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The cathodic arc plasma from AlCr composite cathodes

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Cathodic arc deposition is a frequently applied method for the synthesis of thin films and coatings. The use of alloy or composite cathodes with two or more elements is a convenient and economic way to supply the non-gaseous elements for the film growth. AlCr composite cathodes are typically used in reactive processes, where N_2 or O_2 are added to the discharge, in order to synthesise nitrides, oxides or oxynitrides. A detailed understanding of the discharge properties is vital for the further optimisation of the deposition processes to enable synthesising thin films or coatings with improved properties. Within the current work the plasma properties of the cathodic arc plasma from AlCr cathodes with compositions of 75/25, 50/50 and 25/75 at.% in Ar, N2 and O2 atmosphere was studied in detail. This included the evolution of the charge states and the ion energies with changing gas background pressure as well as the most probable ion energy or velocity as a function of the cathode composition and type of gas atmosphere. The latter allows conclusions about the origin of individual ion species, i.e. to identify ions that were formed near the cathode surface. The information gained from analysing the plasma properties will be set in the context of results obtained from characterising the eroded cathode surfaces. Due to periodic melting and solidification of the cathodes' near-surface region in the vicinity of cathode spots, intermixing of Al and Cr and the formation of intermetallic as well as nitride and oxide phases occur. The eroded cathodes were analysed by X-ray diffraction and cross-sectional imaging and elemental distribution mapping using scanning electron microscopy. The formation of intermetallic phases depends on the cathode composition. The presence of the reactive gases N_2 and O_2 only altered the appearance of the cathodes in their main erosion zone to a limited extent. Significant cathode poisoning due to the formation of nitride and oxide phases was only observed outside the erosion zone.

Keywords
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