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Localized traveling ionization zones and their importance for the high power impulse magnetron sputtering process[1]

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High power impulse magnetron sputtering (HiPIMS) is a technique to deposit thin films with superior quality. A high ionization degree up to 90% and the natural occurence of high energetic metal ions are the reason why HiPIMS exceeds direct current magnetron sputtering in terms of coating quality. On the other hand HiPIMS suffers from a reduced efficiency, especially if metal films are produced. Therefore, a lot of research is done by experimentalists and theoreticians to clarify the transport mechanisms from target to substrate and to identify the energy source of the energetic metal ions.
Magnetron plasmas are prone to a wide range of wave phenomena and instabilities. Especially, during HiPIMS at elevated power/current densities, symmetry breaks and self-organization in the plasma torus are observed. In this scenario localized travelling ionization zones with certain quasi-mode numbers are present which are commonly referred to as spokes. Because of their high rotation speed compared to typical process times of minutes their importance for thin film deposition was underestimated at first. Recent investigations show that spokes have a strong impact on particle transport, are probably the source of the high energetic metal ions and are therefore the essence of HiPIMS plasmas. In this contribution we will describe the current understanding of spokes, discuss implications for thin film synthesis and highlight open questions.

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