PO3013

Off-normal Film Growth by High Power Impulse Magnetron Sputtering

Viktor Elofsson, Mattias Samuelsson, Daniel Magnfält, Ulf Helmersson, Kostas Sarakinos

Linköping University, Linköping, Sweden

vikjo@ifm.liu.se

In this study we seek to elucidate the process-microstructure relations in films grown off-normally by high power impulse magnetron sputtering (HiPIMS). Various peak target power densities (up to ~1.3 kW/cm^2) and deposition rates (~5-25 nm/min) are utilized to grow Cu and Cr films from a cathode placed at an angle of 90 degrees with respect to the substrate normal. Si (100) wafers covered either by a ~2 nm native SiO^2 or by a ~120 nm sputtered Ti layer are used as substrates. For reference, films are also deposited by direct current magnetron sputtering (DCMS). Scanning electron microscopy is employed to determine column tilting and film deposition rates while X-ray diffraction techniques monitor crystal structure and grain tilting. It is demonstrated that the columnar microstructure of Cu tilts less away from the substrate normal as the peak target power density increases. We attribute this behaviour to an increase of the ionization degree of the sputtered material [1], which may lead to a larger fraction of deposited species deflected towards the substrate normal [2]. In addition, it is shown that the change in tilting is not caused by the lower deposition rate when increasing the peak power density. For the Cr films, the tilting angle is constant and independent of the peak power density. Comparison between Cr and Cu reveals that the Cr columns are positioned much closer to the normal. The difference in the column tilting is found to decrease and later vanish when the homologous temperature during growth of Cr is increased from 0.13 to 0.28. The reason for this behaviour is discussed in light of nucleation and growth characteristics at the various deposition conditions. X-ray diffraction analysis reveals that Cu films exhibit an (111) fiber texture, where the grains are better aligned with each other and oriented closer to the normal as the peak power density is increased. All Cr films are found to be biaxally textured with an out-of-plane orientation influenced by the peak power density and the presence or not of a Ti layer on the Si substrate.
[1] K. Sarakinos, et al. Surf. Coat. Technol. 204, 1661 (2010)
[2] see e.g. J. Alami, et al. J. Vac. Sci. Technol. A 23 278 (2005)

Keywords
HiPIMS
glancing angle deposition