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# Low-Temperature Sintered $\text{Bi}_{0.5}\text{Na}_{0.5}\text{TiO}_3\text{-SrTiO}_3$ Incipient Piezoceramics and the Co-fired Multilayer Piezoactuator thereof

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## Abstract

Lead-free  $\text{Bi}_{0.5}\text{Na}_{0.5}\text{TiO}_3\text{-SrTiO}_3$  incipient piezoceramics with  $\text{Li}_2\text{CO}_3$  and  $\text{MnO}_2$  additives were successfully fabricated at low firing temperature for applications in co-fired multilayer piezoactuators. The addition of  $\text{Li}_2\text{CO}_3$  effectively shifted the sintering temperature from  $1230^\circ\text{C}$  down to  $1075^\circ\text{C}$ , where the ceramics were co-fired with a Ag/Pd (75/25) inner electrode. The prototype actuators were prepared by tape-casting method using ceramics with the composition of  $0.74\text{Bi}_{0.5}\text{Na}_{0.5}\text{TiO}_3\text{-}0.26\text{SrTiO}_3\text{+}0.15\text{wt\%MnO}_2\text{+}0.45\text{wt\%Li}_2\text{CO}_3$ . The total number of active layers was 13, and each ceramic layer had a thickness of  $60\ \mu\text{m}$ . The actuator output a large strain up to  $\sim 0.20\%$  at a driving field of  $4\text{kV/mm}$ , due to the field-induced phase transition between the ergodic relaxor and ferroelectric phases. The excellent voltage-displacement performance of the prototype actuator demonstrates the potential for industrial applications.

Keywords: lead-free piezoceramics; perovskite;  $\text{Na}_{0.5}\text{Bi}_{0.5}\text{TiO}_3$ ;

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