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Investigation of high power impulse magnetron sputtering (HIPIMS) discharge using fast ICCD camera

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High power impulse magnetron sputtering (HIPIMS) combines impulse glow discharges at power levels up to the MW range with conventional magnetron cathodes to achieve a highly ionised sputtered flux. The dynamics of the HIPIMS discharge was investigated using fast Intensified Charge Coupled Device (ICCD) camera. In the first experiment the HIPIMS plasma was recorded from the side with goal to analyse the plasma intensity using Abel inversion to obtain the emissivity maps of the plasma species. Resulting emissivity maps provide the information on the spatial distribution of Ar and sputtered material and evolution of the plasma chemistry above the cathode. In the second experiment the plasma emission was recorded with camera facing the target. The images show that the HIPIMS plasma develops drift wave type instabilities characterized by well defined regions of high and low plasma emissivity along the racetrack of the magnetron. The instabilities cause periodic shifts in the floating potential. The structures rotate in ExB direction at velocities of 10 kms^{-1} and frequencies up to 200 kHz. The high emissivity regions comprise Ar and metal ion emission with strong Ar and metal neutral emission depletion. A detailed analysis of the temporal evolution of the saturated instabilities using four consequently triggered fast ICCD cameras is presented. Furthermore working gas pressure and discharge current variation showed that the shape and the speed of the instability strongly depend on the working gas and target material combination. In order to better understand the mechanism of the instability, different optical interference band pass filters (of metal and gas atom, and ion lines) were used to observe the spatial distribution of each species within the instability.