Study of electrical properties of piezoresistive pastes and determination of the electrical transport

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Abstract. Thick-film resistors (TFRs) consist of a percolating network of conducting oxide nanoparticles dispersed in an insulating glassy matrix, whose resistive properties are dominated by quantum tunneling across insulating layers separating adjacent conducting grains. Tunneling processes are at the origin of the high sensitivity of the TFRs resistances to applied strains. In this work, we aim to define the electrical transport law between metallic nanoparticles in piezoresistive pastes. We have measured transport and piezoresistive response for different RuO_2-based TFRs as a function of metallic concentration x and RuO_2 grain sizes.
The study reveals that the conductivity is shown to vanish as x approaches a critical concentration x_c by following a power law with nonuniversal critical exponents, while the piezoresistivity diverges at the same critical concentration. We argue that nonuniversality and diverging piezoresistivity have the same origin and arise from the highly fluctuation inter-grain tunneling distances determined by the segregated microstructure of TFRs.

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