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Impedance Characteristics and Sputtering Behaviour of Two Pulsed DC Arc Discharge H- Sources

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Caesiated surface plasma sources are commonly used for high current H- production. These are pulsed DC arc discharge sources with varying geometries. The DC arc discharge is typically current-controlled, i.e. the discharge voltage is a free parameter adjusting over time and within the pulse. The longevity and performance of ion sources are critical factors in particle accelerators, especially for applications requiring high-intensity beams. One failure mechanism of these ion sources is electrode deformation by sputtering. The development of sputtering models that account for the physical interactions between ionized particles and material surfaces can help in the understanding and optimisation of ion source lifetimes. This paper presents a sputtering model developed for the pulsed DC discharges and investigates its potential utility in evaluating and comparing the lifetimes of two distinct ion source technologies: the ISIS H- Penning source and Fermilab's H- Magnetron source. By analysing the sputtering behaviour under operational conditions, the model can estimate the relative sputtering rate within the discharge pulse and the dependence of the sputtering on ion source control parameters and discharge properties . The study highlights how the model can be adapted to different source architectures, offering insights into source design improvements and lifetime predictions, ultimately aiding in the optimization of ion source technologies for high-energy physics applications.

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