Assessment of different compression test setups for the (electro-) mechanical characterization of piezo-ceramics and multilayer actuators

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Abstract:
The (electro-) mechanical characterization of piezo-ceramic materials is a challenge due to their highly nonlinear stress-strain behavior. The results of 4-point bending tests are hard to interpret and therefore compression tests are often performed. Nevertheless uniaxial compression tests of very stiff materials like ceramics are obviously difficult, since a homogeneous stress distribution in a certain area is required for determining the mechanical properties. In particular for slender geometries (*i.e.* stack actuators) bending effects have to be avoided.

In this work experiments and nonlinear FE simulations for different types of compression test setups and specimen geometries are compared. The aim is to identify optimum conditions for the application of load. It is desired to achieve an error tolerance for the alignment of specimens with the loading axis.

In addition 3D-FE simulations with a nonlinear material model have been used for the analysis of the distribution of reversible and irreversible strain. As a result an optimum setup is found which yields bending stress below a critical value. Under this condition bending can easily be treated as a linear superposition of strains measured on opposing sides. This is crucial for the assessment of strain measurements of slender bar geometries where bending cannot be completely avoided and has to be considered.