Tuesday Morning, November 5, 2002

Advancing Toward Sustainability Topical Conference
Room: C-210 - Session AT-TuM

Aerosols and Climate Change, Growing Energy Demands, and Benign Semiconductor Manufacturing

Moderator: R.L. Bersin, Emergent Technologies Corporation

8:40am **AT-TuM2 Individual Particle TOF-SIMS Imaging Analysis of Aerosol Collected During the April 2001 Asian Dust Event**, ***R.E. Peterson***, *B.J. Tyler*, University of Utah

Time of Flight Secondary Ion Mass Spectroscopy can provide information regarding the surface chemistry, including both organic and inorganic compounds, of individual atmospheric aerosol in the micrometer size range. X-ray analysis has commonly been used to analyze the composition of single particles but has several important limitations. Principally, X-ray analysis cannot be used to study organic compounds in the aerosol, it offers low sensitivity for light elements common in crustal material and it cannot distinguish isotopes. TOF-SIMS has the potential to provide superior performance in these areas. We have developed statistical image processing methods to allow extraction of individual particle spectra from TOF-SIMS images. In mid April 2001 a strong Asian dust event was tracked by satellite across the Pacific Ocean and into the continental United States. While Asian dust deposition is common in Hawaii, strong events characterized by significant visibility degradation have been much less frequently reported in the Rocky Mountain west. Samples were taken during and after the event at the University of Utah in Salt Lake City, Utah. Size segregated samples were collected on aluminum substrates using an 8 stage Graseby-Anderson cascade impactor and total aerosol samples were collected with 47 mm Fluoropore filters. Surface and depth profile analysis of the particles was performed using a Phi Trift I TOF-SIMS instrument. Statistical methods, including PCA, mixture models and neural networks, were used to extract spectra of individual particles from the TOF-SIMS images and to classify particles based on their surface chemistry and depth profiles. Differences in both the chemistry and size distribution of the particles could be seen between the aerosol collected during the Asian dust event and aerosol collected post-event at the University of Utah site.

9:00am **AT-TuM3 Atmospheric Aerosol Detection, Analysis and Transformation**, ***P.H. McMurry***, University of Minnesota **INVITED**

Atmospheric aerosol particles scatter light, deposit on surfaces and in lungs, and participate in chemical transformations. This lecture will focus on the formation of new particles in the atmosphere by homogeneous nucleation, and on the chemical and physical properties of such freshly nucleated particles. It is important to understand nucleation since it affects the number concentrations of particles in the atmosphere. Number concentrations, in turn, determine the extent to which clouds form, and clouds play a central role in the earth's radiation balance. Our understanding of nucleation has progressed rapidly in the past few years due to recent advances in measurement. Routine measurements of aerosol size distributions down to 3 nm are now possible. Such measurements have shown that nucleation is ubiquitous in the atmosphere. We now are carrying out measurements that will help us understand what species are responsible for the formation and growth of new atmospheric particles. We have developed techniques to measure properties of freshly nucleated (3-10 nm) particles, including their tendency to absorb water, their volatility as a function of temperature, and their chemical composition. In this lecture these new measurement methodologies will be described, and our recent measurements will be discussed.

9:40am **AT-TuM5 Future Environmental Issues Associated with the Generation of Electricity**, ***J. Stringer***, EPRI **INVITED**

Over the next twenty to forty years the world-wide demand for electricity will increase substantially. In part, this is because of the increasing energy demand, particularly in the developing countries, and the increasing fraction of this energy that will be provided as electricity. In part, it is because of the increase in the global population, with most of this increase taking place also in the developing countries. Certainly for the immediate future, this demand will be met largely by the burning of fossil fuels. This will result in significant environmental challenges, and the major challenge is probably the emission of CO_2. It is not the object of this paper to discuss the issue of global warming: it is enough that there will almost certainly be a continuing global political pressure to limit these emissions. The current situation will be reviewed, with special emphasis to the United States, and the probable global developments will be discussed. The current options will be described, including methods that are being proposed for the capture and sequestration of the emitted CO_2. The major issues relate to the separation of the CO_2 from the relatively dilute concentration of the gas in the very large volume of the combustion off-gas, and the transport of the concentrated gas to a repository. The security and permanence of the various proposed repositories clearly must also be clearly defined and monitored. Alternative paths, including the decarbonization of the generation of electricity, will also be discussed. This decarbonization has been in progress for many years, and clearly the end-point in terms of combustion-based generation is represented by the use of hydrogen as the fuel. Production of hydrogen, either by separation of hydrogen from a hydrocarbon such as methane, or by reforming, presents significant issues, and the transportation and storage of the hydrogen are also issues which have still to be solved. Non-combustion based methods - nuclear fission, hydroelectric generation, biomass combustion, wind-power, and photovoltaic generation - will be briefly reviewed in terms of their possible contributions within the time scale defined above. Other aspects of the overall problem include improved efficiencies in the generation of electricity, reduced losses in transmission, and continued improvements in the efficiency of end use. Most importantly, all of this must be achieved with a minimum economic impact

10:20am **AT-TuM7 The Challenge of Relating Basic Research to the Solution of Environmental Problems**, ***D.R. Baer***, Pacific Northwest National Laboratory

Many members of the research community have enthusiastically redirected their research efforts to address important national problems. This paper examines the difficulties researchers face in actually having an impact on solving these problems. Several examples demonstrate the willingness of researchers to undertake environmentally related research projects and to participate in efforts that help define a critical scientific agenda. However, evidence indicates that the transfer of new scientific information to environmental technology and application is a more difficult challenge. There are several barriers to the rapid transfer of new scientific information to technological practice. Barriers include the nature research funding, an accepted (mis)understanding of the relationship between pure and applied research, the challenges of basic scientists and engineers working on multidisciplinary teams and working with non-technical people and organizations who have a vested interest in the problem and solution. To have a significant impact on environmental problems, technologists need to become involved in many activities, well beyond those associated with laboratory research.

10:40am **AT-TuM8 ESH Performance Plays a Vital Role in Sustaining the Growth of the Semiconductor Industry**, ***C. Miller***, *W. Worth*, International Sematech **INVITED**

Rapid technology advances and rapid growth have historically been the basis for the success of the semiconductor industry. Over the last twenty five years the industry has enjoyed a growth rate (~15%) which far exceeds the growth rate of the U.S. economy overall (3-4%). To ensure that this rapid growth rate can be sustained into the future, it is important that the industry makes efficient use of natural resources, minimizes any impact on the environment, and ensures the protection of its workers and the communities in which it operates. It has been repeatedly shown that resource efficiency is linked to lower operating costs and better environmental performance. International SEMATECH's Environment, Safety and Health (ESH) division is engaged in several projects that are aimed at enabling continued, sustainable growth for the industry. These include energy and water conservation, perfluorocompound (PFC) emissions reduction as well as early ESH assessment of the multitude of new chemicals and materials being considered for 157nm photolithography, ultra-low dielectrics, and advanced gate stacks. The timely assessment of any potential ESH impacts associated with these novel materials is essential to ensure that they are used in a safe and environmentally sound manner through cost-efficient ESH solutions and controls. This paper will describe the approach and results of SEMATECH's efforts in the areas of resource conservation, PFC emissions reduction and early identification of potential ESH impacts associated with the next generation semiconductor chemicals and materials.

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