Effect of duty cycles on the deposition and characteristics of high power impulse magnetron sputtering deposited TiN thin films

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ABSTRACT

High power impulse magnetron sputtering (HiPIMS) is a novel physical vapor deposition (PVD) technique. HiPIMS is a low-temperature process, giving well-adherent coatings, better quality films, and droplet-free deposition. It provides enhanced gas dissociation and highly ionized plasma by inputting a high power during short pulses to the target. The target material is therefore not only sputtered but also ionized during the deposition process. In this study, TiN thin films were deposited using a uni-polar mode HiPIMS process. Nitrogen was used as the reactive gas to deposit TiN alongwith Ar gas. The deposition of TiN films was investigated by varying the duty cycles from 2 to 10% to have peak power density ranging from 208 to 1064W/cm2. A high peak power density was obtained at a low duty cycle. DC magnetron sputtered TiN thin film (duty cycle = 100%) was also deposited for comparison.We demonstrate that the HiPIMS deposited TiN thin film exhibits a denser structure and smoother surface at low duty cycles. It was also found that the intense ion bombardment at low duty cycles deteriorates the film structure and their mechanical properties. Moderate ion bombardment at a duty cycle of 4.5% gives the highest (111)/(200) intensity ratio and the highest amount of Ti\N bonding. This results in a film having the highest hardness, elastic modulus, and corrosion resistance of 29.3 GPa, 388.2 GPa, and 1.56E+06 (Ω /cm2), respectively. However, oxygen was found in the resulting films.

Keywords: High power impulse magnetron sputtering (HiPIMS), TiN thin films, Duty cycles, Peak power densi...

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