Tuning the stoichiometry and electrical properties of tantalum oxide thin films

Tantalum oxide has a wide range of applications and has drawn much attention especially for its useful properties in resistive random-access memories, in which the Ta oxide composition plays an important role to control the electrical properties of the TaOx thin films. In this paper, we present a way to tune the composition of TaOx thin films by varying the oxygen partial pressure during growth using pulsed laser deposition. TaOx thin films were deposited at room temperature, under oxygen partial pressures ranging from $10^{-6}$ mbar to $2 \times 10^{-2}$ mbar. Using angle resolved X-ray photoelectron spectroscopy, we show that the composition of the film varies systematically with the oxygen partial pressure during the film growth. We then correlate the oxygen content with the electrical properties of the film and the results show that the composition has a great influence on the resistivity of the TaOx thin films. As the oxygen partial pressure during deposition increases, the percentage of tantalum pentoxide (Ta2O5) as well as the resistivity of the films increases. This experimental approach provides a pathway to control the TaOx thin film stoichiometry and its electrical properties during growth.

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