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Time- and spatially-resolved ion distributions in pulsed-dc magnetron plasma

Martin Cada[1], Petr Adamek[2], Jiri Olejnicek[2], Zdenek Hubicka[2], Jiri Adamek[3], Jiri Stockel[3]

[1]Institute of Physics of the AS CR, v.v.i, Prague 8, Czech Republic [2]Institute of Physics of the AS CR, v.v.i., Prague 8, Czech Republic [3]Institute of Plasma Physics of the AS CR, v.v.i., Prague 8, Czech Republic

cada@fzu.cz

The High Power Magnetron Sputtering System (HiPIMS) equipped with 2” in diameter titanium target has been investigated by means of time-resolved retarding field energy analyser (RFEA) and so called modified-Katsumata probe. Both methods allow determining ions distributions as a function of retarding electric field. However, both methods are not able to resolve the mass of particles. The newly developed modified-Katsumata probe uses a static magnetic field created by Sm-Co permanent magnets to intercept the most of plasma electron and conduct them away to auxiliary electrode. The main stepwise biased electrode collects then plasma ions even above plasma potential. The measurement with ion sensitive probe is similar to measurement with regular Langmuir probe. The commercial apparatus Semion RFEA system has been used. A comparative study of both aforementioned methods has been carried out in pure argon atmosphere at pressure range from 0.3 Pa to 20 Pa and at different distances from the target face. The mean discharge current has been held at 500 mA for all the experiment. The modified-Katsumata probe enables us to obtain ion temperature directly from the probe characteristics. On the contrary, RFEA can measure ion velocity distribution in direction perpendicular to the analyser only. Both methods revealed significantly enhanced energy tail in ion distributions measured in HiPIMS in contrast to dc magnetron or mid-frequency pulsed-dc magnetron. The variances in the measured ions distribution by both methods at the same plasma conditions are attributed to different principle of operation both methods. Then measured data obtained by both RFEA and modified-Katsumata probe bring different information about ion distributions.

Keywords
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