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Large Scale Deformable Mirror Based on Bimorph and Stack Actuators

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Abstract content
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Main element of any adaptive optical system is the corrector which determines the properties and ability of the system. The bimorph deformable mirror (DM) is intended to reproduce and thus correct for low order aberrations [1]. Such mirrors have large deformation stroke (up to 100 microns), wide dynamic range (up to several kHz), ability to hold the intensities up to 20 J/cm2 for pulsed beam and up to 50 kW/cm2 for CW radiation and the possibility to correct for the low-order aberrations by small number of actuators.
Aperture for bimorph DM up to 150 mm is usual now. The 180 mm bimorph DM showed good performance of the wavefront correction in laser systems with sub PW level of intensitiy [2]. But some applications need the DMs of far bigger sizes (about 500 mm), for example, when it substitutes for the final mirror in multi cascade laser system. As the big bimorph DM is rather thin, the surface shape is usually not perfect and stable. We propose the design of large scale DM using both PZT bimorph and stack actuator technologies. The stacks actuators support the DM and allow to change and correct for the surface shape either by open and/or closed loop control.
The results of study of the prototype of such DM will be presented. The DM size was 220 x 220 mm, the thickness was 4 mm, the ratio thickness to aperture was 1/55. Number of bimorph electrodes was 60. Bimorph type DM was glued on the tops of stack actuators. The stacks are arranged on the thick glass base and supported mirror at the periphery outside of the bimorph electrodes. The number of stacks was 12. Initial surface parameters were PV = 19 μ, RMS = 3.4 μ. Part of these aberrations has been introduced by gluing of stack actuators. Correction of the surface by using of 12 stacks actuators only gave us the surface quality PV = 2.6 μ and RMS = 0.3 μ. In the second step this surface was perfectly flattened by all 60 bimorph electrodes to the quality PV = 0.25 μ and RMS = 0.038μ that was about lambda/30.

1] A.Kudryashov, V.Shmalhausen, Opt. Eng., vol. 35(11), 3064 (1996).
[2] A.Alexandrov, V.Zavalova, A.Kudryashov et al., LEI2009 Proc. of the Conference, Brasov, Romania, 16-21 October 2009, Editor D.Dumitras, 123 (2010).

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