Design of "hard" $BiScO_3$-$PbTiO_3$ Ceramics for Shear-bending Mode Actuator using at High Temperature

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Fe and $Pb(Mn,Nb)O_3$ (PMnN) were introduced to modified the $BiScO_3$-$PbTiO_3$ (BS-PT)ceramics to enhance the coercive electric field and depoling temperature. Modified ceramics exhibit "hard" characteristics, such as low dielectric loss, large mechanical quality factor and high coercive electric field. The actuation performance, strain hysteresis and heat generation of the shear-bending mode actuators based on unmodified and "hard" BS-PT ceramics were investigated under different thermal (from room temperature to 300 ^oC) and electrical loadings (from 2 to 10 kV/cm, from 1 to 1000 Hz). The maximum working temperature of this shear-bending actuators is 150 ^oC higher than those of traditional piezoelectric actuators based on commercial $Pb(Zr,Ti)O_3$ materials. Furthermore, although the piezoelectric properties of unmodified type ceramics based on BS-PT ceramics were superior to those of "hard" ceramics, the maximum displacement of the actuator based on "hard" ceramics was larger than that fabricated by unmodified ceramics at high temperature. The maximum displacement of the actuator based on "hard" ceramics was 22 μm under an applied electric field of 10 kV/cm at 300 ^oC. The strain hysteresis and heat generation of the actuator based on "hard" ceramics was smaller than those of the actuator based on unmodified ceramics in the wide temperature range. These results indicated that the shear-bending actuator based on "hard" piezoelectric ceramics was more suitable for high temperature piezoelectric applications.