

7<sup>th</sup> International Conference on

# Smart Materials and Structures

July 02-03, 2018 | Vienna, Austria

## Adaptation of a universal testing machine to characterize the material response of multi-layered piezoelectric actuators under fully coupled loading scenarios

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Multi-layered piezoelectric actuators (MPAs) are commonly used to control injection valves in combustion engines. The functional and structural integrity of such devices is associated with the loading conditions as well as with the MPA-design. In this work, commercial multilayered piezoelectric actuators have been characterized under distinct thermo-electro-mechanical loading conditions to predict their response in service. An acoustic emission microphone has been set up to the machine in order to detect the possible onset of cracks in the actuator during loading. In addition, the stiffness of the testing machine has also been adjusted to simulate realistic conditions. The adaptation of the universal testing machine has enabled the measurement of mechanical stress, strain, electrical charge (polarization) and the applied electrical voltage (electrical field strength) within the MPA. Hence, the stiffness, dielectric hysteresis, butterfly loop and the performance have been determined.

### Recent Publications

1. Schwaab H, Grünbichler H, Supancic P and Kamlah M (2012) Macroscopical non-linear material model for ferroelectric materials inside a hybrid finite element formulation. *International Journal of Solids and Structures*. 49:457–469.
2. Grünbichler H, Kreith J, Bermejo Moratinos R, Supancic P and Danzer R (2010) Modelling of the ferroic material behaviour of piezoelectrics: characterization of temperature-sensitive functional properties. *Journal of the European Ceramic Society* 30:249–254.
3. Bermejo Moratinos R, Grünbichler H, Kreith J and Auer C (2010) Fracture resistance of a doped PZT ceramic for multilayer piezoelectric actuators: effect of mechanical load and temperature. *Journal of the European Ceramic Society* 30:705–712.
4. Deluca M, Bermejo Moratinos R, Grünbichler H, Presser V, Danzer R and Nickel K G (2010) Raman spectroscopy for the investigation of indentation-induced domain texturing in lead zirconate titanate piezoceramics. *Scripta Materialia* 63:343–346.

### Biography

Hannes Grünbichler has his expertise in Materials Science and in using FE-simulations tools such as ANSYS. He is a Chartered Engineering Consultant for Materials Technologies and Engineering and an Expert Witness for Materials Science and Testing. At present, he is a Lecturer at the FH Technikum Wien and cooperates with the Montanuniversität Leoben.

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