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The effect of magnetic field on the deposition rate in a HiPIMS discharge

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HiPIMS (High Power Impulse Magnetron Sputtering) is a relatively new highly ionised sputtering technique used to deposit engineering quality thin films, with the advantage that the deposition flux can be guided to the substrate through electrical biasing. Deposition rate is an important, if not crucial, process parameter in the deposition of thin films in industry.
Using a Maxtek TM-400 deposition rate monitor, we have investigated the dependence of the deposition rate, (at a typical substrate position, 100 mm from the cathode), on the magnetic field configuration, in particular the magnetic field strength. Four different cases are considered. The field was varied by moving the permanent magnets of the magnetrons back from the target using external screw gauges.
In this study the discharge was operated at an average power of 680 W, an average pressure of 0.54 Pa, a repetition rate of 100 Hz and a pulse width of 100 μs for all four magnetic field cases chosen.
The results show that the deposition rate can be increased by a factor of 2 as the total magnetic field strength at the cathode field is reduced by only 33%. The results are interpreted from the effect of the changing B-field on the distribution of plasma potential in the bulk plasma. For increasing B, a large potential barrier exits between target and substrate for most of the pulse on time which acts to hinder the transport of low energy post-ionized sputter metal flux to the substrate, which in HiPIMS mode forms the much of the material deposited.
The results also show that for constant discharge powers thinner cathode targets produce higher deposition rates. These findings together with the B-field variations will be discussed in this paper.

Keywords
HiPIMS
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