Influence of substrate microstructure on the high field dielectric properties of $BaTiO_3$ films

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Abstract: The temperature dependence of the electrical leakage current density of chemical solution deposited $BaTiO_3$ films on high purity Ni foils was investigated as function of the underlying Ni microstructure. Depending on the Ni heat treatment prior to $BaTiO_3$ deposition, it was found that pores in the dielectric followed the profiles of the underlying Ni grain boundary grooves. The electrical properties were then characterized on capacitors with and without the presence of Ni grain boundaries. When a Ni grain boundary from the substrate was present in the capacitor used during the electrical measurements, the loss tangent of the capacitor rose rapidly for dc biases exceeding similar to 25 kV/cm. The critical bias increases to similar to 100 kV/cm when no substrate grain boundaries are included in the capacitor. In addition, the capacitance-voltage curves are much more symmetric when grain boundaries are absent. This disparity in the electrical behavior was analyzed in terms of the mechanisms of charge conduction across the Ni-dielectric interface. While a reverse biased Schottky emission mechanism dominates the current in areas free of Ni grain boundaries, the barrier at the cathode is ineffective when Ni grain boundaries are present in the substrate. This, in turn, leads to a larger leakage current dominated by the forward biased Schottky barrier at the anode. The results are important to both embedded and surface mount capacitors.