MSc project

Details of project

Project title: Multi DoF Piezoelectric Mono Layered Actuator
Project type: MSc graduation
Project duration: 6-9 months
Starting date: to be discussed

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Context

In a lithographic machine many elements are moved with piezoelectric actuators. Piezo actuators can extend in the length direction if an electric field is applied in the polarization direction. If the field is perpendicular to the polarization, the piezo will make a pure shear deformation. Often multi degree-of-freedom piezo actuators are made from multiple, different piezo elements. But in principle these can be combined in 1 single element, by applying multiple fields to this element.

The piezo electric relations are described by the constitutive equation in tensor form. The filling of the tensor is determined by the crystal structure/class. By taking different materials, different actuation-direction combinations are possible.

In conventional piezoelectric actuators, the field is uniform over the cross-section and only one in direction. For the multi-electrode the direction and density varies. Methods on how to calculate these fields and the associated local and global deformations need to be investigated. In a more advanced scenario a segmented electrode with small voltage variations may be used to further optimize the electric field.

On the practical side, the electrodes at the different sides of the piezo need to be properly isolated from one and other to prevent electric breakdown between them. This requires a non-standard manufacturing procedure.

Assignment / project description

1. Literature study on (multi dof) piezo operation of PZT and other material types
2. Simulation of a multi-electrode piezo element. Focus on electric field distribution through the material and optimal electrode design.
3. Design of a multi-electrode piezo element (dimensions, required electric fields)
4. Experimental implementation and verification on a test setup
5. Writing report and presenting methods and results