Wednesday Morning, November 15, 2006

Vacuum Technology
Room 2000a - Session VT+AS-WeM

Outgassing, Materials Coatings for Reduction of Outgassing

Moderator: L. Westerberg, Uppsala University, Sweden

10:40am **VT+AS-WeM9 Outgassing of Construction Materials for Vacuum Chambers and Coatings for Reduction of Outgassing***, J. Setina,* Institute of Metals and Technology, Slovenia **INVITED**

In vacuum systems we have to deal with continuous gas desorption from the chamber walls and inflow from the technological process. Working pressure in a vacuum system is a counterbalance of total gas flow rate and available pumping speed. Vacuum technological processes are very diverse and span more than 15 decades of pressure: from coarse vacuum to extremely high vacuum (XHV). To properly design a vacuum chamber, the vacuum engineer needs, reliable data on outgassing of constructional materials for the working conditions. Extensive data can be found in the literature, but there is considerable scatter in the data due to differences in sample quality, preparation technique, cleaning procedure and measurement method. Different methods for measuring outgassing will be discussed. Vacuum gauges can also influence the result as they can outgass, pump or significantly change the gas composition by promoting chemical reactions on hot filaments. Therefore, the measurement setup has to be considered and evaluated carefully to determine the uncertainty of the results. In ultrahigh vacuum (UHV) systems the dominant gas is hydrogen that is dissolved in the material used in its construction and continuously diffuses towards the chamber walls and desorbs into the vacuum. To achieve UHV, outgassing has to be reduced to the lowest practical values. Established methods are pre-treatment of materials (vacuum firing, air bake) and in-situ baking of the vacuum chamber. For XHV systems, such treatments are often not sufficient and passive barrier coatings to reduce gas diffusion have been reported in the literature. Published results for coatings on stainless steel or aluminum such as TiN, BN and SiO2 are not consistent. Hydrogen suppression depends on film thickness and density and also on pre-treatment of the coating substrate. These conditions were not the same in the published works and important experimental details are often missing.

11:20am **VT+AS-WeM11 Reducing SS 304/316 Hydrogen Outgas to 2E-15 torr liter/cm@super 2@ s***, Y.T. Sasaki,* Quantum Mechanics Corp.

Significant reduction in the outgassing rate of 300-series stainless steel is routinely attained through combination of electropolishing and vacuum baking. Preferential removal of Ni, Fe, and Mn from the surface of stainless steel by electropolishing creates virtual chromium coating without trapping impurities under the surface. It also reduces the atomic surface area by more than an order of magnitude. When the material is vacuum-fired to remove interstitial hydrogen, the resultant stainless steel exhibits an outgas rate of ca. 2E-15 torr liter/cm@super 2@ s, as well as drastically reduced adsorption, absorption and catalytic behaviors.

11:40am **VT+AS-WeM12 Summary of the 45th IUVSTA Workshop on NEG Coatings for Particle Accelerators and Vacuum Systems****, H.C. Hseuh,*** Brookhaven National Laboratory*; K.J. Middleman, O.B. Malyshev,* CCLRC Daresbury Laboratory, UK*; P. Manini,* SAES Getters S.p.A., Italy

The 45th IUVSTA Workshop on NEG coatings for Particle Accelerators and Vacuum Systems was organized by the Accelerator Science and Technology Center (CCLRC Daresbury Laboratory, UK) and the Italian Vacuum Association. This workshop was held in Catania, Italy from April 5-8, 2006. The TiZrV NEG coating was introduced as a new technology for vacuum applications at the end of 1990s. The interest to this new technology has grown over the past 6 years since the first NEG coated vacuum chamber was installed at the ESRF (France). With conventional vacuum technology, an outgassing surface and a pump (lumped or distributed) are two different elements of a vacuum system. In comparison to this new NEG technology most surfaces of the vacuum chamber are coated with a TiZrV alloy which after activation desorbs much less than conventional materials such as stainless steel, copper and aluminium. The NEG coating also has pumping properties which results in a much low residual gas pressure. Due to a need for exchanging information between different research groups involved in the accelerator community as well as UHV pump manufacturers a dedicated workshop was set up to discuss NEG coatings. This paper summarises the main topics and discussions from the NEG workshop, those being, materials alternatives to TiZrV, production of the coating, characterisation (material science, electronic, photo-electronic and vacuum properties), problems associated with the study of NEG coatings and a final discussion on what further studies are needed for a successful vacuum system design. @FootnoteText@ Presenting author email address: hseuh@bnl.gov *Work performed under the auspicious of U.S. Department of Energy for the presenting author; and the corresponding funding agencies for co-authors.

12:00pm **VT+AS-WeM13 Delicacy in the Activation and Measurement of Non-Evaporable Getter (NEG) Films***, **K.J. Middleman**, O.B. Malyshev,* CCLRC Daresbury Laboratory, UK*; R. Valizadeh,* Manchester Metropolitan University, UK

In recent years a new innovation to improve the performance of the "vacuum vessel" has been the development of a vacuum chamber with a Non-Evaporable Getter (NEG) coating magnetron sputtered onto the inner walls.@footnote 1-3@ This technique was intensively developed at CERN and is now widely used in a number of electron accelerators@footnote 4@ for narrow gap insertion device vessels where conductance limitations restrict the pumping speed available and cause a pressure rise resulting in increased gas brehmstralung. This new technique is still in its infancy and there are a number of issues which are still not yet fully understood. A number of unanswered questions remain for accelerators with regard to NEG coatings including how they can be optimised to exhibit low photon, electron and ion stimulated desorption yields and reduce secondary electron emission. The benefits of NEG coated vacuum chambers for accelerator vacuum systems led to a fundamental study of NEG coating research in the UK between ASTeC and MMU. This paper looks at the delicacy of producing NEG coated chambers and how the method of activation and regeneration of such coatings can have a significant impact on the end result. Identical NEG films were sputtered onto both planar and tubular samples with significant differences observed between the two in terms of both pumping capacity and sticking coefficients. Critical issues such as the ratio of NEG coated to uncoated surface will also be presented. @FootnoteText@ @footnote 1@C. Benvenuti, J.P. Bojon, P. Chiggiato and G. Losch, Vacuum, 44, 507 (1993)@footnote 2@ C. Benvenuti and F. Francia, J. Vac. Sci. Technol. A 6 (4), 2528 (1988)@footnote 3@ C. Benvenuti and F. Francia, J. Vac. Sci. Technol. A 8 (5), 3864 (1990@footnote 4@ R.Kersevan. "Performance of a narrow-gap, NEG-coated, extruded aluminium vacuum chamber at the ESRF." Proc. of EPAC-2000, Vienna, Austia, p. 2291.

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