Vacuum Technology
Room 201 - Session VT-ThM
Pumps and Large Vacuum Systems
Moderator: J.C. Helmer, AVS Fellow

8:20am **VT-ThM1 Design, Construction and Maintenance of Large Vacuum Systems*, K.M. Welch,*** Consultant **INVITED**

Most good vacuum technicians know how to define the sources and sinks in large systems. We are conversant in gauging, pumps, flanges and seals, valves, leak detection, control systems, etc. We understand gas desorption mechanisms, beam scattering phenomena, the properties on a variety of esoteric materials, and other such art forms of our trade. This technical competence is necessary, but not sufficient for successful project execution. The keystone to the successful execution of any project resides in the planning, the planning methodology, and then the effective communication of that plan to facilitate coordination and engender cooperation. This seems rather mundane. But, it is truly the management challenge of any major project. Planning must be made with insight to the technical, fiscal, temporal, safety, and human relations components of the project. We must effectively communicate with management, sponsoring agencies, project organizations, service groups, staff, and with vendors. Most of Deming's 14 quality assurance tenants relate to creating an enlightened environment of good communications. All projects progress along six distinct, closely coupled, phases. The six phases are in a state of perpetual change. These project phases and their elements are discussed, along with a few management tools which have proven of value in the planning and execution of major projects.

9:00am **VT-ThM3 Design of the US Spallation Neutron Source Ring Vacuum Systems*, H.C. Hseuh,*** Brookhaven National Laboratory*; M. Mapes,* Brookhaven National Laboratory, usa*; D Pate, L. Smart, J. Tang, R. Todd, D. Weiss,* Brookhaven National Laboratory

Brookhaven is undertaking the design, construction and commissioning of the accumulator ring and the beam transport lines for the 1 GeV US Spallation Neutron Source. A vacuum of 1x10@super -9@ Torr or less is required in the ring to minimize the beam-residual gas ionization. All internal surface of the ring vacuum chamber walls will be coated with TiN to minimize the secondary electron yields thus avoiding the potential mulit-pactoring and e-p instability observed at some proton and positron storage rings. The layout of the ring and transport line vacuum systems, the design of the vacuum chambers, vacuum pumps and other hardware are presented. The calculated pressure distribution in the ring and the transport lines will be given. Development of the TiN coating process will be described. The architecture of the vacuum instrumentation and controls based on serial network links, PLCs and EPICS will also be presented. *Work performed under the auspices of the U.S. Department of Energy.

9:20am **VT-ThM4 The Interesting and Important Problem of Water in Vacuum Systems*, H.F. Dylla,*** Jefferson Lab **INVITED**

The author will review the phenomenology of water adsorption/desorption in vacuum systems. A review of the literature of outgassing shows that for unbaked metals, the outgassing is dominated by water, and the outgassing rate (Q) obeys a power law of the form Q = Q0 t -a, where a is near unity. A series of outgassing measurements@footnote 1@ have been performed on well characterized stainless steel surfaces which show that the outgassing power law exponent can vary from a = 0.7 - a = 1.2 as the metal surface is exposed from extremely dry N2 to increasing partial pressures of H2O. Relatively simple engineering formulae exist which quantify the amount of adsorbed/desorbed H2O as a function of exposure pressure, time and temperature. Models have been developed consistent with these data which invoke the oxide layer as the source volume for the outgassing and assume that the outgassing rate is limited by diffusion from the near surface region. Alternative models for outgassing of water have been described which assume surface desorption as the only source term.@footnote 2@ The author will discuss the additional measurements and modeling that are needed to achieve a more sophisticated understanding of water outgassing from metal surfaces. This work supported by US DOE Contract No. DE. @FootnoteText@ @footnote (1)@ Minxu Li and H.F. Dylla, J. Vac. Sci. Technol. A11, 1702 (1993); A12, 1772 (1994); A13, 1872 (1995). @footnote (2)@ P.A. Redhead, J. Vac. Sci. Technol. A, 13, 467 (1995).

10:00am **VT-ThM6 Large Motion Feedthrough Designs for Ultra Accurate Positioning in Vacuum*, T. Bisschops,*** Philips Research, The Netherlands

In the near future machining of special materials or substrates and e.g. semiconductor lithography will require an ultra clean gaseous or vacuum atmosphere. Large workpieces or substrates will need to be positioned at high speed (e.g. 20 m/s) with high acceleration (e.g. 2 g) and high accuracy (e.g. 5 nm). For industrial heavy duty applications large, differentially pumped, motion feedthrough designs have been developed. Feedthrough designs that allow for long stroke (e.g. 0.5 m) X, Y, Z, phi, theta positioning with high accuracy and for vacuum applications in the 10e-6 to 10e-8 mbar range will be presented.

10:20am **VT-ThM7 Design and Operation of Scroll Type Dry Primary Vacuum Pumps*, A. Liepert*,** *P. Lessard,* Varian Vacuum Technologies

Since being rediscovered two decades ago, scroll technology has been successfully adapted to vacuum use. Several innovations have allowed scroll-type pumps to produce vacuums lower than 10 mtorr; the pumps are used in many applications requiring an inexpensive, dry, long-lived pump. In this article, we detail the scroll design procedure, focussing on the tradeoffs between the need for sufficient vacuum and low manufacturing cost. In particular, the bearing and axial seal design are detailed. As an illustrative example, we consider the design requirements for a high helium compression scroll design for use in leak detectors. We also present guidelines for proper pump operation, including the need for gas ballasting, limits on high pressure operation and proper pump isolation schemes.

10:40am **VT-ThM8 Influence of the Production Parameters on the Vacuum Properties of Ti-Zr-V Non-evaporable Getter Films***, C. Benvenuti,* ***P. Chiggiato****, S. Clair, J.B. Clark, P. Costa Pinto, A. Escudeiro Santana, V. Ruzinov, I. Wevers,* CERN, Switzerland

Non-evaporable thin film getters of various composition have been produced by sputtering. Among the about 20 materials which have been studied, the lowest activation temperature (about 180°C) has been displayed by a Ti-Zr-V coating obtained from a cathode made of intertwisted elemental wires. In order to optimise the vacuum properties of this coating, the production parameters have been varied, namely sputtering configuration (diode or magnetron), discharge gas, deposition rate, discharge voltage, substrate nature and temperature during coating. The films have been analysed by electron microscopy, electron stimulated desorption, ultimate pressure, pumping speed and rare gas degassing rate measurements. The results are presented and discussed.

11:00am **VT-ThM9 Influence of the Elemental Composition and Crystal Structure on the Vacuum Properties of Ti-Zr-V Non-evaporable Getter Films***, C. Benvenuti, P. Chiggiato, A. Mongelluzzo,* ***A. Prodromides****, V. Ruzinov, M. Taborelli,* CERN, Switzerland*; F. Lévy,* EPFL, Switzerland

Non-evaporable thin film getters of various composition have been deposited by sputtering. Among the 20 materials that have been studied, the coating with the lowest activation temperature (about 180 °C) has been found in the Ti-Zr-V system sputter-deposited from a cathode made of intertwisted wires of the constituent elements. In an attempt to reduce the activation temperature, Ti-Zr-V films of various composition have been deposited by means of a dedicated three-cathode planar magnetron sputtering configuration, and then characterised by Auger electron spectroscopy and pumping speed measurements. We have found that the lowest activation temperatures and the highest pumping speeds are obtained only in a confined zone of the Ti-Zr-V system, corresponding to an amorphous or nanocrystalline structure. Important and irreversible reductions of the getter film pumping speed are observed when the film structure is modified by heating.

11:20am **VT-ThM10 Miniature Vacuum Pumps*, J.W. Weed*[1]*,*** Sandia National Laboratories **INVITED**

Miniature analytical instruments that operate in a rarified gas environment will require vacuum pumping systems that are of suitable performance, size, weight, and power consumption. A subset of these analytical instruments will require throughput pumping systems, that is systems that exhaust pumped gas to the external environment rather than capturing it. Vacuum pumps are available in both capture and throughput configurations. Most "normal" sized gas analytical systems in use today are equipped with throughput pumping systems because of sampling and total mass flow requirements. This talk will describe existing pumps and efforts to miniaturize them. Performance and design criteria will be explored focusing on creating specifications based on overall system requirements.

[1] **Featured Speaker - Science and Technology in the 21st Century**

Problems with shrinking existing designs as well as several novel designs will be considered. Some new microfabrication processes will be described with an eye towards techniques that will be helpful in the fabrication of miniature vacuum pumping systems. *Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Contract DE-AC04-94AL85000.

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