Electrochemical Oxidation as Vertical Structuring Tool for Ultrathin ($d < 10$ nm) Valve Metal Films

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Abstract

Stepwise potentiostatic oxidation is used to reduce the thickness of thin aluminum and tantalum films from an initial thickness of 10 nm down to 2 nm. The thicknesses of the oxide and the residual metal are adjusted by the finite potential of an electrochemical oxidation procedure which consumes the initially 10 nm thick metal films. The metal–metal oxide interfaces are smooth and sharply defined. The metal consumption and oxide formation are proportional to each other by the ratio of their specific densities. This enables the derivation of a metal consumption factor for the residual metal film. Residual aluminum films show a significant increase of the specific resistivity with decreasing film thicknesses. This can be explained by modified electronic transport in the residual aluminum for example by changed electronic scattering processes at the metal–metal oxide interface or in the metal. Residual tantalum films show a weaker dependence of the specific resistivity down to 3 nm pointing to only slightly changed transport properties for electrons in the thin tantalum layers.

Footnotes

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