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Gas conditioning of DC high voltage photoguns using krypton

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Obtaining field-emission-free operation of a DC high voltage photo-electron gun (photogun) can be challenging, particularly at bias voltages > 200 kV. Polarized electron beams employ delicate GaAs-based photocathodes. Any level of field emission from the photogun cathode electrode can degrade the vacuum inside the photogun leading to a rapid decrease in photocathode quantum efficiency. High voltage gas conditioning using noble gasses has become a common technique to successfully eliminate field emission and thereby prolong the operating lifetime of the photocathode. In the presence of field emission, the gas introduced into the photogun vacuum chamber becomes ionized. The ions are then accelerated towards the negatively biased cathode electrode, sputtering away the field emitter and becoming implanted which serves to increase the work function. Noble gasses are used because they are not pumped by the non-evaporable getter pumps inside the photogun: after the flow of noble gas has been halted, the photogun vacuum quickly recovers. Initial attempts to 'gas condition'electrodes employed helium. This contribution describes Jefferson Lab's experience with krypton gas conditioning of high-voltage dc photoguns and its effect on voltage-induced gas desorption. In addition, the technical challenge of needing voltage headroom to eliminate field emission will be discussed. For example, successful field emission free operation of the DC high voltage photogun operating at 200 kV might require gas conditioning at voltage up to 300 kV and this can lead to insulator electrostatic failure.

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