Thursday Afternoon, November 6, 2003

Vacuum Technology
Room 323 - Session VT-ThA

Industrial Vacuum Applications

Moderator: N.T. Peacock, MKS Instruments

2:00pm **VT-ThA1 The Role of Outgasssing, Outdiffusion and Desorption in Vacuum Coating**, ***D.M. Mattox,*** Management Plus Inc. **INVITED**

The role of vacuum technology in the vacuum coating industry has changed significantly in the last 30 years. Previously the objective of producing a vacuum was to attain the best possible vacuum in the shortest time possible. In recent years to this goal has been added the requirements of establishing specific partial pressures of inert and reactive gases and vapors, generating uniform plasma environments and controlling the gas flow and gas distribution in the processing system. The vacuum systems are of ten required to handle toxic and corrosive gases and to tolerate fine particles generated in the processing. The increasing use of polymer substrates and rolls of films (webs) has increased the demands imposed for handling outgassing and desorption during vacuum processing. This paper will describe some of the problems and solutions used not only to address the problems of outgassing and desorption but also to minimize the problems by proper system design and substrate treatments in the vacuum system.

2:40pm **VT-ThA3 Pumping Characteristics of Metal Films in a Vacuum Glass Vessel: Experimental and Theoretical Issues**, ***A. Bonucci,*** *C. Carretti, G. Longoni, R. Giannantonio, M. Urbano,* SAES Getters SpA, Italy

The evaluation of the pumping characteristics of metallic films deposited onto glass surfaces in a vacuum environment is a very important issue for several industrial and research applications. Many years ago, an optimized experimental setup was established to measure the pumping characteristics of barium films inside Cathode Ray Tubes (CRTs). However, some technological limitations, related both to the particular experimental configuration and to the materials used, prevented the possibility to extend this approach to a more general case, including adsorbing materials different from barium deposited onto surfaces having a geometry different from that of a CRT. The progress in vacuum technology makes today possible to use a large variety of components to assemble an experimental vacuum apparatus. Moreover, the availability of powerful computational tools allows to design the best experimental configuration for any specific purpose. In this work, a new approach to the study of the pumping characteristics of an adsorbing film in a vacuum is discussed. An improved experimental configuration is here first described and a mathematical method, based on the angular coefficients approach, able to suitably calculate the pressure distribution inside a vacuum vessel, is proposed. The agreement between the experimental and the theoretical results obtained in the simple case of a gettering surface deposited onto spherical glass bulbs having different dimensions is finally discussed.

3:00pm **VT-ThA4 Vacuum Thermal Insulation - Inventions for the Future**, ***V. Nemanic,*** Jozef Stefan Institute, Slovenia **INVITED**

The innovative application of vacuum in a gap between two bottles is attributed to Sir James Dewar in 1892. The underlying technical innovations followed through numerous patents that have often driven the remarkable progress in different fields. An examination of the past century of progress is indeed an exciting venture which manifests the state of the art of contemporary vacuum science and technology. The review of operational principles, main technical difficulties and future trends of developments are presented for: 1) cryogenic scientific instrumentation, where the insulating value of the single gap is improved by insertion of multiple reflectors. This was first done in the mid of the last century offering the lowest thermal flux in "super insulated" cylindrical vessels. Well proven solutions in this field seems to have an impact on potential storage of liquid hydrogen as it can become the automotive fuel of the future. 2) everyday thermos bottles became in last few years light and durable by replacing the glass wall with the thin stainless steel. This valuable change did not affect the price, but manifests better evacuation methods and application of new getters. 3) evacuated insulating flat elements with high insulating value are an efficient alternative for polymer foam panels. Longevity sets still very strict requirements for selection of highly porous filler material, as well as for envelope tightness and permeation rate. Anyhow, vacuum panels are already built in energy efficient home appliances and will soon spread in cargo containers and buildings. 4) transparent and translucent vacuum glazing were proposed for over a century in improving concepts in patents. Beside a still limited application in passive solar energy capture elements, the commercial vacuum window glazing, with point supported two sheets of glass, appeared in the last five years. Today performances may be thus optimistically envisioned for tomorrow.

3:40pm **VT-ThA6 A Comparison of Chamber Conductance Calculations Using CFD and a Thermal Radiation Analogy**, ***L.A. Gochberg,*** Novellus Systems

The design of semiconductor vacuum chambers often requires that overall chamber conductance be optimized. In high-density plasma (HDP) chemical vapor deposition (CVD) systems for dielectric deposition in STI applications, a high chamber conductance will promote lower chamber pressures over the wafer. These lower pressures can enhance the ability to perform high aspect ratio dielectric gapfill on the wafer. Flow modeling is routinely used in the design of such CVD systems, employing either Monte Carlo methods or Navier-Stokes solvers (CFD) using slip boundary conditions. In this work, a thermal radiation analogy to free molecular flow is used in place of a collisionless Monte Carlo computation for two different HDP-CVD chamber configurations. Modeling results show that with either the thermal radiation analogy approach, or the CFD approach, chambers with centrally-mounted pedestal chamber designs perform significantly better from a conductance/pressure perspective than do cantilever- mounted pedestal designs. Also, the thermal radiation analogy model approach allows complex 3D chambers to be modeled quickly with general-purpose, commercially available CFD codes. This CFD approach is preferable in industrial environments as opposed to using Monte Carlo methods, which require the use of a separate software modeling approach that is not available commercially, and is difficult to use for complex 3D geometries.

4:00pm **VT-ThA7 CFD Analysis of a 2D Model of a Gaede Drag Pump in Viscous and Slip Flow Regime**, ***S. Giors,*** Varian Vacuum Technology, Italy; *F. Subba,* Politecnico di Torino, Italy

Experimental analysis on a uniform and a tapered Gaede pumps were already performed in Varian in 2002 and the results presented at AVS 49th Intl. Symposium.@footnote 1@ The experimental results assessed both compression and pumping speed performances of those pumps and showed some weaknesses of the Couette-Poiseuille 1D model, developed a few years ago by Helmer and Levi to describe the Gaede stage behaviour and to be used as a design tool.@footnote 2@ A 2D model of the Gaede pump, based on Navier Stokes equations, is now developed and validated against experimental results. A commercial CFD code is used to simulate the pumping performance of a single stage Gaede pump (the uniform one in the experiment) in the viscous regime, for different operating conditions, with and without throughput, in order to assess both compression and pumping speed performances, as well as to improve the general understanding of the physics of Gaede pumps within the limitations of a 2D model. The possibility of extending the Navier Stokes model at low pressure, through slip flow boundary conditions is also explored, and the lower pressure limit found for the resulting model by comparison of the numerical results with the experiment. Validation against experimental results has shown some weakness of the pure 2D model, and ideas to include some 3D effects (e.g. the radial leak path) into the 2D model are proposed for future developments. @FootnoteText@@footnote 1@ S. Giors, R. Gotta, J.C. Helmer, "Experimental analysis of Tapered Gaede pumps", AVS 49th Intl. Symposium oral presentation, Denver CO, November 2002.@footnote 2@ J. C. Helmer, G. Levi, "Transition gas flow in drag pumps and capillary leaks", J. Vac. Sci. Technol. A 13(5), 2592-2599, Sep/Oct 1995.

4:20pm **VT-ThA8 Characteristics Evaluation Practice of Predictable Performance Monitoring for Low Vacuum Dry Pumps in the Semiconductor Production Line**, ***J.Y. Lim,*** Korea Research Institute of Standards and Science, Korea; *W.S. Cheung,* Korea Research Institute of Standards and Science; *J.H. Joo,* Sungwon Edwards Ltd., Korea; *Y.W. Kim,* Samsung Electronics Co. Ltd., Korea; *W.G. Sim,* Hannam University, Korea; *K.H. Chung,* Korea Research Institute of Standards and Science

The early prediction system of performance fluctuation for low vacuum dry pumps in the semiconductor process line has been issued since devastating malfunctions or characteristics degradations of dry pumps due to mainly chemical byproducts during the production processes have been occasionally reported in Samsung Electronics. This motivation drove implementing central monitoring system (CMS) to the production facilities. CMS, however, is not a single condition monitoring or a prediction analysis method, but an overall monitoring program with historical performance data only. To compromise with this issue, the real time, in-situ characteristics evaluation system for two Edwards iH600 dry pumps has

been established at the Ti/TiN chemical vapor deposition system in the Samsung Electronics production line #10, in which system pump malfunction or degradation mostly happens. The real time data in Samsung Electronics and the experimental reference data from the KRISS characteristics evaluation system@footnote 1@ have been thoroughly compared each other and analyzed to ascertain if there exist unusual degradation symptoms such as in pumping speed, power consumption, vibration, noise, etc. The integrated data at the actual process pressure range of about 1 to 10 mbar and experimental measurement rage of about 100 to 10@super -3@ mbar are time-synchronized with respect to the inlet pressure in a scientific manner of coincidence. In this recent work, we report the first significant results of the method of characteristics synchronization between the laboratory and process line in the way of the pump malfunction or degradation symptom to be clearly diagnosed and positively protected during the production process. @FootnoteText@@footnote 1@J.Y. Lim, S.H. Chung, W.S. Cheung, K.H. Chung, Y.H. Shin, S.S. Hong, W.G. Sim, Expanded Characteristics Evaluation for Low Vacuum Dry Pumps, AVS 49th International Symposium, November 4, 2002, Denver, CO, USA.

4:40pm **VT-ThA9 An Alternative-voltage Penning Cell for Low-voltage Vacuum Gauges and Other Applications*, S.A. Cherenshchykov,*** National Science Centre "Kharkov Institute of Physics and Technology", Ukraine

A two-anode Penning cell with cold cathodes was researched. Due to additional source of a variable voltage used as power source, it becomes possible to ignite and to support the discharge at significantly lower voltage. This phenomenon was observed in a wide range of pressures (from 5 Pa up to 10@-6@ Pa). The reduction of Penning discharge voltage was up to 20 volts at the pressure value of 0.3 Pa and up to 300 volts when pressure was the lowest. The discharge current decreased together with pressure. The discharge current irreproducibility at the pressure of 10@-5@ Pa was not worse than 12 %. The current of existing discharge in magnetic field increased in many times under effect of additional variable voltage. It is supposed that efficiency of ionization of low-pressure gas will increase under affect of variable voltage. These discharge properties can make the basis for perfection of devices that use the Penning cell and other discharge magnetic cells (such as full and partial pressure gauges, leak detectors, ion pumps, ion sources and hot plasma sources). The new properties of the discharge can promote expansion of its application area, in particular, on sources of vacuum ultra-violet and soft x-ray radiation and polarized charged particles. The working model of the vacuometer was created based on such discharge. This vacuometer can unite all the advantages of magnetic discharge vacuometer and hot-cathode ionizing vacuometer. Besides it could be cheaper, is safer from the point of view of explosion possibility. Its power consumption and the heat dispersion on its gauge are almost hundred times lower. In addition, it can be smaller in volume and weight in comparison with analogues.

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