Time and energy-resolved mass spectrometry study of the HiPIMS discharge operated in Ar and Ar-N_2 atmospheres

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High Power Impulse Magnetron Sputtering (HiPIMS), a promising physical vapor deposition process, uses short voltage pulses with a low-duty cycle to produce a large number of ionized sputtered particles [1]. Adding a reactive gas to the HiPIMS method opens up new possibilities for synthesizing unique materials with various characteristics and compositions. Nonetheless, using HiPIMS in a reactive process is challenging due to the intricate time-dependent interaction between discharge characteristics and reactive gas supply [2]. Therefore, a more profound understanding of discharge behavior in reactive HiPIMS is needed to achieve control over the deposition process.

In this experimental study, an investigation of the reactive sputtering process using mass spectroscopy was performed. A titanium cathode was the sputtering source, and total pressure and supplied power were maintained constant. Two cases were studied: one with a low current (60 A) and another with a high current (150 A). A Speedflo Mini fast feedback control system was utilized to measure throughout the hysteresis curve. Four distinct points representing the metal, transition, and poisoned regimes were selected for the study. In these points, the ion flux of the species impinging the mass spectrometer was determined. Time-resolved and time-averaged ion energy distribution functions (IEDF) were captured for Ar^+, Ar^{2+}, Ti^+, Ti^{2+}, N^+, and N^{2+} under all investigated conditions. This study builds upon previous optical measurements [3], providing further insights into the reactive sputtering process.

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