**Inverted Geometry Ceramic Insulators in High Voltage DC Electron Guns for Accelerators**

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A photo-emission electron gun (photogun) operating at 130 kV direct current (dc) is utilized at the Jefferson Lab (JLab) Continuous Electron Beam Accelerator Facility to generate a continuous wave beam of spin-polarized electrons for high-energy nuclear physics experiments. Over the past decade, JLab has tested and implemented ceramic insulators in inverted-geometry guns, connecting commercial high voltage cables to electrodes in vacuum with the the following four criteria: a) applying sufficiently high voltage to reduce space charge forces in the electron bunch, b) achieving ultra-high vacuum conditions to preserve the photocathode quantum efficiency, c) providing field-emission-free operation, to prevent gas load produced when field emitted electrons impact the vacuum chamber, and d) eliminating high voltage breakdown (arcing), for reliable operation. This contribution reports on the development of a reliable insulator-cable connector for applying 500 kV dc to a future polarized beam photogun operating at 350kV without field emission. For every test, a highly polished stainless steel spherical electrode was mounted to the narrow end of a conical-shape ceramic insulator that extended into the vacuum chamber, serving as the cathode support structure. The cathode was biased using a 500 kV dc Cockcroft-Walton power supply inside a sulfur hexafluoride tank connected with a commercial high voltage cable to the conical insulator’s open end. Voltage was applied incrementally, while monitoring power supply current, vacuum pressure, and field emission levels using Geiger-Muller X-ray detectors. The assembly was modeled in Solidworks and exported to CST EM suite for electrostatic simulations. Two pure alumina inverted insulators 0.2 m long suffered breakdown at ~300 kV dc. A third insulator with a triple-point junction shielding the cathode reached 375 kV, and a shorter doped alumina inverted insulator reached 360 kV, both without breakdown. These observations are in line with existing results on the use of shielding electrodes and bulk-doped insulators that allow charge drainage. Implementing the use of inverted geometry insulators, high voltage conditioning with Kr gas, and mirror-finish electrodes has been essential to the success of the JLab polarized photogun providing >98% beam uptime, but higher voltage photoguns for the Electron Ion Collider and the proposed International Linear Collider require large, custom-made, inverted-geometry insulators and the remaining issues with field emission must be resolved.

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