Preparation and Characterization of Lead Iron Tantalate Thick Films

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Abstract

Thick film compositions based on solid solutions of relaxor ferroelectric Pb(Fe1/2Ta1/2)O3 (PFT) and normal ferroelectric PbTiO3 were prepared and applied for class II capacitors. Lead iron tantalate was synthesized by the two-step wolframite method. Phase composition of the product was controlled by X-ray diffraction analysis. Pastes were prepared by mixing nonorganic powders, previously ball milled, with organic binder. Thick film capacitors were screen printed on alumina substrates and fired in a VI-zone belt furnace. Bottom and top electrodes were deposited from Ag or Pt pastes. The dielectric layers were fired at peak temperature 870°C for 10 min. In order to shift the temperature of ferroelectric-paraelectric transition from -30°C for pure PFT towards higher temperatures the addition of 10, 15 and 20 mol % of PbTiO3 was used. Introduction of small amounts of MnO2 or Co3O4 (0.1 - 0.5 mol %) to the pastes facilitated sintering of the layers and resulted in an increase in their resistivity. The electric permittivity and dissipation factor of the layers were determined in the temperature range from -55 to 250°C and in the frequency range 10 Hz - 1 MHz. Resistivities of the thick films were measured in the temperature range 20 - 500°C. On the basis of the Arrhenius relationship the activation energies of electrical conductivity were determined. Chemical composition and microstructure of the layers were characterized using a X-ray microprobe and a scanning electron microscope. The advantageous features of the developed thick films were: lack of any nonferroelectric fluxes, dense microstructure, relatively high dielectric permittivity (300 - 1800), high resistivity (about 10exp12 ohmcm), low temperature coefficient of capacitance, low electrical field dependence of capacitance and resistance to moisture.