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Use Guidelines for TRS Single Crystal Based Stacked Actuators

Although TRS piezoelectric single crystals possess exceptional properties compared to conventional ceramic materials, the crystals require special consideration to ensure that the high performance properties can be realized. Due to the unique nature of the single crystal materials, TRS would like to provide some guidelines for operating and driving the single crystal based stack actuators. The guidelines are summarized in Table I with a more in depth discussion below.

Table I. Guideline Summary Table

Maximum Unipolar Electric Field	< 25 kV/cm
Maximum Negative Electric Field	< 2 kV/cm
Maximum Temperature	<70ºC
Maximum Tensile Stress	0 MPa
Maximum Compressive Stress	20 MPa

Physical/Handling

The single crystals are mechanically weaker than polycrystalline ceramics due to the fact that there are no grain boundaries, which can help to arrest a propagating crack. Therefore the crystals require additional handling care. If dropped they may break very easily.

Driving Conditions

The stacks should not be driven at a unipolar electric field greater than 25 kV/cm due to the internal stresses generated within the crystal as well as the morphotropic phase boundary (MPB). At fields approaching 30 kV/cm the crystals will pass through an electric field induced phase transition from rhombohedral to tetragonal and the crystals can partially depole causing a drop in properties. The crystals also have a relatively low coercive field (E_C ~ 2.5 kV/cm), which limits the maximum negative field, which can be applied in bipolar drive conditions. Due to the mechanical weakness of the crystals they should not be placed in tensile stress conditions. Under compressive loads the crystals behave similarly to ceramics, but it is recommended that the maximum applied compressive stress be limited to <20 MPa. The crystals also have a very large dielectric constant and therefore it is important to realize that under dynamic driving conditions (i.e. high frequency and high electric fields) a higher current may be observed and your application configuration may require the proper drive electronics to handle these conditions.

Temperature

Again due the presence of the MPB (see above) the crystals are also temperature limited. If the crystals are heated above approximately 80-90ºC, they will pass through the phase transition from rhombohedral to tetragonal and partially depole causing a drop in properties. Thermal shock should also be avoided if possible due to the possibility of causing micro-cracking in the crystals, which can further degrade the performance of the crystals.

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