Vacuum Technology Division
Room Hall A - Session VT-MoP

Vacuum Technology Poster Session

VT-MoP1 Behavior of the Negative Collector Current in Ionization Vacuum Gauges, ***K. Kokubun***, *M. Hirata,* Electrotechnical Laboratory, Japan

In or near XHV pressure region, negative collector currents have been observed in the Extractor vacuum gauges that several times experienced a baking at 573 K for about 70 hours.@footnote 1@ It was found that the negative collector current continued to flow even when the gauge was not in operation. Authors confirmed that in these gauges a negative electromotive force of - 1 V to - 100 mV was formed in the system including the collector electrode and the gauge body, and simultaneously the insulation of the collector electrode degraded due to unknown causes. These results suggested that some new structure was formed in the gauge head system by the bakings. This conjecture was supported by measuring the temperature dependences of the negative collector current, the negative e.m.f., and the insulation resistance. These temperature dependences were remarkably different from those of a normal gauge. Especially, the insulation resistance drastically increased to about 330 K, and then abruptly decreased. This behavior was in strong contrast to that of the normal gauge. On the other hand, in the normal gauge a significantly larger positive e.m.f. was observed. But it was found that only a small positive current flowed because of the very large insulation resistance of the collector electrode. @FootnoteText@ @footnote 1@K.Kokubun and M.Hirata, J. Vac. Soc. Jpn, 40, 137(1997).

VT-MoP2 Compatibility of a Control Unit and a Sensing Coil Unit with a Rotor Ball of a Spinning Rotor Gauge, ***M. Hirata***, Electrotechnical Laboratory, Japan

A spinning rotor gauge is one of the most reliable vacuum gauge. The gauge is a noble viscosity gauge which is essential to a transfer gauge and a reference gauge in high vacuum. The gauge consists of a control unit, a sensing coil unit and a rotor ball installed in a tube. The rotor is operated frequently in a different pairing of the control unit and the sensing coil unit for convenience of transportation and use. In order to clarify the interchangeability of the electronic unit and the sensing coil unit with the rotor ball, accommodation coefficient of the rotor ball in the different pairing was measured preciously by a direct comparison with a reference spinning rotor gauge. Pressure measurements by the two gauges was simultaneously done by using a personal computer. While repeatability within 0.1% was obtained in the measurement of the relative accommodation coefficient, the rotor showed a slightly high value, 0.5%, in the coefficient in special pairings. Consideration of the experimental results in detail showed that one of seven coil units gave slightly high value in the coefficient. The coefficient did not depend on the control unit. Big tilt of the sensing coil units, about 15@degree@ from the normal vertical axis, also gave a slightly high value in the coefficient. Remagnetization changed the value of the coefficient occasionally. It seems that the coefficient depends on the mode of the rotation of the ball. A fixed pairing of the rotor with the sensing unit is preferable for a reliable pressure measurement by the gauge.

VT-MoP3 A New High-Power Ion Source Based on Magnetically Neutral Loop Discharge, ***F. Shimokawa***, NTT Opto-electronics Laboratories, Japan

We developed a new high-power ion source based on the high-density plasma formation method that is known magnetically neutral loop discharge (NLD). Our original ion source consists of three separate electromagnetic coils, as well as ion extracting grids and a quartz vessel chamber with a one-turn RF antenna coil, which is the main component of the conventional RF ion source. The three separate electromagnetic coils are located around the periphery of the chamber. The current in the middle coil flows in the opposite direction of the currents in the top and bottom coils. By using these source configurations, a magnetically enhanced plasma that is known as NLD occurs in the chamber. Our source produces a high plasma density of 10@super 11@ cm@super -3@, which is 10 times higher than that of the conventional source under a lower gas pressure of 0.1 Pa. Also, it is possible to control both the ring-like plasma diameter and the high-density plasma generation position in the chamber. As a result, we achieved the high ion current density (10 mA/cm@super 2@) at 300 V of ion extracting voltage, which is almost 10 times higher than the conventional source. Furthermore, we also obtained a high ion current uniformity of about 3% over a 6-inch diameter by using our source's plasma space controllability. A processing system that uses this new source will contribute to faster processing, excellent uniformity processing, and high quality processing for ion beam etching, ion beam deposition, and ion beam sputter deposition. Many other applications are also expected to come about from this method.

VT-MoP4 Stabilization of Long Travel - Single Bellows - Horizontal Manipulators, ***V.S. Smentkowski***, *A.L. Linsebigler,* General Electric Corporate Research and Development Center

Single bellows, long travel, horizontal manipulators are required for many experiments in surface science. Unfortunately, the gravitational force exerted on long travel - single bellows - horizontal manipulators results in stability problems including, but not limited to unwanted sample vibrations and non-reproducible sample positioning. We have designed, built, and tested a simple add on device that efficiently alleviates such problems. The device that will be described can be used with any manipulator, regardless of age. The cost to implement this device (machining and parts) is minimal.

VT-MoP5 Pressure Wave Propagation by Gas Expansion in a High Vacuum Tube, ***T. Takiya***, Hitachi Zosen Corporation, Japan*; F. Higashino,* Tokyo Noko University, Japan*; Y. Terada, A. Komura,* Hitachi Zosen Corporation, Japan

This paper describes an unsteady tube flow model which accounts for the effect of contracted flow around the entrance orifice of a tube. The sudden expansion of gas introduced into a vacuum tube is an important phenomenon, which has to be studied in relation to leakage accidents of vacuum devices. In order to predict the pressure wave propagation speed, it is necessary to model the gas expansion in a vacuum tube. So we proposed an analytical model for gas expansion in a high vacuum tube, with the aim of preventing vacuum hazards at scientific experimental facilities. Setting a very high pressure drop between the outside and inside of the vacuum tube makes the model applicable to high vacuums, although the model is based on continuous fluid dynamics. We installed an orifice on the inlet end of the tube in the model, and investigated the orifice aperture effect on the propagation velocity of pressure waves. It was found that a rarefaction wave rather than a shock wave was primarily involved in vacuum accident damage, and that orifice aperture controls pressure increase rate in the low pressure regime more sensitively than in the high vacuum regime. This study was carried out to provide necessary data in designing vacuum protection for long tube-like devices, such as the beamline for synchrotron radiation, by solving the set of basic equations that incorporates important conditions.

VT-MoP6 Measurement of Secondary Electron Yields of Copper Materials and the Surface Analysis, ***S. Kato***, *K. Kanazawa,* KEK, Japan*; N. Kitano, N. Matsuda,* Tokyo Denki University, Japan

Photoelectron instability is one of serious problems in a positron storage ring of colliding accelerators such as PEP-II and KEKB where a current of a couple of amps is stored. It occurs in a manner that the positron beam interferes with an enormous amount of secondary electrons emitted from surfaces of vacuum pipes bombarded by a large amount of photoelectrons due to synchrotron radiation. This instability considerably disturbs beam operation. In this study, secondary electron yields from copper materials where some surface treatment techniques were performed were measured to make a comparison with other materials. Target samples were prepared by three different chemical polishing techniques using a) a water solution of sulfuric acid and hydrogen peroxide, b) a water solution of citric acid and c) a) and subsequent b). These samples were treated in the same condition as the extruded copper chambers for KEKB electron-positron collider. The secondary electron yields were measured at a typical condition of a kinetic energy ranging from 0.1 keV to 2.0 keV at a normal incident and a sample temperature of 23 ° C. The residual gas pressure of the sample chamber was less than 2x10@super -7@ Pa during the measurements. In order to avoid electron beam induced contamination at the sample surface from the residual gas even so, a total dose of electrons for a measurement was limited to be 1x10@super 12@ electrons/cm@super 2@ by use of a pulsed beam. Characterization of those surfaces was also done by Auger electron spectroscopy with argon ion sputter etching. This gives information about depth profiles of atomic compositions in an altered surface layer due to the treatment discussing the interrelation between the secondary electron yields and the surface atomic compositions. The lowest maximum yield of secondary electrons of 1.05 was observed at the surface treated as (a) where the oxidized layer was found to be the most stable against a long exposure to air in contrast to the surface treated as (b).

VT-MoP7 Study of Field Emission Properties of GaN grown by ECR MBE, ***I.E. Berishev**, O. Kameli, D. Starikov, A. Bensaoula, I. Rusakova,* University of Houston*; V.P. Ageev, M.V. Ugarov, A. Korabutov,* General Physics Institute, Russia

GaN thin films were grown by electron cyclotron resonance (ECR) molecular beam epitaxy (MBE) on Si (111) wafers. X-ray diffraction and both scanning and transmission electron microscopy were used to characterize the thin films in order to determine their crystal structure and surface morphology. The films consisted from clearly defined columns about 100 nm in diameter. Despite the large defect density, a strong room temperature photoluminescence signal was observed from these samples. The origin of this luminescence and its role on field emission will be discussed. The surface of the films exhibited random array of sharp tips at the microscopic level with about 5x109 tips/cm2 density. The field emission characteristics, voltage threshold and emission current, of these thin films were order of magnitude higher than any published data. The dependence of the emission characteristics on the doping level, substrate orientation, film thickness, and post-growth surface modification were investigated. Potential GaN/Si-based field emission devices will be discussed and preliminary results will be presented.

VT-MoP8 Outgassing Tests on Materials Used in the DIII-D Tokamak@footnote 1@, ***K. Holtrop**, M. Hansink, A.G. Kellman,* General Atomics

In order to achieve high performance plasma discharges in the DIII-D tokamak, impurity levels must be carefully controlled. Since first wall materials can desorb volatile impurities during these discharges, it is important to characterize and control the outgassing of these materials. An outgassing chamber was built to measure the outgassing properties of various materials used in the DIII-D vessel. The results of pump-down tests performed on ATJ graphite, thin grafoil gaskets, and MGO coaxial cables will be presented. In addition, to pumpdown tests it was desired to study the behavior of the materials at temperatures up to 400°C, which is the maximum temperature to which the DIII-D vessel is baked. The station was modified to include independent heating control of the sample and a simple load-lock chamber. @FootnoteText@ @footnote 1@Work supported by the U.S. Department of Energy under Contract No. DE-AC03-89ER51114.

VT-MoP9 Simple Catalytic Cell for Restoring He Leak Detector Sensitivity on Vacuum Systems with High D@sub 2@ Backgrounds*, ***J. Busath**, H.K. Chiu,* General Atomics

The DIII-D National Fusion Facility at General Atomics focuses on plasma physics and fusion energy science. The DIII-D tokamak is a 35 M@super 3@ toroidal vacuum vessel with over 200 ports for diagnostic instrumentation, cryogenics, microwave heating, and four large neutral beam injectors. Maintaining vacuum in the 10@super -8@ Torr range is crucial for producing high performance plasma discharges. He leak checking the DIII-D tokamak and the neutral beamlines has historically been difficult. D@sub 2@ is used as the fill gas in most plasma discharges. After plasma operations, D@sub 2@ out-gassing from the torus walls and internal beamline components can exceed 10@super -4@ Torr l/s. The mass of D@sub 2@ molecule (4.028 amu) is indistinguishable from that of the He atom (4.003 amu) to a standard mass spectrometer leak detector. High levels of D@sub 2@ reduce leak detector sensitivity and effectively mask the He trace gas signal rendering normal leak checking techniques ineffective. A simple apparatus was developed at GA to address these problems. It consists of a palladium based catalyst cell and associated valves and piping placed in series with the leak detector. This reduces the D@sub 2@ throughput by a factor greater than 10,000, restoring leak detector sensitivity. This paper will briefly discuss the development of the cell, the physical processes involved, the tests performed to quantify and optimize the processes, and the operational results at DIII-D. @FootnoteText@ *Work supported by the U.S. Department of Energy under Contract No. DE-AC03-89ER51114.

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