Tuesday Morning, November 5, 2002

Vacuum Technology
Room: C-104 - Session VT-TuM

Novel Vacuum Materials and Pumps, Including Getters
Moderator: M.L. Ferris, SAES Getters USA

8:20am **VT-TuM1 Expanded Characteristics Evaluation for Low Vacuum Dry Pumps**, ***J.Y. Lim***, *S.H. Chung, W.S. Cheung, K.H. Chung, Y.H. Shin, S.S. Hong,* Korea Research Institute of Standards and Science, *W.G. Sim*, Hannam University, Korea

Since positive-displacement dry pumps were first launched into the semiconductor industry in 1984, issues concerning about characteristics evaluation on consistent bases have been continuously arisen from the mass production lines. Besides their clean and continuous pumping capability, occasional devastating malfunctions or characteristic degradations of such pumps during the manufacturing processes have been also reported in the Korea semiconductor industry. On behalf of these issues, the integrated characteristics evaluation system for dry vacuum pumps has been developed collaborating with several semiconductor and branch dry pump manufacturers in Korea. The evaluation system exploits the constant volume flowmeter to measure the mass flow rate in standards level, and facilitates the evaluation of spatially averaged sound power levels using a reverberation chamber.[1] New and overhauled roots, claw, classical screw, and scroll type pumps supplied from the manufacturers have been evaluated using the evaluation system in terms of ultimate pressure, pumping speed, vibration, and sound power. The correlation analyzed among those results shows clear signs of pump degradation related each other. We selected the mass flow measuring method with a constant chamber volume of 874 L because of its direct monitoring capability not allowing blind mass flow rate measurement, and proved the method allows us to measure five decades of mass flow rates from 0.01 to 10^3 mbar-l/s with an uncertainty of ±3% which is within the internationally accepted standards limit. In this work the integrated characteristics evaluation method has been significant because of pump degradation or malfunction symptom to be further understood and predicted.

[1]W.S. Cheung, J.Y. Lim, K.H. Chung, Experimental study on noise characteristics of dry pumps, The 2002 International Congress and Exposition on Noise Control Engineering, Inter-noise 2002, Dearborn, MI, USA.

8:40am **VT-TuM2 High Throughput Continuous Cryopump, with Gas Dynamic Compression of the Helium Minority Stream, for Pumping Fusion Reactors**, ***C.A. Foster***, Cryogenic Applications F, Inc., *S. Willms, S. Letzring,* Los Alamos National Laboratory, *D. Schechter*, Cryogenic Applications F, Inc.

An analysis of the flow of gases in a large cryopumping system designed to pump a magnetic plasma fusion reactor is presented. The pumping system for a 3gigawatt thermal reactor must handle a throughput of 2 Pa-m3/s of He and 200Pa-m3/s of D/T and maintain a pressure in the diverter at about 0.5Pa. A cryopump which removes the cryo-ice during operation with a regenerating head or "snail" is capable of pumping the D/T stream. A set of twelve 500mm bore pumps would each pump 16.7 Pa-m3/s of the D/T stream with the He being pumped by a set of turbo pumps downstream to the cryopumps. In designing the entrance baffle and analyzing the gas flow in the pump, it was determined that whereas the gases were close to free molecular flow conditions in a room temperature design, at 30K they would be in the viscous flow regime. The viscous flow conductance of the entrance duct at room temperature was not drastically different from that calculated using the free molecular flow equations. However, Poiseuille flow has a strong temperature dependance, so that the pressure drop across a pipe in viscous flow at 30 K is dramatically lower than at 300K. Since a cold baffle is typically used to precool the gases entering a cryopump, it was decided to replace it and the room temperature ducts with a refrigerated duct operating in the viscous flow regime. An analysis of long cold ducts replacing the conventional vacuum pipes between the reactor diverter chamber and the cryopumps allowed the pipe size to be reduced by a factor of four in area. This is especially advantageous in a reactor since the vacuum ducts have to pass between the coils and through the neutron shielding blankets. An analysis of the fluid flow of the D/T and He in the cold ducts showed a gas dynamic drag compression of the He minority species(10X to 30X) by the D/T stream as was utilized in the Gaede diffusion pump. This pre-compression allows conventional turbo-molecular pumps to be used as the compound helium pumps.

9:00am **VT-TuM3 Vacuum System Design and Simulation Program for PCs**, ***R.A. Langley***, *L.R. Baylor, P. LaMarche*, Oak Ridge Scientific Consultants

A new integrated software package for Windows has been developed to design vacuum systems and to simulate existing vacuum systems. The package is modeled after earlier DOS based programs by Santeler.[1,2] The initial setup of the design calculation allows the choice of up to five parallel pumping modules on the vacuum chamber with the choice of up to six different gas types. At this stage, the primary pump for each module is chosen. Each pumping module is then separately addressed to choose the optimum secondary pump or pumps for that pumping module. Both circular and rectangular cross section tubing is allowed. Pumping speed data for many types of pumps and many sizes of pumps is maintained within the program and additional pumping speed data can also be input for use by the program. The calculation is based on a precision set of gas flow equations for all pressure conditions, i.e. molecular, transition, and viscous, and provides pumpdown and steady state data. True gas fractionation is calculated and gas flow for tubes of varying lengths, i.e. from an orifice to a long tube, can be calculated. Various examples of the use of the program will be presented.

[1] Donald J. Santeler, Vacuum System Design, Donald J. Santeler Assoc.
[2] Donald J. Santeler, VSD-II Vacuum System Design, Donald J. Santeler Assoc.

9:20am **VT-TuM4 Design Fabrication and Processing of Vacuum Chambers for High Energy Accelerators at Brookhaven***, ***H.C. Hseuh***, *M. Mapes, D. Weiss*, Brookhaven National Laboratory **INVITED**

There are several distinct accelerators and storage rings at Brookhaven ranging in length from tens of meters for the Tandem to several kilometers for the Relativistic Heavy Ion Collider. The vacuum systems of these facilities must provide a suitable environment for the circulating beams while also being subjected to the intense bombardment of various energetic particles. The unique physics requirements and material selection criterions for the vacuum chambers will be described. The fabrication, cleaning and conditioning of the vacuum chambers will be reviewed. The treatment, sealing techniques and performance of non-conventional materials such as ceramic and ferrites in an ultrahigh vacuum and high radiation environment will also be presented. *Work performed under the auspices of the U.S. Department of Energy.

10:00am **VT-TuM6 Advanced Materials and Fabrication Techniques for the Next Generation Light Source**, ***J.R. Noonan***, *G.A. Goeppner, J. Gagliano, R.A. Rosenberg,* Argonne National Laboratory, *D.R. Walters*, Veeco International **INVITED**

The next generation of light source will probably be based on electron linear accelerators using a laser driven photocathode gun. The accelerator requirement will be very stringent: very short pulses (< 100 fs, >1,000 amp peak current, and large electric accelerating gradients > 30 MeV/m). These specifications will impose new, significant requirements on the vacuum systems. For example, the cathode material in the photocathode gun not only must have high photo-electron yields, but also must withstand high laser power and high RF electric gradients. The beam tube must be fabricated to new tolerances with respect to surface finish, surface resistance, and change of cross section. The new accelerator requirements are leading the need for new materials and manufacturing technology. The talk will review research at several Free Electron Laser accelerators, and how the technology assisted the success in VUV photon emission from free electron lasers.

10:40am **VT-TuM8 Investigations of Novel Getter Materials**, ***W. Knapp***, *D. Schleussner,* Otto-von-Guericke-Universität Magdeburg, Germany, *T. Stenitzer,* Konstantin Technologies GmbH, Austria, *K. Chuntonov*, Alkali Metals Ltd., Israel

The novel chemisorbents on the basis of alkali, alkali-earth and rare-earth metals have recently emerged as one of the most promising getter materials. The novel getters are based on an A-B alloy system, where A is a chemically active metal and B is a fusible non-volatile metal. Metal B is creating a protective shell on the whole surface of the novel getter material, which is impermeable during handling and storing and permeable when activated. The main advantages of the novel getters compared to the standard getter materials in use are: - Much higher kinetic and capacity sorption, - Significant lower activation temperatures, - Very small size and flexible design possible, - Easy handling of very active materials, e.g. Li, Na, Cs etc. In quantitatively proof of advantages and for basic getter investigations an ultra-high vacuum (UHV) experimental setup with a high measurement standard was developed. Getter temperatures and gas flow rates are regulated for different operations. On the basis of precise total and partial vacuum pressure measurements the getter sorption capacities are valued and compared in dependence on vacuum pressure range and kind of gases. For this with our experimental setup different measurement methods are possible, like pressure rise, throughput and difference method. We investigated sorption capacities of standard and novel getters using the pressure rise method. In our presentation comparative results of our investigations are presented and discussed.

11:00am **VT-TuM9 Modern Types of Getters for Novel Applications**, ***L. Rosai***, Saes Getters, Italy

Modern applications of gettering aimed to remove unwanted impurities and contaminants in vacuum and gas filled environments encompass new types of evacuated or gas filled devices, each requiring a tailor made solution in terms of gettering materials, geometry, process integration. In addition to the traditional types of getters in form of rings, porous pellets and coated strips, nowadays new configurations are available to meet the specific requirements of new applications: the getters can be prepared in form of very porous thin films sheets, coated in- situ as sputtered films, patterned on a semiconductor substrate, made in form of thin permeable bags filled with different materials each devoted to a specific gettering task, filling small capsules equipped with special mounting features. In these modern getters the so called activation process is no longer necessary thanks to special features of getter packaging and/or a natural activation occurring during device manufacturing. New types of getter pumps, not requiring substitution for many months or years are also available, for different applications in portable instruments, semiconductor, LCD and magnetic recording media manufacturing In some of these applications these new getter types are necessary not only for ensuring a long life to the device but also as a process aid during the manufacturing of the device itself .The vacuum and purity requirements of the most recent applications of getters will be illustrated. These will include: Vacuum Insulated Panels, Vacuum Pipes, Flywheels, Plasma Display Panels , Field Emission Displays, OLEDs, MEMS, Opto-electronic devices, Magnetic recording devices, Semiconductor and LCD production tools.

11:20am **VT-TuM10 Gaede Langmuir Award Address: The Impact of Non-evaporable Getters on the Evolution of UHV/XHV Technology**, ***C. Benvenuti****, CERN, Switzerland **INVITED**

Non-Evaporable Getters (NEG) entered the field of UHV technology with the advent of powder-coated gettering strips. Coated strips are particularly well suited to provide large, linear pumping for the conductance limited vacuum chambers of particle accelerators. An example of this application is the pumping system of the Large Electron Positron collider (LEP) at CERN. The development of alloys of lower activation temperature (about 400 °C) may be seen as another major break-through in the NEG technology. In this case the activation may be achieved "passively" during the bakeout of a stainless steel vacuum system, resulting not only in a simplified solution (no need of electrical insulation, feedthroughs and power supply), but also in improved vacuum performance (larger pumping speed and capacity, lower ultimate pressure). The final stage of the NEG technology evolution has been reached with the recent development of thin getter films coated on the inner surfaces of a vacuum chamber. These films offer an even lower temperature of activation (180 °C), a feature which renders them applicable also to copper and aluminum structures. In addition, they provide large and evenly distributed pumping, suppress the thermal degassing of the underlying material and strongly reduce, after activation, both the degassing and the secondary electron yield induced by the surface bombardment. The impact of NEGs on the evolution of vacuum technology will be illustrated and the new possibilities offered by the thin film coatings will be reviewed with the help of some examples.

* Gaede Langmuir Award Winner

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