PO3052

Behavior of spokes at different magnetic fields

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The investigations of the non-reactive high power impulse magnetron sputtering (HiPIMS) discharge using current probes, high speed camera imaging and optical spectroscopy showed that plasma is not homogenously distributed over the target surface, but it is concentrated in regions of ionization zones called spokes which rotate above the erosion racetrack. The spokes were observed for certain combination of experimental parameters such as discharge current, pressure, target material and working gas. Their rotation velocity was determined to be in the range from 4 to 10 km/s from oscillations on both the floating potential of the probe and collimated optical signal. The high speed camera imaging enabled us to observe mode number, i.e. number of spokes, the transition between spoke modes and different characteristic shapes of the spokes. In this contribution magnetic field influence on spoke behavior is studied by high speed camera imaging in HiPIMS discharge using titanium target (3'' in diameter). Employed camera enables us recording of two successive images in the same pulse with minimal time delay of 2 μs between them. It allows us to determine not only the number of spokes but also the spoke rotation velocity and spoke rotation frequency for studied pressure range from 0.15 to 5 Pa and discharge current up to 350 A. Three different magnetic fields of 37, 72 and 91 mT were employed. It was concluded that the increase the magnetic field caused the increase of number of spokes observed at the same pressure and the same discharge current. The spoke rotation velocity was independent on the magnetic field strength. The investigation revealed different characteristic spoke shapes depending on the magnetic field strength - both diffusive and triangular shapes were observed for the same target material.
This research has been partially financially supported by the Czech Science Foundation in frame of the project 15-00863S by the project CZ.1.05/2.1.00/03.0086 funded by European Regional Development Fund and the project LO1411 (NPU I) funded by Ministry of Education Youth and Sports of Czech Republic.

Keywords
spoke
magnetic field
HiPIMS