

Anodic Formation of TiO₂ Dielectric Films

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The aim of this research is a capacitor with an energy density comparable to that of batteries. When titanium of high purity is anodized a TiO₂ film with high dielectric strength (0.75V/nm) and high charge density is obtained. The energy density is of the order of 100 to 200 Wh per kg of dielectric. Titanium oxide films were grown at voltages from 1 to over 400V. Film thickness was measured from interference colors in diffuse daylight, Figure 1, and on cross sections by electron microscopy.

Experimental parameters were (a) purity of the titanium substrate, (b) surface preparation by chemical cleaning, etching and electro-polishing, (c) anodizing solutions and (d) solution modifiers. The parameters during anodization included temperature, voltage, current density, and anodizing time.

A number of anodizing solutions were tried, including phosphoric acid and sodium silicate. Their effectiveness was studied by evaluating breakdown voltage, charge density and leakage current. The mechanisms responsible for leakage current are not fully understood. The experimental work on surface preparation, anodization parameters and evaluation of the dielectric properties and microstructure will be discussed. mixed with small amount organic solvent, like ethylene glycol can give oxide higher charge density and lower leakage current density. It is suggested the organic solvent can cover the defects of the titanium surface before the oxide grows, it may reduce the leakage current.

Fig 1. Titanium anodized at different voltages in 1% H₃PO₄, at room temperature. Current limit at 8mA/cm²

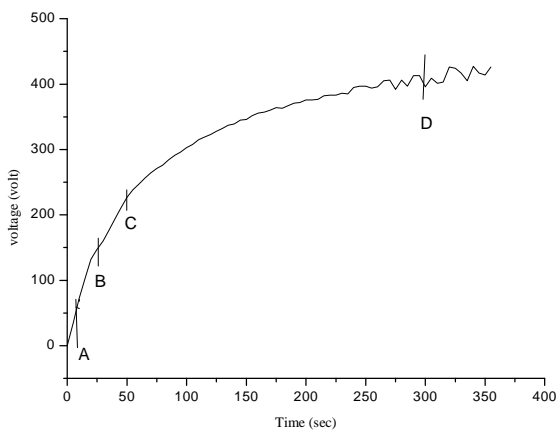


Fig2. Anodizing formation time verse voltage. High purity titanium was anodized at 18mA/cm².

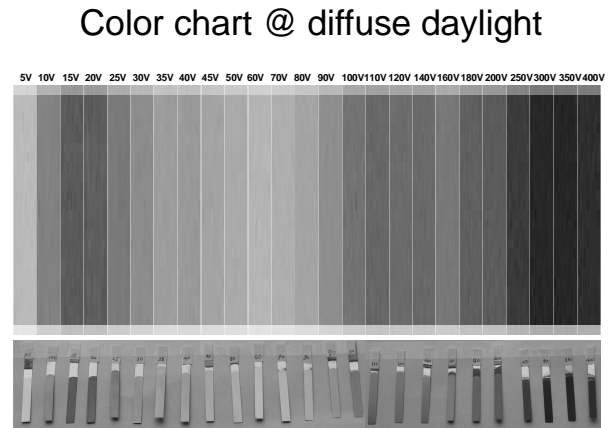


Fig 3 Charge density and leakage current density of high purity titanium anodized to 30V at temperatures between 20 and 80°C in H₃PO₄.

