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Key Features of Reactive High Power Impulse Magnetron Sputtering

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For many thin film applications, such as optical coatings, energy-related coatings, hard coatings, etc., the coated layers are not single metal thin films, but rather compound coatings obtained from at least one metal (e.g. Al, Ti) or a non-metal (e.g. C, B) and a reactive gas (e.g. O₂, N₂). This talk will address a promising thin film deposition technology called high power impulse magnetron sputtering (HiPIMS), and how this method differs from conventional processes. Key features in reactive HiPIMS, such as eliminated/reduced hysteresis and stable high-rate deposition in the transition mode, will be discussed. It will be shown that the discharge current evolution plays an important role, which we will analyze by investigating the combined processes of self-sputter recycling and process gas recycling using results from recent plasma process modelling in combination with experimental plasma characterization. Above a critical current density of the order of J_{crit} ≈ 0.2 A/cm², a combination of self-sputter recycling and gas-recycling is generally required. The relative contributions of these recycling mechanisms, in turn, influence both the electron energy distribution and the stability of the discharges. A new framework including a generalized recycling map will be introduced to quantify these effects.

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