

OR0403

Single Cathode Superimposed High Power Impulse Magnetron Sputtering

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High power impulse magnetron sputtering (HiPIMS) is a promising I-PVD technique for thin film growth on an industrial scale. Inherent for the technique is a high fraction of ionization of the sputtered material. This condition favours the growth of dense films with typically smoother surface structures. However, a shortcoming of the technique is the reduction in deposition rate seen when HiPIMS is employed as an alternative to direct current magnetron sputtering (DCMS). A promising route to deposit films with HiPIMS characteristics, and at deposition rates comparable to DCMS has been demonstrated when a cathode operated in HiPIMS mode combined with a second cathode operated in DCMS mode [1]. This type of process shows that a maximized amount of ionized material may not be a necessity to deposit films of HiPIMS quality, but rather growth conditions where enough ions are generated to assure the desired film properties. In this study we have combined a HiPIMS and a DCMS power supply to a single cathode for magnetron sputtering of Cr in an industrial high vacuum system. Power combinations ranging from pure DCMS to pure HiPIMS have been investigated while keeping the combined total deposition rates constant. The HiPIMS power was regulated by means of altering the pulse repetition frequency (50 to 350 Hz in steps of 50 Hz), thus not changing the pulse shape significantly. The films deposited were examined by four-point probe, amperometry, and cyclic voltammetry. A general trend in decreased resistivity and oxidation currents was observed with increased HiPIMS power. Most of these improvements were observed for films where the applied HiPIMS power was <40% of the total power, where a reduction in resistivity from ~60 to ~45 $\mu\Omega\text{cm}$, and oxidation currents reduced from ~3.3 to ~1.6 μA (3600s, at 1.0V vs. Ag/AgCl). Further increase of HiPIMS power, and thereby ion content, resulted in comparably moderate improvement in aforesaid film properties.

[1] See for example J. Paulitsch, P. Mayrhofer, W.-D. Münz, M. Schenkel, Annual Technical Conference Proceedings of the Society of Vacuum Coaters, 2007, p. 150.

Keywords

HiPIMS

DC superimposed HiPIMS