# MICRO-MECHANICAL VOLTAGE ACTUATED CANTILEVER BEAM FEM ANALYSIS AND MANUFACTURE IN A FUSED QUARTZ GLASS

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Fused quartz can be modified with very intensive femtosecond laser pulses through non-linear absorption processes and the modified places can then be etched with a hydrofluoric acid [1]. Through this process we can make micro resolution complex 3d structures. A cantilever beam mechanical structure is one of the simplest and widely used in micromechanical systems. Alone it can be useful in a precise micro-movement detection, estimation of deformation of microstructures due to the applied forces, atomic microscopes, microgrippers and etc. If we selectively sputter the silver/gold contacts and apply voltage, we can then control the movement of the beam with prior to it's dependency of the applied voltage. The movement of those beams is based on a good glass tensile strength, as fused quartz can bend without causing a deformation if the bending flexure is narrow enough and the stress distribution doesn't overcome the tensile strength.

In this study we show a finite element method analysis and geometrical parameter optimization results, which were made with Comsol Multiphysics software. We also compare the manufactured voltage-actuated cantilever beam tip displacement dependencies with the modelled ones, mentioned above. We demonstrate, that the simulation results are similar to the experimental ones. We also show that the stress distribution doesn't overcome the elastic limit of the material and that there are almost no stresses outside the hinge of cantilever. The values of the eigenfrequencies are also given and the usage of the fundamental one in alternating voltage frequency is shown.

The cantilever beam which flexure hinge's width is 4 μm and length is 100 μm was manufactured with a 60 μm gap between contacts. With a 30 V voltage applied to this beam it bends 4.5 μm (tip displacement). After the geometrical parameter optimization we achieved the 11 μm stable displacement when a 23 V voltage is applied to the beam, which flexure hinge's width is 8 μm and length is 350 μm, gap between contacts is 25 μm.

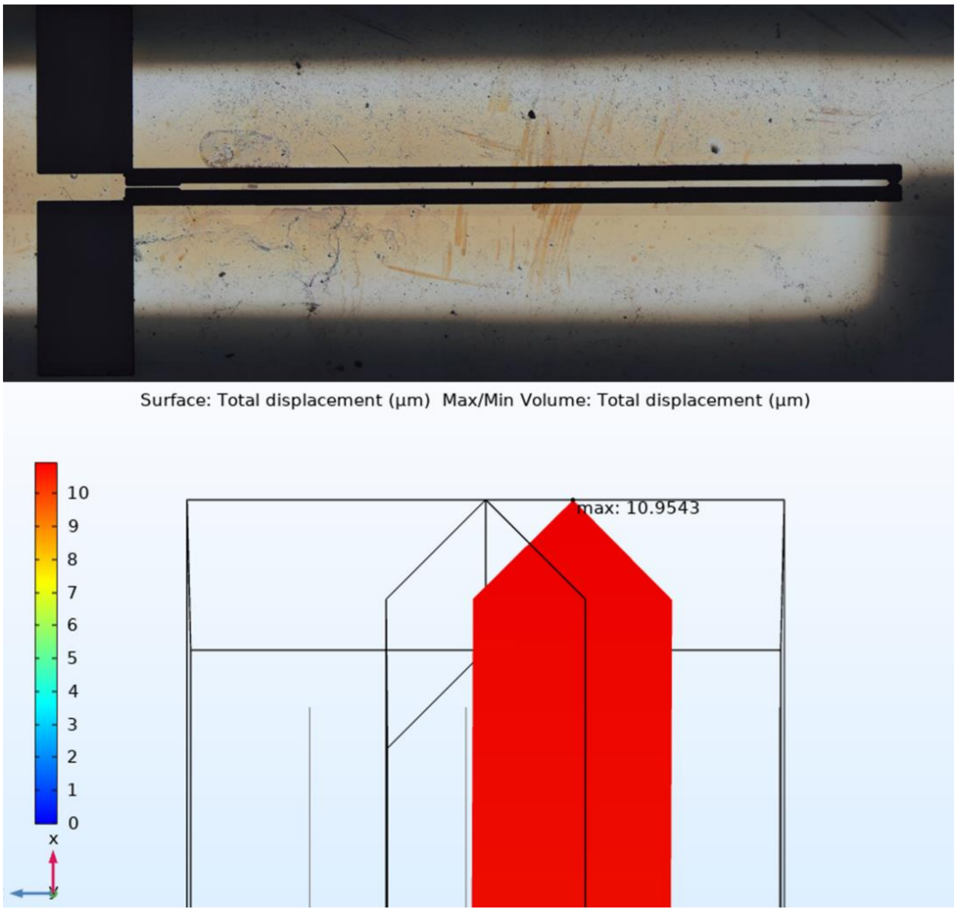


Fig. 1. The manufactured cantilever beam and the optimized beam tip displacement below.

[1] Y. Bellouard, A. A. Said, P. Bado, Integrating optics and micro-mechanics in a single substrate: a step toward monolithic integration in fused silica., Optics Express 13, 6635-6644 (2005).