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Time-resolved plasma parameters in the HiPIMS discharge with Ti target in Ar/O atmosphere

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The High Power Impulse Magnetron Sputtering System (HiPIMS) equipped with 2" in diameter titanium target has been investigated by means of time-resolved Langmuir probe and time-resolved ion flux probe. The plasma parameters such as electron mean energy, plasma density, plasma and 'floating' potential have been measured in distance 70 mm from the target face and below racetrack. The ion flux at the substrate placed at the same position as the Langmuir probe has been determined from current waveforms measured at a planar probe, on which 50 kHz pulsed DC voltage bias of different magnitudes has been applied. The effect of working gas pressure and mean discharge current has been investigated on plasma operating in a reactive mode. The ratio of Ar/O_2 mixture was kept at 4:1. The pressure of argon/oxygen mixture has been varied from 0.3 Pa to 20 Pa. The peak discharge current reached 90 A.
The fine temporal resolution of measured probe characteristics revealed decrease in electron effective temperature during pulse ON followed by the steady value at 0.6 eV for all the pressures. For the pressure 2 Pa, we observed a local maximum in T_{eff} (0.9 eV) at the end of cathode voltage pulse. Furthermore, during the pulse OFF time we observed exponential-like decay of the electron temperature for all the pressures. The plasma density demonstrated steep increase during pulse ON time followed by exponential-likedecay during plasma OFF phase. The ion flux measurements have revealed approximately 3 times higher magnitude in the ion flux on the substrate for lower pressures than for higher pressures. Furthermore, the ion flux has increased more slower during the pulse ON time and we have observed a peak at the end of the plasma pulse for higher pressure. The influences of these phenomena on the total energy flux at substrate and on thin film properties are discussed.

Keywords
HiPIMS
Langmuir probe
ion flux
reactive sputtering