The target sputtering mechanism in HIPIMS

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Abstract

High Power Impulse Magnetron Sputtering (HIPIMS) is a novel technology with advantages of high plasma density, high ionization of the sputtering materials, which could lead dense film structure, great mechanic properties and better adhesion than that deposited by dc Magnetron Sputtering (DCMS). However, the low deposition rate, usually 30-50% to DCMS, still attracts the attention of the researchers. In this paper, the spatial and temporal behaviors of the plasma and the morphology of the sputtered target were investigated to explain the low deposition rate in HIPIMS. Cu target was chosen due to its low sputtering threshold and high self-sputtering coefficient. The negative voltages applied to the target were 600, 800, 1200, 1500 and 1700 V, respectively. The negative pulse was 50μs in width, 100Hz in frequency and the etching time was 8h. The voltage and current waveforms were observed by an oscilloscope (RIGOL, model DS1064B) with a voltage probe (Tektronix, model P5100) and a current monitor (Pearson, model 411). The etching morphology of the Cu target was measured by a rough meter (Taylor Hobson, model Form Taylor surf PGI 1240). The surface morphology of the Cu target was characterized by scanning electron microscopy (SEM, FEI Quanta 200f, USA). The target sputtering current increases from 1.38A to 19.38A with the rise of target voltage and the power of the target rises from 45.8 W/cm2 to 1.8kW/cm2. The target sputtering mode changes from gas sputtering to self-sputtering. Target trace morphology is the Gaussian distribution, and the width of trace morphology enlarges first and then covers the whole target, the depth increases with the target voltage increasing. SEM images show that the surface morphologies are same in different target voltage, but the arc discharge appears which causes the fire pit morphologies as the target voltage is 1700V.

Keywords: HIPIMS, magnetron sputtering, sputtering mechanism, target

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