

Nanolaminate Copper Barriers of Ru/TaN_x Thin Films by Inductively Coupled Plasma Enhanced Atomic Layer Deposition

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Ru/TaN nanolaminate barriers and Cu interconnect were sequential directly grown on dual damascene nano-porous dielectrics by inductively coupled plasma enhanced atomic layer deposition (PEALD). Ru/TaN thin films were successfully deposited by home-built PEALD using [Ru(EtCp)₂] and Ta(NC₂H₆)₅ as precursor with high energy reductive Ar/H₂ and Ar/O₂ plasma. The substrate temperature of Ru/TaN thin films were 300 and 250 °C with 500 cycles to PEALD process. The N₂ purge time and plasma power were held on 5 s and 400 W. Ru/TaN thin films were analyzed by X-ray photoelectron spectroscopy (XPS: Perkin Elmer PHI 670) and HRTEM (JEOL JEM-2100F). The resistivity was measured by using Hall effect measurement system (Accent/HL 5500PC). Fig. 1 shows the XPS of Ru 3d spectra deposited by PEALD. The energy states of 3d_{5/2} (at 280.2 eV) and 3d_{3/2} (at 284.3 eV) indicated metallic Ru. However, the lower intensity peaks at 281.2 eV and 285.9 eV are from RuO₂. Growth rate of Ru the films was increased significant from 0.01 to 0.1 nm/cycle by using dc biased PEALD. The resistivity of Ru thin films prepared by PEALD was 40 μΩ cm. The growth rate of TaN thin films was 0.05 nm/cycle as the PDMAT pulse time is more than 2 s. Cross-section HRTEM image in Fig. 2 shows that the Ru/TaN nanolaminate barriers were formed. In summary, Ru/TaN nanolaminate barriers were prepared by using Ru(EtCp)₂ and Ta(NC₂H₆)₅ precursor with the aid of the high energy reductive Ar/O₂ and Ar/H₂ plasma in ITRC PEALD system.

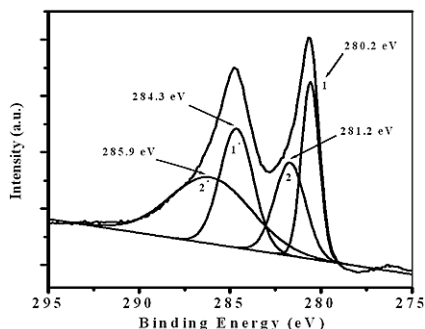


Fig.1 Ru 3d XPS spectra for a 4.8 nm Ru thin film deposited by PEALD.

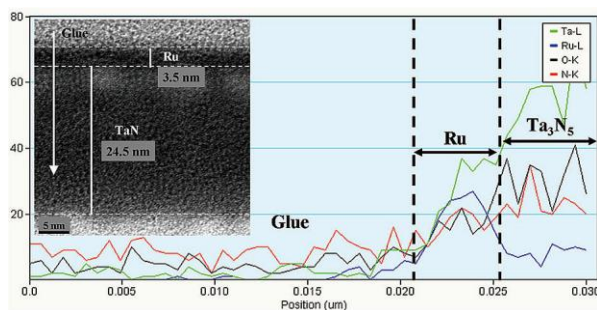


Fig.3 HRTEM image and EDS of Ru/TaN nanolaminate by PEALD.