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Design optimization of an actuator pattern for a unimorph deformable mirror

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Abstract content
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For a high order correction of laser beams usually a deformable mirror (DM) is used. A lot of different concepts exist for the design of these mirrors. Especially unimorph deformable mirrors feature low cost, low power consumption and a high stroke capability for the correction of large wave front aberrations. Additionally our approach is using technologies based on wafer level manufacturing of ceramic substrate materials which potentially leads to low cost deformable mirrors.

The optical performance of a DM is commonly stated by the capability to reproduce Zernike polynomials with respect to the amplitude and the precision of the individual coefficients. These values are determined by the actuator pattern of the DM. A pre-optimization of electrode patterns which was used as an input for finite element analysis (FEA) has been done. This pre-optimization was done with the help of the symmetry properties of the Zernike polynomials, adapted to our fixed edge mirror mount boundary condition. For the verification of the FEA model, the computed values have been compared to an analytical model. A high agreement between these values has been found. The deflection shapes for each individual actuator were calculated with the FEA software CoventorWare.

The result was the maximum adjustable Zernike coefficients which can be represented with the deformable mirror. Also the precision, indicated by the RMS error and the purity have been evaluated. We've computed these values for five different actuator layouts. Based on the results two actuator patterns with 41 actuators, consisting of 40 actuators located in the middle and one outer actuator ring have been selected. With the inner 40 actuators a concave deformation can be achieved. While applying a voltage to the outer actuator, the mirror deforms convex. This effect can be used for increasing the working range of a deformable mirror.

Furthermore the electrical contacting of the actuators has been optimized. A reduction of the feed lines dimensions for contacting the actuators with the contact pads located at the rim has been achieved. These contact pads were used for a global electrical connection of the DM. A larger and a more uniform deflection of the actuators is expected.

First measurement results obtained with these mirrors are also presented and are compared to the values obtained by the optimization process.

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