# Photo Controlled Deformable Mirrors: from material design to sky demonstrator

Deformable mirrors are active optical devices that have been founding an increasing interest in many technological field from astronomy to microscopy and high power lasers. The capability of such devices to change their optical surface makes possible to correct aberrated wavefronts (by the atmosphere or the inhomogeneous medium) and reaching a better resolution of the optical system and, in some cases, the diffraction limit performances.

This approach, known as adaptive optics, is crucial in modern ground-based astronomical instrumentation, where the potential resolution of large mirror telescope can be exploited only if the atmosphere distortion is compensated and the disk seeing is squeezed toward the Airy disk shape.

Different approaches have been developed to make a deformable mirror. The most common are: piezoelectric actuators (stack or bimorph), voice coils, MEMS (both electrostatic and electromagnetic). In spite of the fact that the actual technologies match most of the requirements of the astronomical field, we have to pay a big complexity of the device with risks in terms of reliability and duration.

The possibility to avoid the presence of real, physical actuators is actractive and this possible thanks to the Photo Controlled Deformable Mirrors (PCDMs), where a light pattern is sent on the back of a photoconductor slab. The light pattern defines the size, shape and density of actuators that can be optimized according to the wavefront to correct. In the illuminated areas of the photoconductor, a change in the electrostatic pressure is produced that locally modify the deformation of a reflective membrane which is electrically coupled with the photoconductor.

The performances of the device depend on many parameters and a suitable model for the device is desirable in order to find strategies and guidelines to improve it. The model has to cover the electrical, optical and mechanical parts of the device and has to describe both the behavior in the transient and in the regime condition.

Both organic and inorganic photoconductors are considered with different final applications. Indeed, inorganic photoconductor will be used to build fast deformable mirrors, whereas organic materials will be chosen for memory effect mirrors, where a certain shape is induced and kept for a certain time.

Starting from the output of the model, the photoconductor materials will be selected and/or synthesized and characterized. Based on them, the deformable mirror will be built and tested at the laboratory level and the results compared with those predicted by the model. A suitable projection system will be developed to produce the virtual actuators

pattern. At the same time, scientific astronomical cases that could benefit from this technologies will be studied.

The candidate will perform research activities focusing on different aspect of the presented technology. In particular, there will be the development of an opto-electric-mechanical model of the PCDM in the different working regimes; moreover, the candidate will be involved in the design and realization of mirror prototypes. Finally, a key step in the research program will involve the simulation of expected performances of an adaptive optical system in the field of astrophysics.

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