

High Rated Alumina Nanotemplate Fabrication on Silicon Wafer with Controlled Pore Diameters

Nosang V. Myung, Jean-Pierre Fluerial, Minhee Yun,
William West and Daniel Choi

Jet Propulsion Laboratory, California Institute of Technology
Pasadena, CA 91109

Abstract:

Alumina nanotemplates with various pore diameters (12 nm to 100 nm) were galvanostatically and potentiostatically anodized from e-beam evaporated Al (5 micron)/Ti (200 Å)/Si at room temperature.

Galvanostatically controlled anodizing with high current density (e.g. 100 mA cm⁻²) produced higher ordered hexagonal pore structure than low current density, independent of anodizing solutions. The alumina nanotemplate formation rate was linearly dependent on applied current density. Formation rates of 2 micron/min, 1 micron/min were achieved at 100 mA cm⁻² and 50 mA cm⁻², respectively.

Different concentrations of sulfuric acid (10-40 v%), oxalic acid (0.3 M) and mixed solutions of sulfuric and oxalic acid were used.. At fixed current density, alumina nanotemplates produced from sulfuric acids have smaller pore diameters and lower porosity than from oxalic acids. In addition, sulfuric acid produced more ordered pore structure than oxalic acid. The breakdown voltage (U_B) varied linearly with log of sulfuric acid concentration at room temperature ($U_B = 24.5 - 11 \log [H_2SO_4]$). The breakdown voltage also decreased with temperature, which produced smaller pore diameter.

The pore diameter of alumina nanotemplates synthesized from evaporated aluminum varied linearly with a slope of 2.1 nm/V. This slope is slightly smaller than reported data on bulk aluminum (2.2 nm/V and 2.77 nm/V). The difference may be due to the purity of film and number of film defects.