Vacuum Technology
Room 2000 - Session VT-WeM

Electron, Photon and Ion-beam Induced Desorption and Their Effects on the Dynamics of Accelerators

Moderator: L. Westerberg, Uppsala University, Sweden

8:00am **VT-WeM1 New Understanding of Ion-Beam Induced Gas Desorption*, *A.W. Molvik,*** *M. Kireeff Covo,* Lawrence Livermore National Laboratory*; F.M. Bieniosek, P.A. Seidl,* Lawrence Berkeley National Laboratory **INVITED**

Heavy-ion accelerator rings are frequently limited by gas-pressure rise, whereas proton rings are generally limited by electron clouds. We have shown that the desorption caused by high-energy ions is driven by the electronic component of ion slowing in matter, known as electronic sputtering to distinguish it from conventional or physical sputtering that is driven by nuclear scattering of ions in matter. A large body of literature exists on electronic sputtering, but does not include sputtering from metals that are clean except for one to a few monolayers of gas. We measured desorption by 70-1000 KeV potassium ions, for which the dominant ion energy loss transitions from nuclear stopping at 70 keV to electronic stopping above 250 keV. We found that gas desorption scaled with the electronic component, (dE/dx)@super n@ where 1<n<2 power. Gas desorption by electronic sputtering is closely related to electron emission from ion impact, a process that scales linearly with dE/dx, but desorption can be two orders of magnitude greater. Desorption from nominally clean stainless steel scales slowly with the ion angle of incidence, unlike other electronic-sputtering studies for which desorption scales linearly or faster with 1/cos(@theta@). Mitigation measures vary with ion energy: roughened surfaces significantly reduce desorption by low energy ions, but increase it for grazing-incidence energetic ions whose range encompasses multiple hills. @FootnoteText@ *This work performed under the auspices of the U.S. DOE by Univ. of California, Lawrence Livermore and Lawrence Berkeley National Laboratories under contracts No. W-7405-Eng-48 and DE-AC02-05CH11231.

8:40am **VT-WeM3 Ion-Induced Desorption Yields for U@super 73+@ and Ar@super 10+@ Ions at 15-100 MeV/u***, H. Kollmus, M. Bender, M.C. Bellachioma,* GSI, Germany*; E. Mahner,* CERN, Switzerland*; A. Kraemer,* GSI, Germany*; L. Westerberg,* ***E. Hedlund,*** Uppsala University, Sweden*; O.B. Malyshev,* CCLRC Daresbury Laboratory, UK*; H. Reich-Sprenger,* GSI, Germany

During operation of the heavy ion accelerators at CERN, GSI and BNL large pressure rises, up to several orders of magnitude, due to ion beam-loss induced desorption have been observed. In order to get a better understanding of these phenomena at intermediate energies we have measured desorption yields, @eta@, (released molecules per incident ion) for 15, 40 and 100 MeV/u U@super 73+@ beam on samples of 316LN stainless steel, 6028 aluminum and OFE copper. In a second experiment we used 40, 80 and 100 MeV/u Ar@super 10+@ beam on a 316LN stainless steel sample. The experiment was done in a UHV setup at GSI in Darmstadt, Germany. From the desorption yields, calculated from the measured pressure rises, as a function of energy loss, dE/dx, we deduced power laws in the order n=2-4. This is compared with theoretical power-law models for sputtering.

9:00am **VT-WeM4 Electron and Ion Desorption Studies at RHIC***, **S.Y. Zhang**, H.C. Hseuh, P. Thieberger,* Brookhaven National Laboratory

The electron cloud, beam induced pressure rise and experimental background are limiting factors of RHIC heavy ion and polarized proton luminosities. Electron and ion desorptions with the normal and shallow angle incidents are relevant in machine improvement. In this talk, the effects of electron and ion desorptions on steel, NEG and saturated NEG surface in machine operation, beam study, and test stand will be reported.

9:20am **VT-WeM5 Ion-Induced Gas Desorption Modeling in High Vacuum Systems*, *M. Kireeff Covo,*** UCB and LLNL*; A.W. Molvik, A. Friedman,* LLNL*; J.-L. Vay, F.M. Bieniosek, D. Baca, P.A. Seidl,* LBNL*; J. Vujic,* UCB

Ion beam interaction with walls desorbs gas and electrons. The gas can move to the beam path and be ionized. In a positively-charged particle beam the produced ions are expelled by the space-charge beam potential and the electrons are trapped inside a potential well. This ubiquitous effect grows at higher fill factors (ratio of the beam to the tube radius) and degrades the quality of the beam. In order to simulate it, we measured the gas desorption yield of stainless steel using the Gas-Electron Source Diagnostic in two distinct high vacuum facilities (High Current Experiment at LBNL and the 500 kV Ion Source Test Stand at LLNL). The desorption process is result from the interaction of the surface gas layer with ion-induced electrons. The experimental results will be discussed and compared with a theoretical model. @FootnoteText@ *This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48, and by Lawrence Berkeley National Laboratory under Contract DE-AC03-76F00098.

9:40am **VT-WeM6 Photon Stimulated Desorption from Aluminum and Electroplated Copper Chambers***, **J. Gómez-Goñi,*** Universidad Politécnica de Madrid, Spain

Photon stimulated desorption (PSD) from aluminum and copper electroplated vacuum chambers have been obtained using synchrotron radiation of critical energies ranging from 12.4 to 280 eV. We first compared different cleaning methods on electroplated copper, including bakeout, pre bakeout (bakeout in situ, venting and pumping) and glow discharge with argon and 10% oxygen. As expected, in situ bakeout gave the best results, followed by glow discharge, which was quite effective removing desorbed gases. After this experiment, we compared two chambers manufactured with different copper electroplating methods measuring initial yields differing by factors between 1 and 3. During dose accumulation, the cleaning effect was more clearly seen in one of them, especially for hydrogen. Initial desorption yields were also measured for an aluminum chamber, before and after bakeout. We obtained that initial yields were almost linear with critical energy in this range. The difference between baked and unbaked aluminum was mainly due to water yield which was greatly reduced after bakeout. For aluminum we obtained that photoelectron production yield was linear with critical energy and specific pressure rise was also linear with photoelectron yield. Combining both facts we obtained that photoelectron stimulated yields were independent of critical energy for both baked and unbaked aluminum. This relation suggested a process where photoelectrons are responsible for the desorption of molecules.

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