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Temporal Development of the Plasma Composition of Metal Plasma Streams in a Reactive Environment

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We describe the temporal development of the plasma composition in a pulsed plasma stream generated by a cathodic arc. Cathode materials used were Zr and Cr at various nitrogen pressures. The time resolved plasma composition for the cathode materials was analyzed with time-of-flight charge-to-mass spectrometry, and was found to be a strong function of the nitrogen pressure. Large plasma composition gradients were found within the first 70 microseconds of the pulse, the nitrogen concentration increasing when increasing pressure. The results are explained by the formation and erosion of a compound layer at the cathode surface in the presence of a reactive gas. The average charge state was also found to be affect by the reactive gas pressure as well as by the time after ignition. The charge states were highest in the beginning of the pulse at low nitrogen pressure, decreasing down to a steady-state value at high pressure. The results are of importance for reactive plasma processing and for controlling of the evolution of thin film composition and microstructure. This is obtained from an increased understanding of plasma composition and distribution of energetic species (resulting from the distribution of charge states).