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Screen-printed piezoceramic thick films

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The attractive piezoelectric properties of Nd doped lead zirconate titanate (PZTN, $Pb_{0.988}(Zr_{0.52}Ti_{0.48})_{0.976}Nb_{0.024}O_3$) ceramics have led to the extensive use of these materials in different technological applications. In recent years, the drive toward device miniaturization has created a strong interest in PZT thick-film technology. With thicknesses in the range 5–80 μm, screen-printed PZT thick films fill an important technological gap between thin-film and bulk ceramics offering the advantage of miniature scale and direct integration into hybrid electronic packages.

On the other hand, the screen printing process presents potential thermal matching and chemical compatibility problems between the functional film, the substrate and the electrodes at the processing temperatures used.

Different PZTN inks have been optimized using terpineol as solvent. Their rheological and thermal behavior, were thoroughly characterized before printing them on different substrates. Among the ones generally used, silicon and alumina were selected as substrates for this study. Silicon for its applications in microelectromechanical systems (MEMS) and alumina because is a widely used cheap substrate for the electronics industry.

By optimizing the ink formulations and adjusting the screen printing setup, homogeneous single or multiple thick films with excellent printing resolution on both substrates were obtained.

Thermal analysis of PZTN inks was carried out to define the burnout process necessary to obtain cracks-free films. Sintering tests showed the massive PbO diffusion into the alumina substrate already at 900°C whereas, crack-free PZTN thick films with thickness ranging from 5 to 20 μm were obtained on silicon.