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Low Temperature Sintering of PNSZT

Pb-based piezoelectric materials are useful for a wide variety of applications because of their large dielectric constants, high polarization values, and strong piezoelectric coefficients. Unfortunately, they also typically require sintering temperatures >1200°C which leads to problems with stoichiometry control of the volatile Pb cation as well as, in the case of tape-cast and other co-fired materials, the required use of Pt electrodes. The ability to densify such materials at temperatures below 1100°C without compromising electrical performance would not only reduce issues related to Pb loss, but would also enable the use of significantly-cheaper co-fired electrodes such as Ag70-Pd30.

A systematic study of dopants that can be used to lower the sintering temperature of PNSZT ($Pb_{0.992}(Zr_{0.815}Ti_{0.05}Sn_{0.135})_{0.9845}Nb_{0.155}O_3$) has been completed. A total of 19 compositions were fabricated and sintered in the temperature range of 800°C to 1250°C. Additives that were studied include Cu_2O, B_2O_3, La_2O_3, and a PbO-based glass. Densities greater than 98.5% of the theoretical density can be obtained at temperatures as low as 1100°C with as little as 0.2 wt% of a Pb glass additive. The sintering temperature can be further reduced using Cu_2O; densities as high as 98% can be achieved at 900°C. A microstructural analysis of the samples was completed and electrical properties of the samples were measured. The results show that the sintering temperature can be greatly reduced without detrimental effects to the properties of the PNSZT.

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