Characterization of the ion emission in a pulsed vacuum arc with an axial magnetic field

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An experimental study of the metallic ion flux generated in a pulsed copper vacuum arc with an annular anode and operated with an axial magnetic field of variable intensity is presented. Employing an insulating drift duct, and for a magnetic field intensity ($B$) of 180 G, it is found that the axial ion flux collected by a probe decreases with the cathode-probe distance ($d$) and increases with $B$ (with respect to the non-magnetized case) by a factor that depends on $d$. For the closest distance ($d = 6$ cm) that factor is of the order of 2-3, while for the largest distances it increases up to 25. It is also found that the ion losses along the duct wall follow an exponential law, with a decay length that increases with the magnetic field strength. This decay length was larger than that reported by other authors who employed metallic ducts. A simple conical model of ion emission indicates that without a magnetic field, the ions are emitted with large angles with respect to the normal to the cathode surface, while in the presence of a magnetic field of 90-180 G the ion emission is highly collimated, but the ion current emerging from the anode aperture is much smaller than the ion current generated at the cathode surface. The arc voltage increases considerably with the magnetic field intensity, indicating that the inter-electrode plasma becomes resistive in the presence of a transverse field, which magnetizes the electrons. However, this increase in the arc voltage does not follow a simple scaling law with magnetic strength as predicted by the plasma theory.