and measurement of trans-endothelial electrical resistance (TEER) across a monolayer of cells indicated that the integrity of BBB was compromised after the treatment. The results from our studies suggest that treatment with AZT + IDV may oxidatively challenge the BBB during antiretroviral therapy via mitochondrial dysfunction, thereby altering the functionality of this layer.

## **Electrodeposition of Superlattices in the Magnetite/Zinc Ferrite System which Exhibit Resistance Switching**

Rakesh V. Gudavarthy, Dept. of Chem., MS&T

**Abstract:** In this work, both defect-chemistry and compositional superlattices in the  $\text{Fe}_3\text{O}_4/\text{ZnFe}_2\text{O}_4$  system are electrodeposited. There is interest in depositing thin films and superlattices based on  $\text{Fe}_3\text{O}_4$  because the conducting cubic phase transforms to the insulating monoclinic phase below the Verwey transition at 120 K, making it a good candidate for resistance random access memory (RRAM) devices. For such RRAM devices, it is often necessary to have nanophase material. Electrodeposition can produce such nanophase material with precise control of composition and morphology by simply controlling the temperature, pH and overpotential. In  $\text{ZnFe}_2\text{O}_4$ , the Zn(II) substitutes for Fe(II) producing a material that is antiferromagnetic below the Néel temperature.

Films of  $\text{Fe}_3\text{O}_4$  are electrodeposited with stoichiometries that depend on the applied potential. We prepare the films by electrochemical reduction of a Fe(III)-TEA (triethanolamine) complex at 80 °C in strongly alkaline solution. Because of the electrochemical-chemical nature of the deposition mechanism, it is possible to control the composition of film through the applied overpotential. At low overpotentials at which  $j = 0$ , the surface concentration of  $\text{Fe}(\text{TEA})^{3+}$  should be equal to the bulk concentration, whereas at high overpotential at which  $j = j_L$  the surface concentration of  $\text{Fe}(\text{TEA})^{3+}$  should approach zero. Hence the material should have an excess of  $\text{Fe}^{3+}$  at low overpotential and an excess of  $\text{Fe}^{2+}$  at high overpotential. X-ray diffraction, Mössbauer and magnetic studies have confirmed that stoichiometric magnetite can be produced at -1.065 V vs. Ag/AgCl. Superlattices of the material are electrodeposited by pulsing the applied potential between -1.01 and -1.065 V vs. Ag/AgCl. Compositional superlattices can be produced by adding Zn(II) to the deposition bath.

We have shown that epitaxial magnetite films and superlattices on single crystal Au(111) substrate exhibit resistance switching.<sup>1</sup> A stoichiometric  $\text{Fe}_3\text{O}_4$  on Au(111) produced at -1.065 V has only one resistance switch. On the other hand, the superlattices on Au(111) have multistate resistance switching and a unique negative differential resistance feature.

## **Toward Higher Energy Density Dielectrics Through Nanocomposites**

Sasidhar V. Siddabattuni, Dept. of Chem., MS&T

**Abstract:** Dielectric materials that are capable of storing large amounts of electric energy are desirable for many electronic and electric systems. Since the electric energy density in a linear dielectric material is equal to  $kE_b^2/2$ , where  $k$  is the dielectric constant ( $\epsilon'$ ) of the material and  $E_b$  is the dielectric breakdown strength, both large  $\epsilon'$  and high  $E_b$  are required for large electric energy storage. While ceramic materials like barium titanate usually have large  $\epsilon'$ , they are limited by their relatively small  $E_b$ , poor processability and mechanical properties. On the other hand, polymers usually have higher  $E_b$  and excellent mechanical properties and processability but suffer from a smaller  $\epsilon'$ . A higher  $E_b$  is more beneficial to enhance energy density than a proportional increase in  $\epsilon'$ . Thus, numerous efforts have been ongoing to combine polymers of high  $E_b$  with nanoparticles of high  $\epsilon'$  with the desire to enhance the dielectric film energy storage density through nanocomposites. In this work, we strengthen the nanocomposite filler-polymer interface through the use of bifunctional reagent, 2-aminoethyl dihydrogen phosphate (AEP), to modify the surface of titania and barium titanate. The AEP filler surface can then covalently react with polymer matrix during cure to achieve a strong, covalent interface when used with thermosetting composites, such as an epoxy polymer matrix. Results show that interfacial covalent bonding is an effective approach to increase the electrical resistance of a polymer-particle composite to charge flow and dielectric breakdown. Interface-modified composites retain the glass transition temperature of pure polymer, reduce Maxwell-Wagner relaxation of the polymer-particle composite, and have a reduced sensitivity to dielectric breakdown compared to composites with adsorbed interfaces.

## **The Sexuality of the Chemistry of Explosives and Explosives at S&T or Why Things Go Boom... How Chemistry Plays In Explosives**

Prof. Paul Worsey, Dept. of Mining and Nuclear Engineering, MS&T

**Abstract:** A humorous take on explosives chemistry and the perhaps the reason why it should be left in the hands of Chemists. This will be followed by a brief condensed history of the chemistry of explosives to present, a briefing on where 99% of explosives are used, and what the explosives program is up to at Missouri S&T.

## **Novel Imaging Platform for Deciphering Motions in Living Cells**

Prof. Ning Fang, Dept. of Chem., Iowa State University

**Abstract:** Characteristic translational and rotational motions of bimolecular and nanoparticles are fundamental to most chemical and biological phenomena. Translational motion can be readily revealed by a variety of single-particle/molecule tracking methods. However, rotational motion is much more difficult to resolve due to technical limitations. The prominent examples of lacking knowledge on rotational motion are endocytosis and intracellular transport in live cells. The current understanding of rotational motion was acquired mostly in vitro using methods based either on fluorescence polarization or on super-localization of translational probes. Resolving dynamic rotational motion in living cells or other complex environments is still challenging. We developed novel optical imaging tools, based on plasmonic nanoparticle probes and differential interference contrast (DIC) microscopy, to visualize and decipher single-nanoparticle/molecule translational and rotational motion in complex environments and address outstanding questions in chemical and biological systems that were previously unattainable. Our current efforts are focused on deciphering rotational motions involved in receptor-mediated endocytosis, intracellular transport, and rotational diffusion on the cell membrane.

## **Oxidation of Zirconium Diboride Based Ultra-High Temperature Ceramics**

William G. Fahrenholtz and Gregory E. Hilmas, Dept. of Material Science and Engineering, MS&T

**Abstract:** Oxidation behavior of zirconium diboride based ultra-high temperature ceramics will be discussed. When exposed to oxidizing environments,  $ZrB_2$  undergoes stoichiometric oxidation forming  $ZrO_2$  and  $B_2O_3$ . At elevated temperatures,  $B_2O_3$  volatilizes, leaving a layer of porous  $ZrO_2$ , which is not protective and allows rapid oxidation of the underlying ceramic. The most common strategy for improving oxidation resistance is to add silicon containing compounds such as SiC or  $MoSi_2$ , which results in formation of a  $SiO_2$  layer that provides improved oxidation protection at intermediate temperatures. This presentation will focus on key aspects of the response of  $ZrB_2$ -based ceramics to oxidizing environments. Cross sections of oxidized specimens will be characterized to determine the composition and thickness of reaction layers. Thermodynamic tools will be used to interpret the evolution of structure during oxidation. In addition, the addition of tungsten will be discussed as an alternative to silica formers for improving oxidation protection.

## **The History of the Chemistry Set**

Dennis L. Whitney, Environmental Engineer, American Airlines, Retired

**Abstract:** Toy chemistry sets have been a favorite and useful tool in chemical education since they were first introduced by Mr. Gilbert and Mr. Porter in the 1920s. Unfortunately, they are



now no longer widely available. A short discussion will be presented as to both how the chemistry set evolved from mining tools and the magic sets that were popular in the last century and the cause of their recent decline as a popular toy for children. Some vintage chemistry sets will be displayed.

## Surface Plasmon Resonance Imaging

Dr. Yi Chen, Institute of Chemistry, Chinese Academy of Sciences, Beijing, China

**Abstract:** Surface plasmon resonance imaging (SPRi) was developed based on a phenomenon of surface plasmon wave which was first observed in 1902 <sup>[1]</sup> but elucidated in theory half a century later, in 1959 <sup>[2]</sup>. SPRi appeared for the first time in 1987 <sup>[3]</sup>. However, it has also been delayed to develop into an analytical method, *though*, it is inherently a high throughput technique suitable for study of intact biological macromolecules <sup>[4]</sup>. We have worked on SPRi since 1997, starting from the design and fabrication of SPRi systems due to the unavailability of a commercial instrument at that time. With laboratory-fabricated systems controlled also with laboratory-edited image workstations, color or grey images of chemical microdots spotted on gold sensing surfaces were easily imaged at a density of up to about 5000 dots/cm<sup>2</sup>. Methods were then explored for high throughput analysis of various samples and chemical or biochemical processes. Some examples will be discussed like protein denaturing, enzymatic digesting or decomposing, and molecular recognizing events. These works suggest that SPRi could become a novel high throughput platform for characterization and determination of intact biological molecules including not only proteins but also DNA, saccharides and many glycol-conjugates. Further studies are however needed and waiting for conduction.

## Bogan with Poems on Science

Prof. James J. Bogan, Curators' Teaching Professor of Art History and Film, MS&T

**Abstract:** Professor Bogan will present some of his poems that have been inspired by science and engineering. In addition he will screen his most recent short film, MAN vs. TREE, to illustrate how the experimental method can be used in documentary film production.

## Chemistry in Shakespeare

Prof. Nicholas W. Knight, Dept. of English, MS&T

**Abstract:** By using references found in Shakespeare's 30 plays, written between 1588 and 1610, we can discern his awareness of the current developments in the sciences of chemistry, biochemistry, medicine, astronomy, physics, geography, geology, and psychology. He explicitly refers to both the much earlier work of Galen (~130--~200), and his near-contemporary Paracelsus (1490--1541), in *All's Well that Ends Well*, moving from alchemy and astrology to medicine. In *Romeo and Juliet*, he deals with drugs and poisons. Not only are these plays evidence of Shakespeare's knowledge of the scientific developments of his time, but a close analysis of *Documented Polypharmacology in Treating Diseases* a treatise by his son-in-law, John Hall, reveals, for his period of time, an advanced knowledge of the methodology and practice of medicine, both in Shakespeare's own family and in the nobility in Shakespeare's England.

## The Role of Materials in the Development of Mankind

Dr. Wayne Huebner, Dept. of Materials Science and Engineering, MS&T

**Abstract:** Advances in the development of man can be traced to his mastery of the world of materials around him. This presentation will initially focus on the ages of man from the Stone Age through today's Nano/Bio Age, with particular emphasis on the evolution of our understanding of structure-processing-property relationships. Then I will present many examples of leading-edge materials research at S&T.

## The Heat Capacity of Sodium Atoms as an Ideal Gas and a Real Gas

Dr. Louis Biolsi, Dept. of Chem., MS&T

**Abstract:** The ideal gas heat capacity of sodium atoms is calculated to high temperatures. At higher temperatures, the increasing size of the atoms as a consequence of the population of highly excited electronic energy levels must be considered or the heat capacity becomes very large.

The sodium atoms are also considered to be a real gas that obeys the virial equation of state. The first non-ideal term in the virial expansion is evaluated. This involves the second virial coefficient which depends on the interaction between two sodium atoms. Contributions to the

heat capacity of sodium atoms from the virial coefficients associated with the lowest ten states of the sodium dimer are considered.