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3P45 - Statistical examination of spoke evolution in HiPIMS

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Plasma in high-power impulse magnetron sputtering (HiPIMS) discharge, similarly to other discharges utilizing ExB field (Hall thrusters, homopolar devices), undergoes self-organization into the ionization zones rotating in the ExB direction, called spokes. In different experimental conditions the appearance, number and rotational velocity of spokes change. Additionally, the spokes were observed to split and merge over time even when discharge parameters were kept constant.
A study is presented where a novel diagnostic method of strip probes together with well-established fast camera screening were utilized in order to track spokes during the whole stable high-current phase of the HiPIMS pulse. Strip probes embedded to the target locally capture the current flow over the whole pulse, while the fast camera captures a plasma emission from the whole target at a given time. Such combination allows observing events such as spoke merging and splitting in more detail.
It was found that spoke merging and splitting events effect neighboring spokes. Additionally, when spokes split or merged overall charge supplied through the spokes was conserved. Statistical examination of measured data revealed two distinct tendencies of the spoke configuration. At the low pressure, spokes merged and split over time seemingly in a random fashion around a stable configuration, while in higher pressure spoke splitting was strongly favored over the merging process. Therefore, at higher pressure number of spokes was observed to increase in time despite the discharge current and cathode voltage were kept constant. Based on experimental results, a phenomenological model based on the metal resputtering was created in order to explain merging and splitting events.

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