

## **Miniature accordion shaped low voltage piezo actuators for high displacements**

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New 3-D piezoelectric actuators are developed to gain higher displacements or specific bending effects. 3-D actuators of e.g. accordion shaped structure, so called S-morphs, have the potential to be used as miniaturized optical shutters of e.g. 7.5 x 2.5 x 1 mm<sup>3</sup> size for optical telecommunications. To exhibit the desired displacement of > 300 µm, specific multilayer structures and electrode designs must be developed. To lower the voltage of the power supply for these miniaturized devices, multilayer structures based on thin tapes must be used. By the deliberate preparation of alternating laminated and non-laminated areas of the stacked tapes in combination with a specific electrode design for benders, new types of actuator displacement can be achieved. The paper will describe two processing routes to manufacture accordion shaped multilayer structures. The performance including the accordion movement under cycling voltage will be demonstrated.

One route starts from tape cast PZT green tapes of 90 µm thickness, the other from extruded and stretched PZT filled thermoplastic films (Solufill<sup>®</sup>) of 50 µm thickness. The sheets are screen printed and laminated similar to standard planar multilayer processing. The most important difference compared to normal multilayer processing is the necessity to create a laminated multilayer structure with non-laminated areas beneath laminated ones, and to keep this structure during binder burnout and sintering. Finally the alignment of the electrode design with its alternating termination must be controlled throughout the process to guarantee that the electrode configuration fulfils its function during the polarization step and during the bending performance.