Microstructural and Mechanical Characterizations of RT Sputtered RuO$_x$ Thin Films

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Abstract

RuO$_x$ thin films were deposited at room temperature by reactive RF magnetron-sputtering using Ar/O$_2$ discharges of varying O$_2$ flow ratio ($f_{O_2}$) over the range 10% to 50% and were characterized using X-ray diffraction, X-ray reflectivity, X-ray photoelectron spectroscopy, resistivity, stress-temperature measurements and nanoindentation tests. With the increase of $f_{O_2}$, the film texture change was observed. Films deposited with $f_{O_2}>25\%$ were determined to be stoichiometric. The residual stresses in the as-deposited films were all compressive and increased with addition of O$_2$, except for the film sputtered at $f_{O_2}=20\%$ which was in biaxial tension. The film deposited at $f_{O_2}=30\%$ had a low resistivity value of 68 $\mu\Omega$-cm, high hardness value and near zero stress (<50 MPa tensile) after a thermal cycle in air up to 500 °C which is promising for use in micro-devices.