High-Intensity Ultrasound-Assisted Low-Temperature Formulation of Lanthanum Zirconium Oxide Nanodispersion for Thin-Film Transistors

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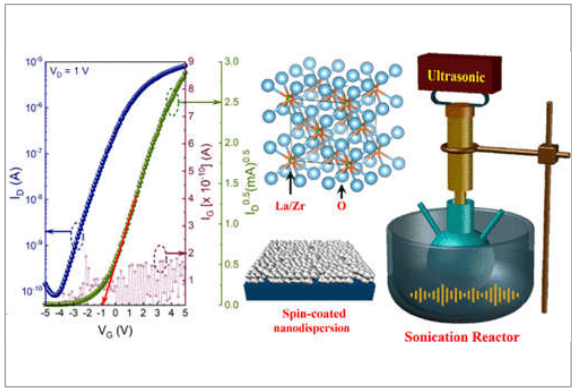
SUBJECTS: Thin films, Oxides,

Abstract



The process complexity, limited stability, and distinct synthesis and dispersion steps restrict the usage of multicomponent metal oxide nanodispersions in solution-processed electronics. Herein, sonochemistry is employed for the *in situ* synthesis and formulation of a colloidal nanodispersion of high-permittivity (κ) multicomponent lanthanum zirconium oxide (LZO: $La_2Zr_2O_7$). The continuous propagation of intense ultrasound waves in the aqueous medium allows the generation of oxidant species which, on reaction, form nanofragments of crystalline LZO at ~80 °C. Simultaneously, the presence of acidic byproducts in the vicinity promotes the formulation of a stable as-prepared LZO dispersion. The LZO thin film exhibits a κ of 16, and thin-film transistors (TFTs) based on LZO/indium gallium zinc oxide operate at low input voltages (≤4 V), with the maximum mobility (μ) and on/off ratio (I_{on}/I_{off}) of 5.45 ± 0.06 cm^2 V^{-1} s^{-1} and ~10^5, respectively. TFTs based on the compound dielectric LZO/Al_2O_3 present a marginal reduction in leakage current, along with enhancement in μ (6.16 ± 0.04 cm^2 V^{-1} s^{-1}) and I_{on}/I_{off} (~10^5). Additionally, a 3 × 3 array of the proposed TFTs exhibits appreciable performance, with a μ of 3–6 cm^2 V^{-1} s^{-1}, a threshold voltage of −0.5 to 0.8 V, a subthreshold swing of 0.3–0.6 V dec^{-1}, and an I_{on}/I_{off} of 1–2.5 (×10^6).