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(POS-22) 2D fluid modelling of a magnetron discharge

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Recently, it was observed that under moderate pressure (p > 10Pa), nanoparticles can be created using sputtering magnetron discharges [1]. Although such plasma source has been widely studied at low gas pressure (p < 0.1Pa) in the context of industrial application such as thin film coating, there are only few plasma models at the fairly high-pressure range where collisions between sputtered species and the background neutral particles favor the growth of nanoparticles. Such small "dust particles" were also observed in tokamaks of graphite wall [2].

Magnetron discharges in which the plasma density may reach 10ˆ18 m-3 in the cathode region could help us to understand their formation in the coldest plasma region of tokamaks. Experimental studies are in progress at PIIM laboratory in Marseille where magnetically confined plasmas are generated using sputtering magnetron discharge. The feed gas is argon at 30 Pa and the magnetron cathode is in tungsten.

In that context a new and reliable numerical model is currently under development in order to investigate the transport of sputtered tungsten atoms in the discharge. Usually, cold plasma discharges are simulated using PIC-MC or kinetic models [3], but in this presentation, we present a 2D axisymmetric fluid model. In particular, as to resolve the sheaths, we developed a non quasineutral drift-diffusion model of two fluids –ions and electrons.

First two moments of the Boltzmann equation are solved for both with the energy equation only solved for the electrons. Second order finite difference and a fourth order Runge-Kutta method are used for the spatial and temporal discretization. Poisson equation completes the model, and we use kinetic boundary conditions based on a shifted and truncated velocity distribution functions [4]. Some results including plasma potential and density profiles of different species from the first numerical simulations are shown.

References

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[3] G. J. M. Hagelaar et al., Journal of Applied Physics 93, 67 (2003)

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