Bismuth Based Pyrochlore Dielectric Thin Films Deposited at Low Temperature for Thin Film Multilayer Capacitor Applications

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Bismuth Based pyrochlore dielectric thin films exhibit many unique properties, such as excellent frequency response, extra-low dielectric loss and dielectric tunability and are excellent candidates for the applications like integrated capacitors, thin film field-effect transistor and tunable microwave devices.

Amorphous BZN thin films have been deposited at room temperature and annealed at the temperatures below 150 °C. TEM analysis shows that there are nano-crystallines embedded in amorphous film matrixes. Amorphous BZN thin films exhibit high dielectric constant and low dielectric loss, as well as excellent dielectric properties in the microwave range, which make them ideal candidate materials for the embedded devices with low processing temperature.

Thin film multilayer capacitors (MLCs) composed of amorphous $Bi_{1.5}Zn_{1.0}Nb_{1.5}O_7$ (BZN) dielectric layers with Cu internal electrodes were fabricated by radio-frequency magnetron sputtering at a temperature below 150 °C. Both BZN thin films and Cu internal electrodes were deposited in-situ through a set of steel shadow masks at room temperature and post-annealed at 150 °C. The thin film MLCs with different number of BZN layers were fabricated. The thin film MLCs with 5 BZN layers exhibit promising properties with dielectric constant of 72, capacitance density of 1600 nF/cm2, and loss tangent of 5.4 % at 10 kHz. These results suggest that the BZN thin film MLCs have potential applications for the embedded PCBs.