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Plasma spokes in reactive high power impulse magnetron sputtering

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High power impulse magnetron sputtering (HiPIMS) is a versatile PVD technique for growth of the thin films with advanced properties. Versatility of HiPIMS originates not only from the additional external parameters such as pulse duration and frequency, but also from the complex plasma where the plasma composition and the charge state of the metal ions can be controlled. Understanding the complex nature of the HiPIMS plasma is necessary in order to exploit its full potential.
A time resolved analysis of the emission of HiPIMS plasmas reveals self-organised patterns in the form of rotating spokes. It has been shown that the plasma oscillations are commonly found in magnetrons, regardless of the power supply and power levels obtained. In HiPIMS, The shape of the spokes is very characteristic depending on the target material. The localised enhanced light emission has been correlated with the ion production. Based on these data, the peculiar shape of the emission profiles can be explained by the localised generation of secondary electrons (SE), resulting in an enhanced outward diffusion. This general picture is able to explain the observed emission profile for different target materials including gas rarefaction and second ionization potential of the sputtered elements.
The spokes have been extensively investigated in a non reactive HiPIMS discharges, and here we present the results of the plasma diagnostic of HiPIMS plasma in reactive mode. The target poising occurring when reactive gas is introduced strongly affects the sputter yield and the secondary electron sputter yield. We present the evolution of the spokes along the hysteresis curve during a reactive HiPIMS discharge for different target material/reactive gas combinations.
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