Seminar

Institute for Plasma Research

Title : Plasma parameters and instability during thin film deposition

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Date : 25th May 2016 (Wednesday)

Time : 03:30 PM

Venue : Seminar Hall, IPR

Abstract:

Magnetic field (B) distribution of reactive magnetron sputtering system was measured and compare with simulated distribution using COMSOL software. Distribution of Plasma parameters i.e. electron density was simulated using measured B through Particle In Cell - Monte Carlo collision (PIC-MCC) simulation and discussed its effect on plasma parameters. The magnetic field decreased axially and increased radially away from the cathode centre. Plasma parameters such as electron temperature (Te), electron number density (ne) were estimated using both electron flux (EF) and electron energy distribution function (EEDF) methods at different axial and radial positions. Deposition rate (Dr) was obtained for the same positions where the above plasma parameters were quantified. It was found that the Dr, thickness and grain size of the thin films are in accordance to that of the profile followed by the plasma parameters. Paschen curve for Ar gas was obtained during Cu deposition. Five process parameters of Paschen curve were used to obtain the electron density and deposition rate of the deposited nanostructured thin films. Plasma parameter such as electron density was correlated with the deposition rate. It is observed that minimum deposition rate obtained at plasma process parameter corresponding to Paschen minimum. This investigation helps to understand and optimize the quality of nanostructured thin film dependence on process parameter.

Floating potential fluctuations from a direct current magnetron sputtering plasma have been analyzed using time series analysis techniques like phase space plots, power spectra, frequency bifurcation plot, etc. The system exhibits quasiperiodic-chaotic-quasiperiodic-chaotic transitions as the discharge voltage was increased. The transitions of the fluctuations, quantified using the largest Lyapunov exponent, have been corroborated by Hurst exponent and the Shannon entropy. It is found, the Shannon entropy is high for quasiperiodic and low for chaotic oscillations. Further, the nonlinear dynamics of a direct current magnetron sputtering plasma is visualized using recurrence plot (RP) technique. RP comprises the recurrence quantification analysis (RQA) which is an efficient method to observe critical regime transitions in dynamics. RQA provides insight information about the system's behaviour. Intrinsic noise-induced coherence resonance has been observed in a direct current magnetron sputtering plasma. Oscillatory responses are observed as a function of discharge voltage. The observation has been qualitatively investigated using time series spectrum of floating potential fluctuations. Initially, plasma exhibited few peaks in the time series plots. With increase of the discharge voltage, the number of peaks gets increased with increased amplitude of oscillations. The phenomenon of coherence resonance has been investigated using power spectrum which was quantified by using normal variance and Hurst exponent. Weiner filter and log - log plots of the power spectrum have been used to find out the noise component in the oscillations.