Division of Chemical Education, co-sponsored with Division of Environmental Chemistry, and Society Committee on Education

Undergraduate Research Poster Session

CHED 238

"CDtrodes" vs. traditional gold film electrodes in determination of a soil pollutant

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San Antonio has several of the oldest coal burning power plants in the nation. These plants are "grandfathered" with respect to environmental laws because they were built before more stringent environmental laws that govern what these plants may emit into the air. Literature has suggested a link between rates of autism and the locality of a these plants. It has been argued that the increased rates of autism are due to mercury in the environment. Stripping voltammetry from gold electrodes has proven to be a sensitive technique for mercury analyses. A CDtrode is a term coined in the literature for gold electrodes literally cut from commercial gold compact disks. Traditional gold electrodes are prepared by depositing a gold film onto a carbon electrode. The advantages and disadvantages of CDtrodes will be presented along with the results of the search for mercury in the soil in the San Antonio region.

CHED 239

Comparing the properties of pyridinium and 4-dimethylaminopyridinium ionic liquids

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Ionic liquids are salts that melt below 100°C. They have generated much interest due to their potential as alternative solvents for a variety of applications. We report here on the physical characterization and properties of 4-Dimethylaminopyridinium based ionic liquids in comparison to their pyridinium analogues. Unlike more common imidazolium and pyridinium type ionic liquids there is a lack of the physical data on DMAP salts. The DMAP and pyridinium salts were synthesized using various alkylating agents such as 3-chloropropanol and 2-bromoethyl ethyl ether. The halide salts were converted to ionic liquids bearing bis(trifyl)imide anions. Physical properties investigated include: viscosity, conductivity and thermal profile. Preliminary results indicate that the ionic liquids in both categories containing alkyl groups with a single hydroxyl unit have the lowest viscosity (109 cP) and highest conductivity (0.80 mS cm-1) at room temperature.This work was

supported in part at BNL by the U. S. DOE Office of Basic Energy Sciences under contract # DE-AC02-98CH10886 and the Louis Stokes Alliance for Minority Program.

CHED 240

Evaluation of simple solar cells using plant materials as the electron donor

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In this research simple solar cells were constructed using various plant materials as the electron donor, graphite as the electron acceptor and iodine solution as the electrolyte. Various plant materials were tested to determine which would give the greatest output.

CHED 241

Gentle capture of an airborne virus for online detection with flow cytometry

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A miniature cyclone was designed to gently capture nanometer-sized aerosols into a continuous liquid flow. Coupled with a flow cytometer, the system was tested for its potential to monitor biological particles semi-continuously. The geometry of the miniature cyclone was designed such that a natural vortex of air swirls a small volume of liquid (100 µl), pulling it upward to coat the inside deposition surface. Two types of fluorescent aerosol standards were used to calibrate the cyclone collection efficiency as a function of size: fluorescent polystyrene latex beads (PSL, Duke Scientific, diameter sizes (Dp) 30nm, 50nm, 100nm, 200nm, 500nm, and 3000 nm) and one water soluble ultrafine quantum dot zinc selenide aerosol (Evident Technologies, Dp 6.1 nm). Collected liquid samples were analyzed with a fluorimeter, which allowed for ± 5% sensitivity in suspended PSL bead concentrations. Transport losses of the insoluble standard suspensions were also characterized in the 1/16” liquid capillary flow. Overall collection efficiencies were higher than 88% for the PSL diameter sizes 30nm < Dp < 3000nm, and dropped to 60% for the quantum dot test aerosol Dp= 6.1 nm. The cyclone was further tested for its ability to collect an airborne virus and detect it inline using flow cytometry. The flow cytometer, which is commonly used for single cell identification via fluorescence, was modified to accept a continuous sample flow (0.02-0.10 ml min^{-1}) from the cyclone. A rod-shaped insect virus (Baculoviridae, nominal Dp 40nm x 300nm), and a plant virus (Tobacco Mosaic, nominal Dp 30nm x 300nm) were bubbled, collected by the cyclone, and stained inline using nucleic acid dyes (sybr green, Molecular Probes, Inc.). A 4-minute incubation time for the stain was required to resolve the virus from the background fluorescence. In addition, the gentleness of the collection method was assessed by using an Environmental Scanning Electron Microscope (ESEM) to examine whether virus breakup occurred in collected samples. Results are presented.

CHED 242

H2Oconee and beyond: Making a difference one paddle at a time

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A research group of undergraduate chemistry majors from Georgia College & State University have come together to monitor the Oconee River Basin. After five years of testing the water around middle Georgia, the research has taken a new spin on water testing by canoeing the Oconee River from start to finish. The Oconee River begins where the Upper Oconee River merges with the Middle Oconee River and ends by combining with the Ocmulgee River to form the Altamaha River in South Georgia. While canoeing, HACH onsite surface water kits have been used to analyze the conductivity, turbidity, pH, as well as nutrient levels. Chemical analysis for organic compounds was done using purge and trap coupled with gas chromatography-mass spectroscopy. This paper highlights the techniques used and also summarizes the results.

CHED 243

In search of the best biodiesel: Bomb calorimetry and GC-MS of biodiesel made from six different oils

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It has become a high priority to develop fuels that come from renewable sources. Biodiesel is one renewable fuel that can be used in vehicle engines already on the road. For this research, biodiesel was made using corn, canola, grape seed, olive, peanut, and soybean oils. Each oil was tested for energy content using bomb calorimetry. Identification of specific methyl esters was performed using GC-MS. A sample of commercial diesel was also tested for comparison.

CHED 244

Investigating the microwave assisted synthesis of ionic liquids

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Ionic liquids have gained a lot of attention as alternative solvents recently and have made their way into industrial labs. The need for developing synthetic procedures that are faster, more efficient and economical is increasing as the number of applications for ionic liquids increase. Typical advantages of microwave assisted synthesis are to significantly reduce reaction times and increase the product yield. We report here on the

synthesis of halide salts based on DABCO diazabicyclo[2.2.2]octane and their conversion into ionic liquids. Reaction conditions, such as the temperature, the nature of the reaction solvent and the length of reaction time, have been varied. A comparison of these two synthetic techniques and the physical characterization of these compounds will be reported. This work was supported in part at BNL by the U. S. DOE Office of Basic Energy Sciences under contract # DE-AC02-98CH10886 and the Louis Stokes Alliance for Minority Program.

CHED 245

Metal uptake by Raphnus sativus using hydroponics

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Environmental pollution is an increasing problem that is contaminating our soil, air, and water. Several factors contribute to pollution in the El Paso, TX area, including several smelter and refinery companies that are in operation. The objective of our study is to determine whether Raphnus sativus (radishes) are able to grow and accumulate toxic elements using hydroponics. Hydroponics is a method used to grow plants in a nutrient rich solution in the absence of soil. Once the radish seeds germinated they were transferred to trays and grown in miracle grow as their support to mature. After four weeks the radishes were then placed in troughs containing a nutrient solution and a nutrient solution contaminated with a 10ppm solution of As, Cd, Cr, Cu, Pb, Sb, and Se. This research was supported in part by the MBRS-RISE grant 5 R25 GM 60424-03, NIH EARDA 2G11HD 035968 Pilot Project, and NSF grant 0421470.

CHED 246

Novel determination of hydrophobic pollutants in surface waters

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Hydrophobic pollutants in lakes and streams have been shown to be concentrated in a thin organic film on the surface of the natural waters. An organic layer on a glass plate can be created through silanization. The plate may then be used to collect hydrophobic compounds present in the film on the surface of polluted waters. The methodology of capturing hydrophobic pollutants along with resultant GCMS analyses will be presented.

CHED 247

Physical properties of phosphate ionic liquids

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Ionic liquids are salts that melt below 100°C and exhibit high conductivities. They are being explored as alternative solvents for a number of applications. As the number of applications increase the need for specific structural types and data on physical properties become more important. We report here on our ongoing investigation of the preparation and characterization of phosphate-containing ionic liquids. Structural types include imidazolium, pyridinium and pyrrolidinium cations coupled with the phosphate anion. Properties such as viscosity, conductivity and thermal profile will be reported. Phosphate ionic liquids have been found to be hydrophilic, hygroscopic and to exhibit high viscosities. This work was supported in part at BNL by the U. S. DOE Office of Basic Energy Sciences under contract # DE-AC02-98CH10886 and the Louis Stokes Alliance for Minority Program.

CHED 248

Sarcosine, AMPA and glyphosate in montmorillonite clay interlayers: a theoretical molecular level study

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Glyphosate is a major herbicide found in commercial products such as RoundUp®. Glyphosate enters the plants through the leaves and inhibits the enzyme 5-enolpyruvylshikimate-3-phosphate, disrupting the process of protein synthesis. Glyphosate reaches the soil due to extended application techniques and run off from rain. There, it may be degraded due to the presence of microorganisms, producing two main compounds: sarcosine and aminomethylphosphonic acid (AMPA). Montmorillonite, a smectite clay, is one of the most common components of soils. Previous studies have shown that glyphosate can enter the interlayer spaces of montmorillonite and adsorb to them through either the amino or the phosphonate moieties of the molecule. Here the interactions of sarcosine and AMPA with the interlayer surfaces of montmorillonite are studied using molecular mechanics modeling techniques to explore the possible accumulation of these compounds in the soil. The results for the three species are compared.

CHED 249

Search for a cadmium point source using stripping voltammetry

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During routine analyses of surface waters in the San Antonio area the San Antonio River Authority discovered traces of cadmium in a local creek. The objective of this project is to determine the point source of the cadmium contamination. An optimum stripping voltammetry method and results of the investigation will be presented.

CHED 250

Synthesis of ionic liquids for toxicity studies

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Research activity in the field of ionic liquids (ILs) has recently generated excitement about their potential as green solvent alternatives. Their relative non-volatility, non-flammability, wide liquid range, and high conductivity render them attractive candidates as alternatives to the volatile organic solvents. As ILs make their way into industrial labs the potential for their release into the environment and the importance of understanding their toxic effects increases. There have been a few reports suggesting ILs are toxic to organisms varying from nematodes to algae and fish. However there have been even less studies of the relationship between the purity of the ILs and their toxic effects if any. We report here on the preparation of various grades of ILs and our preliminary results of their toxicity to different organisms. This work was supported in part at BNL by the U. S. DOE Office of Basic Energy Sciences under contract # DE-AC02-98CH10886.

CHED 251

Trace metal concentrations in soils on the campus of Southern Connecticut State University

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A soil survey was conducted on the campus of Southern Connecticut State University in the fall of 2006. This soil survey tested for concentrations of iron, cadmium, chromium,copper, lead, nickel and zinc. A soil sampler that took cores of the soil was used to extract the soil from the ground. The cores were then analyzed at two levels. Finally, the samples underwent as acid digestion and analysis. Once the concentrations were known, they were compared to the acceptable DEP standards and enrichment

factors were calculated. It was determined that lead was the only enriched metal. Though lead was enriched, all of the metal concentrations were within the DEP limits.

CHED 252

Ultraviolet analysis of the toluene fraction in bitumen from Agbadu (Western Nigeria)

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A bitumen sample obtained from one of the wells by the Nigerian Bitumen Corporation (NBC 7) - located opposite Saint Stephen's primary school, Agbabu, Ondo state Nigeria - was analyzed. The four fractions (saturates, simple aromatics, higher aromatics and polar compounds) obtained from chromatographic analysis were studied further. Ultraviolet analysis of the toluene fraction revealed the presence of some conjugated bonds which could either be dienes or enols. To determine whether dienes or enols are present, however, requires further analysis with techniques somewhat stronger than ultraviolet.

CHED 253

Using a bubble column to measure surface activity for wastewater remediation

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The surface activities of metal complexes have been investigated to improve the efficiency of wastewater remediation. Several experiments were conducted to confirm that the custom-made bubble column and its detection systems were sensitive and reproducible. A series of crystal violet chloride experiments were conducted to calibrate the column using an Ocean Optics visible spectrometer. Potassium chloride solutions were used to calibrate a bipolar pulse conductance instrument and to determine the eddy dispersivity values of liquid solutions moving through the column during bubbling. Work was done to find the linear adsorption isotherm coefficient and surface tension values of sodium chloride and aqueous copper solutions.

CHED 254

"Wood" you use it?

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The increasing price and scarcity of fossil fuels has instigated a worldwide search for a renewable source of energy. A research group of undergraduate chemistry majors from GCSU is teaming up with John Gormly of the Georgia Forestry Commission and Bartram Forest to explore the synthesis of a wood pellet from slash and loblolly pines,

prevalent in middle and northern Georgia. Pelletized wood has shown promise for both small and large scale usage in Sweden and Spain, where over one million metric tons are now being produced and consumed annually. Of that amount, more than thirty percent of the pellets are derived from various species of pine. Varying methods of sample preparation will be analyzed using bomb calorimetry, and the results presented.