



Plasma Source Ion Implantation of High Voltage Electrodes

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Abstract

Field emission and breakdown characteristics of high voltage, large-area electrodes determine the performance of many vacuum-based electron sources. A collaborative plan with the Thomas Jefferson National Accelerator Facility involves studying the behavior of such electrodes after nitrogen ion implantation. A Plasma Source Ion Implantation (PSII) facility is designed and constructed at William and Mary and is used to treat stainless steel electrodes. PSII is a novel implantation technique developed at the University of Wisconsin-Madison.

A workpiece is submerged in a quiescent plasma of the species to be implanted. A series of high, negative voltages (30-100 kV) is applied to the workpiece to accelerate the ions in the plasma, implanting them to depths of several hundred Angstroms. To characterize the response of the modified electrodes to high field gradients, fields as high as 20 MV/m are applied between parallel electrodes in a VG ESCALab MKII surface analysis system. XPS, AES and SEM are used to characterize the surface of the cathodes. The pre-breakdown current from implanted electrodes is compared to that of thin film-coated, polished, electron beam-treated, and untreated electrodes. Current models to explain anomalous field emission are reviewed and considered as explanation of observed effects.