# Optically Driven Deformable Mirrors

## There is no wiring on the back sides of these mirrors.

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Optically driven deformable mirrors may eventually supplant electrically driven deformable mirrors in some adaptive-optics and active-optics applications. Traditionally, the mirror facets in electrically driven deformable mirrors are actuated, variously, by means of piezoelectric, electrostrictive, microelectromechanical, liquid-crystal, or thermal devices. At least one such device must be dedicated to each facet, and there must be at least one wire carrying a control or drive signal to the device. If a deformable mirror comprises many (e.g., thousands) of facets, then wiring becomes a major problem for design, and the problem is compounded in cases of piezoelectric or other actuators for which high drive voltages are required. In contrast, in optically driven mirrors, the wiring problem is eliminated.

The basic principle of actuation of an optically driven deformable mirror is to use a laser beam to actuate a material. For example, a laser beam can be used to heat a material to make the material thermally expand to displace a mirror facet. In an experiment to demonstrate this principle, the actuator was a Golay cell (see Figure 1) having a diameter of ≈6 mm and a length of ≈10 mm. The beam from a laser diode was aimed at an absorber in the cell, thereby heating the gas in the cell. A mirror mounted on a 12.5-μm-thick polyethylene terephthalate diaphragm at one end of the cell became displaced as the gas expanded against the diaphragm. In one representative pair of experiments at a laser beam power of 0.23 W, the beam was mechanically chopped at frequencies of 1 and 5 Hz. The mirror exhibited corresponding oscillating displacements having amplitudes of 373 and 83 μm, respectively.

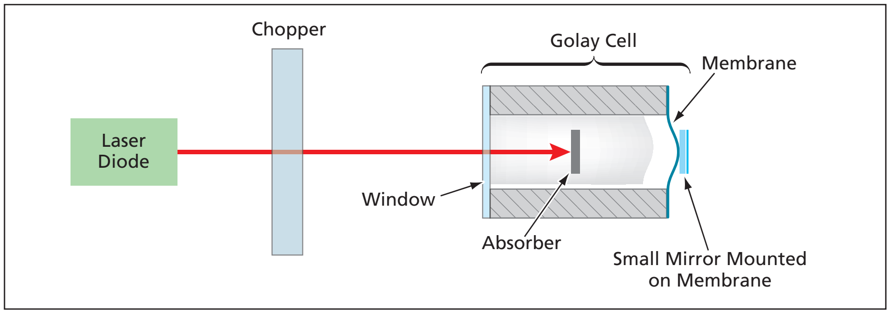


Figure 1. **Light From a Laser Diode** impinges on an absorber in a Golay cell, heating the gas in the cell. A mirror on the diaphragm is displaced by the resulting expansion of the gas.

Figure 2 depicts a simple experimental deformable mirror comprising a 5×5 square array of Golay cells with square mirror facets mounted on their membranes. A typical practical deformable mirror would likely include a much larger array (e.g., 100×100). In the contemplated use of such an array, two computer-controlled single-axis mirrors would be used to raster-scan a laser beam across the array, and the raster scan would be synchronized with an amplitude modulation to control the amount of heat delivered to each cell and thereby to control the displacement of each facet.

*This work was done by Hamid Hemmati and William Farr of Caltech for* **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

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