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Characterization of surface damage on a polished stainless electrode biased to 500 kV DC in SF6 and to 259 kV DC in vacuum

Localized surface damage sites developed on a polished stainless steel cathode after applying 500 kV DC in SF6, followed by 259 kV DC in vacuum. Polished stainless electrodes are commonly used in high voltage photo-emission electron guns for accelerator applications. Achieving field-emission-free operation at bias voltages 200-400 kV DC requires biasing the electrodes ˜ 100 kV higher than the target operational voltage to process field emitters. The electrode was affixed to the narrow, sealed end of a custom conical vacuum feedthrough made from partially conductive alumina. This assembly was mounted in a cylindrical stainless steel chamber with the open end of the feedthrough connected to a sulfur hexafluoride (SF6) gas-insulated Cockcroft-Walton power supply by means of a commercial cable, commonly used in the X-Ray tube industry. Colored spots with diameter ranging from 1 to 5 cm, as well as black 0.1 cm diameter spots were found in the test chamber inner walls upon removing the electrode-feedthrough assembly. Such damage has never been encountered in any of the electron gun vacuum chambers at Jefferson Lab. This contribution describes optical imaging, profilometry and chemical composition results from surface damage sites on a polished stainless steel cathode biased to 500 kV in SF6 and to 259 kV in vacuum.

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