Vacuum Technology
Room Hall A-C - Session VT-WeP
Poster Session

VT-WeP1 Temperature Characteristics of a New Static Expansion Vacuum Standard, *J.C. Greenwood,* ***P. Carroll,*** National Physical Laboratory, UK

The uncertainty in the pressure generated in vacuum standards is often dominated by temperature contributions. In equilibrium, gradients across the system vessels make it difficult to assign a temperature to the gas contained inside. Gradients between vessels can also contribute to errors in the calculation of the generated pressure. To investigate the temperature characteristics of a new Static Expansion vacuum standard at NPL a series of measurements were made using an array of thermister thermometers located at over 100 distinct locations. This level of monitoring is not practical for normal operation, however, the temperature distribution for the system has been mapped so that probe locations for representative temperature measurements have been identified for normal operation. An indication of the worst case error is given together with the improvement in uncertainty for optimally located temperature probes.

VT-WeP2 Thermodynamic Effects on the Pumping Performance of a Dry Scroll Vacuum Pump, ***T. Sawada,*** *S. Kamada, W. Sugiyama, M. Yabuki,* Akita University, Japan*; M. Fujioka, M. Tsuchiya,* ANEST IWATA Corporation, Japan

The theory we proposed before gives the ultimate pressures closely consistent with the values from the actual machine at the rated speed, but gives smaller values than the actual machine does, for lower orbiting speed. This discrepancy increases as the orbiting speed decreases. The theory also seems to be incomplete for other gases than nitrogen, especially for a light gas like helium. It has been confirmed experimentally that this is caused by the difference in clearance between the theoretical analysis and the actual machine. The clearance is constant in the theoretical analysis regardless of the orbiting speed and the type of gases; however, the clearance in the actual machine changes with the temperature changes accompanying variations in orbiting speed and the differences in the thermophysical properties of gases. We propose a thermodynamic model expressing the temperature distributions on the orbiting and fixed scrolls. Since the heat generated in a suction side pockets is very small, it is considered that the heat generated by gas compression is carried adiabatically to around the shaft and then conducted to the orbiting scroll and the fixed scrolls. The temperature of the orbiting scroll rises higher than that of the fixed scrolls because the fixed scrolls are cooled more easily than the orbiting scroll. Then, we obtain the clearance change under the obtained temperature distribution and predict the ultimate pressure of the pump having the changed clearance. The predicted ultimate pressure agrees pretty well with the measured one throughout the experimented range of orbiting speed for all tested gases (nitrogen, argon and helium).

VT-WeP3 Novel Calibration Apparatus for Precise Barometer and Vacuum Gauge, ***S.Y. Woo,*** Korea Research Institute of Standards and Science, Korea*; S.H. Kang, I.M. Choi, Y.J. Lee,* Korea Research Institute of Standards and Science

In order to calibrate accurate absolute pressure gauges such as barometer and vacuum gauge, laser or ultrasonic mercury manometers have been used. However, complexity, harmfulness of mercury vapor, and cost of mercury manometers made it difficult to use in most calibration laboratories. As a substitute, a gas-operated pressure balance is used for calibration of such gauges. However, commercially available pressure balances cannot be suitable because consequent exposure of the piston and masses to the atmosphere raises the problem of contamination and the ingress of dust particles to the gap between the piston and cylinder. Moreover a lot of time is being spent in changing the mass combinations on the piston and breaking the vacuum each time when a different pressure point is required. To overcome these difficulties, we manufactured a novel weight-loading device for changing the masses in situ without breaking the vacuum. This device made it possible to add or remove weights easily in vacuum, thereby greatly reducing the time between measurements. Using this device, we could easily calibrate precise quartz resonance barometers from 940 hPa to 1050 hPa. Moreover we also found that with new calibration technique this device could be used very efficiently for the calibration of vacuum gauge in the range of 100 hPa full scale. In this paper, practical calibration results are presented for a precise barometer (Paroscientific, Model 760-16B) and a vacuum gauge (MKS, CDG 100 Torr).

VT-WeP4 Photon Stimulated Desorption Study for a NEG-Coated Insertion Device Vacuum Chamber for TLS, ***G.-Y. Hsiung,*** *J.-C. Lee,* National Synchrotron Radiation Research Center, Taiwan*; J.-R. Chen,* National Synchrotron Radiation Research Center and NTHU, Taiwan

An aluminum alloy vacuum chamber, 4.6 m in length, for a narrow gap insertion device at Taiwan Light Source (TLS) is coated with the Zr-Ti-V Non-Evaporable Getter (NEG) film on the inner surface. The chamber, after NEG-coating, was installed in the 19B(PSD) beam line at TLS for synchrotron radiation exposure measurement. The yield of photon stimulated desorption (PSD), measured by the throughput method, illustrates a lower value but slowly decayed curve at the earlier exposure beam dose. The desorbed gas species, measured by a quadrupole mass spectrometer, contain the CH@sub 4@, H@sub 2@, CO, CO@sub 2@, as well as Ar. The behavior of pumping and desorption from the NEG coated surface will be discussed.

VT-WeP5 The Effect of Environmental Humidity on Thermal Outgassing Rate, ***C.-K. Chan,*** *Y.-C. Ou, G.-Y. Hsiung, J.-R. Chen,* National Synchrotron Radiation Research Center, Taiwan

This work investigates how humidity of environment affects thermal outgassing rate of an A6063 aluminum alloy chamber. The throughput method was used to measure the thermal outgassing rate of a test chamber exposed to the air with different moistures. The aluminum chamber was then exposed to dehumidified-air under an airshower located at downstream of an oilless compressor. Experimental results indicate that by controlling the humidity around the chamber adequately, the thermal outgassing rate achieved without baking is comparable to that after in-situ bakeout.

VT-WeP6 Vacuum Pump Oil Tests at the National Synchrotron Light Source to Minimize Oil Waste@footnote 1@, ***C.L. Foerster,*** *J.-P. Hu, E. Haas,* Brookhaven National Laboratory

In order to reduce the large amount of oil waste produced during normal operation of the National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory (BNL), an oil-testing project was established to determine if synthetic vacuum pump oil could be used effectively with longer oil change intervals. Due to the large number of oil-sealed rotary vane pumps that are used at the NSLS, a longer oil change interval would reduce maintenance costs as well as oil waste. Initially, two basic types of vacuum pump oils, mineral and synthetic, were selected for direct comparison. Three of the same size two-stage mechanical pumps were set up to run simultaneously with the same gas load. ConvectronR gauges, cold cathode gauges, and isolation valves were connected to a central vacuum chamber having a common inlet pressure control and a sampling valve for residual gas analysis. To simulate oil degradation produced by long-term mechanical pump operation, the system air load was manually controlled with an air bleed valve on the common vacuum chamber and was periodically adjusted to run at 500 mTorr. This easily tolerated pressure range for mechanical pumps was suggested by oil suppliers to expedite the oil viscosity change, acid buildup, and pump-wear debris production. Major advantages are that the testing time will be much quicker and that any back streaming of oil is minimized at this operating pressure. The detailed test data for the resulting oil properties, oil degradation, visual comparison, vacuum conditions, and pump characteristics will be presented for comparison of the pump oils used at NSLS and for estimation of the resulting oil waste reduction.@footnote 1@ Work performed under the auspices of the U.S. Department of Energy, under contract DE-AC02-98CH10886.

VT-WeP7 Plasma Sensors for Control of PVD Processes for Nanostructured Me-C:H Coatings@footnote 1@, ***C.C. Klepper,*** *E.P. Carlson, R.C. Hazelton, E.J. Yadlowsky,* HY-Tech Research Corporation*; M.A. Taher, B. Feng,* Caterpillar, Inc.*; B. Shi, W.J. Meng,* Louisiana State University

To improve the reproducibility of metal-containing amorphous hydrogenated carbon (Me-C:H) coatings deposited by physical vapor deposition (PVD) techniques such as reactive sputtering, various plasma probes are of interest as in-situ sensors integrated with a closed-loop deposition control system.@footnote 2,3@ In a series of Design-of-Experiment (DoE) test runs on an unbalanced magnetron sputtering setup, various plasma probes were tested for their sensitivity to process input factors and as candidates for a feed-back control system. These include

optical emission and absorption spectroscopy of metal atoms, conventional and electron emissive Langmuir probes (LP), and hydrogen atomic line emission (H@alpha@). Of particular interest are combinations of the outputs of these probes. For example, the H@alpha@, divided by the product of the electron density from the LP and the hydrogen partial pressure from a residual gas analyzer (RGA), can be used as a measure of the excitation temperature of the plasma. This factor scales differently from the electron temperature from the LP, which is representative of the cold component that dominates the electron energy distribution function in low-T plasmas. The plasma potential measured from the LP is also of interest, since it, together with the applied substrate bias, determines the energy of ionic species bombarding the substrate. This measurement is primarily sensitive to plasma composition, especially in the reactive phase. Details and interpretation of these dependences, as well as their importance in the design of the closed-loop control system, will be presented. @FootnoteText@@footnote 1@ Partial support for this project came from NIST ATP 70NANBH0H3048 through a subcontract with Caterpillar Inc.@footnote 2@ M. A. Taher, et al., contributed talk in this conference. @footnote 3@ B. Shi, W. J. Meng, Journal of Applied Physics, in press (2003).

VT-WeP10 Adsorption Force Control with Surface Roughness Modification for Smooth Sliding in a Vacuum, ***A. Kasahara***, *M. Goto, T. Oishi, M. Tosa,* National Institute for Materials Science, Japan

Vacuum friction measurement system based on Bowden-Leben type system has been successfully developed that can evaluate sliding friction force under changing load from 1.96N to 0.98mN and under changing atmospheric pressure from 1E+5 Pa to 1E-8 Pa. Friction measurement was carried out on typical vacuum materials as type 304 austenitic stainless steel sheets after such surface treatments as chemical polishing or electrochemical buffing. We have shown that the materials with surface roughness around 100nm can offer as smooth sliding in a vacuum as at an atmospheric pressure. This smooth sliding may arise from absorption gas as lubricant kept in hollows of surface nanoscopic asperities. We accordingly tried to estimate absorption force by decrease in sliding load with the friction measurement system to study the effect of surface roughness on adsorption force and the contribution to smooth sliding in a vacuum. We found existence of absorption force about 20mN on a sample with surface roughness about less than 600nm, at an atmospheric pressure. The sample with the surface roughness under 40nm also showed adsorption force below 0.98mN in a vacuum, while sample with the surface roughness around 100nm showed higher adsorption force over 0.98mN even in a vacuum. The surface roughness can also slow desorption rate of absorption gas layer and keep friction small in a vacuum. It is therefore concluded that the surface with 100nm roughness exhibiting similarly low friction in a vacuum as at an atmospheric pressure is ideal modified surface for trapping adsorbed gases strongly to act as vacuum lubricant. The surface roughness about 100nm will be a good candidate surface for smooth movement in a vacuum.

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