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PIC-MCC simulations on high power pulse magnetron discharge

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The increasing demand of new functional films for technological applications, such as surface protection, low-friction coatings, data storage, optics and microelectronics..., is a strong motivation for research towards both understanding the fundamentals and technical aspects of thin film growth and also developing advanced deposition techniques.
A very promising sputtering/deposition technique, known as High Power Impulse Magnetron Sputtering (HiPIMS), had a rapid development in the last decade due to its high potential for applications. It consists of using the well-known magnetron discharge in high-power pulse operating mode. Despite the advance of HiPIMS, due to its complexity, the experiment is not always straightforward and the research is ongoing for a complete description of the physical processes inside. In the same time, very few scientific papers report on the numerical modelling of HiPIMS and the models are either global or focused on a small region of the discharge. The pulsed discharges require different approaches than the continuous ones, since the time evolution both during the pulse and in the afterglow is of major interest for the understanding of the HiPIMS process.
The present work focuses on the simulation of a HiPIMS device by 2D Particle-In-Cell Monte Carlo Collisions (PIC-MCC) technique. The system is characterized by very short discharge pulses (1-10 μs) attaining cathode currents of tens A for a maximum applied voltage of 1 kV with a pulse repetition frequency in the range of 0.5-5 kHz. The discharge is operated in argon with planar metallic target. The numerical code deals both with charged particles (electrons and ions) and neutrals (gas and sputtered material atoms/molecules) in order to obtain the space-time distribution of plasma parameters (plasma potential, charged and neutral particles density, particles energy) during the pulse. The sputtered material is described as well, in terms of particle density and flux, energy, ionization fraction.

Keywords
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