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A Piezoelectric Bimorph Deformable Mirror Concept by Wafer Transfer for Ultra Large Space Telescopes

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Future concepts of ultra large space telescopes include segmented silicon mirrors or inflatable polymer mirrors. Primary mirrors for these systems cannot meet optical surface figure requirements and are likely to generate over several microns of wavefront errors. In order to correct for these large wavefront errors, high stroke optical quality deformable mirrors are required.

JPL has recently developed a new technology for transferring an entire wafer-level silicon membrane from one substrate to another. A thin membrane, 100 mm in diameter, has been successfully transferred without using adhesives or polymers. A transferred membrane was patterned and its measured peak-to-valley surface error across 1.5 mm by 1.5 mm square shape was only 9 nm.

The mirror element actuation principle is based on a piezoelectric bimorph. A voltage applied to the piezoelectric layer induces stress in the longitudinal direction causing the film to deform and pull on the mirror connected to it. The advantage of this approach is that the small longitudinal strains obtainable from a piezoelectric material at modest voltages are thus translated into large vertical displacements.

By utilizing the membrane transfer technology, an optical quality mirror membrane can be transferred onto a micro actuator array. The membrane transfer technology will be combined with the piezoelectric bimorph actuator concept to develop a compact deformable mirror device with a large stroke actuation of a continuous mirror membrane, resulting in a compact AO systems for use in ultra large space telescopes.