Optical diagnostics of hot-target magnetron sputtering discharge

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The so-called hot magnetron sputtering (HMS) is considered as a promising way to increase the deposition rate as compared to classical cold magnetron sputtering (CMS), which is widely used in industry nowadays. In the HMS configuration, the sputter target is thermally insulated. This situation allows applying higher power density to the magnetron source, which, in turn, leads to heating of the target [1] and, consequently, to a higher deposition rate [2]. Although the HMS has been studied over the past decades, a comprehensive investigation of this regime is still required.

In this work, the CMS and HMS plasmas were studied and compared using in situ time-resolved optical emission spectroscopy (OES). Meanwhile, the target temperature was independently controlled by pyrometry and using Planck's radiation law fitting. The obtained results highlight the complex dynamics of plasma particles in the HMS case, reflecting a decent increment in the number of sputtered atoms, as well as initiation of significant thermionic emission. Moreover, a population inversion of both ground and corresponding excited electronic states is revealed for Nb. Notably, in the HMS system with a Nb target, a deposition rate of 0.1 μm/min is achieved at a target temperature of 2100 K. This is a threefold higher value than the maximum deposition rate obtained in the CMS case.

References:

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