

Concept of a 50K+ DM

Flexible Optical BV, Leiden University

DM workshop, Delft, February 22, 2012

Outline

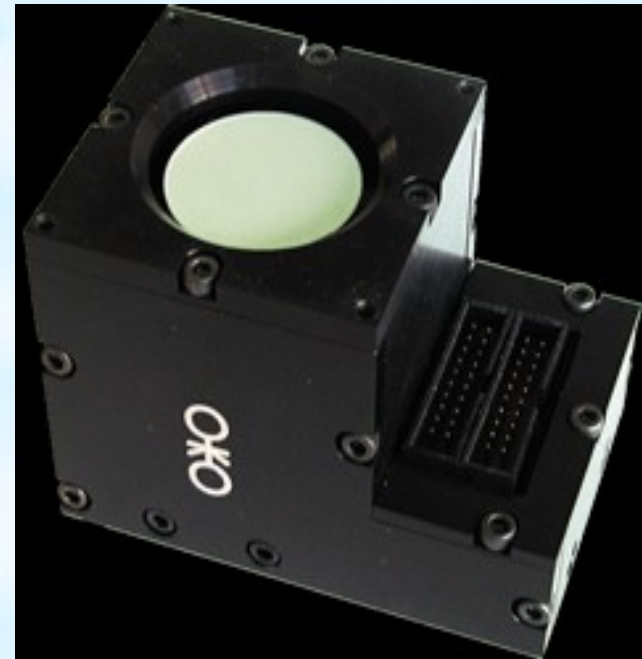
- Short company presentation and existing technologies and
- Solutions: multiplexing, low-voltage
- Future low-order concept of a DM
- Future high order concept of a DM
- Conclusions

About OKO Tech

- Since 1997 delivered ~ 1000+ deformable mirrors
- Current rate: 50 to 100 DMs per year, including custom designs (high power, cooled, femtosecond compressors, special devices)
- ~10+ closed-loop AO system sets per year.

OKO Piezo DM

- High power laser coatings: loads up to 30 kW, cooled
- 2 kHz bandwidth, 6 μm full stroke, 1.5 μm interactor
- 18 to 109 actuators
- Zero print-through for low-order Zernike modes (no hot spots in laser applications)



OKO MMDM

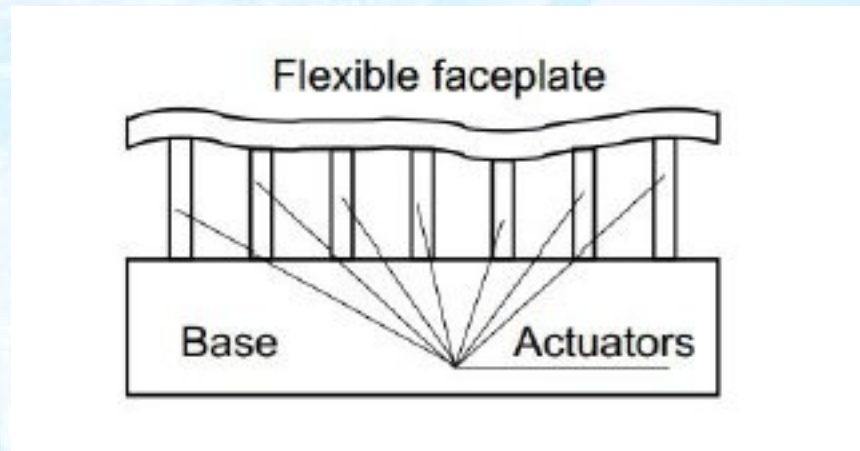
- Zero hysteresis
- Lambda/20 rms long-term stability (16 days test)
- Lambda/100 repeatability open loop
- Cryogenic operation
- 1 kHz bandwidth
- 9 μm WF defocus, 4.5 μm astigmatism, 3.5 μm coma, 2 μm spherical aberration
- 17ch +tip/tilt, 37, 59, 79, 159 channels, 15, 30,40,50 mm



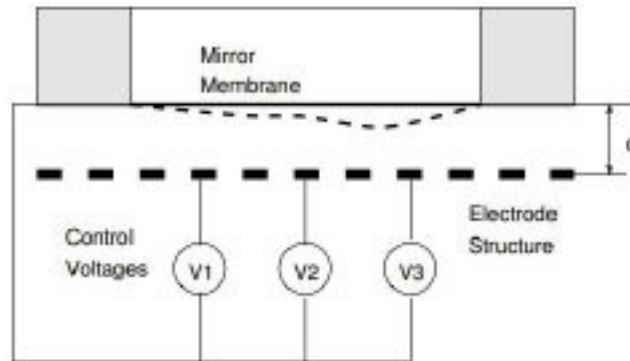
Feedforward control PDM

Direct control of Zernike modes with 37-channel piezoelectric DM without a wavefront sensor

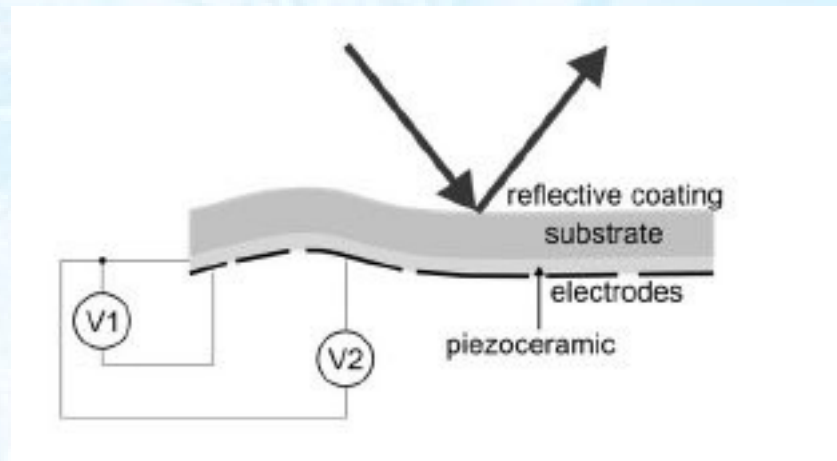
Continuous faceplate



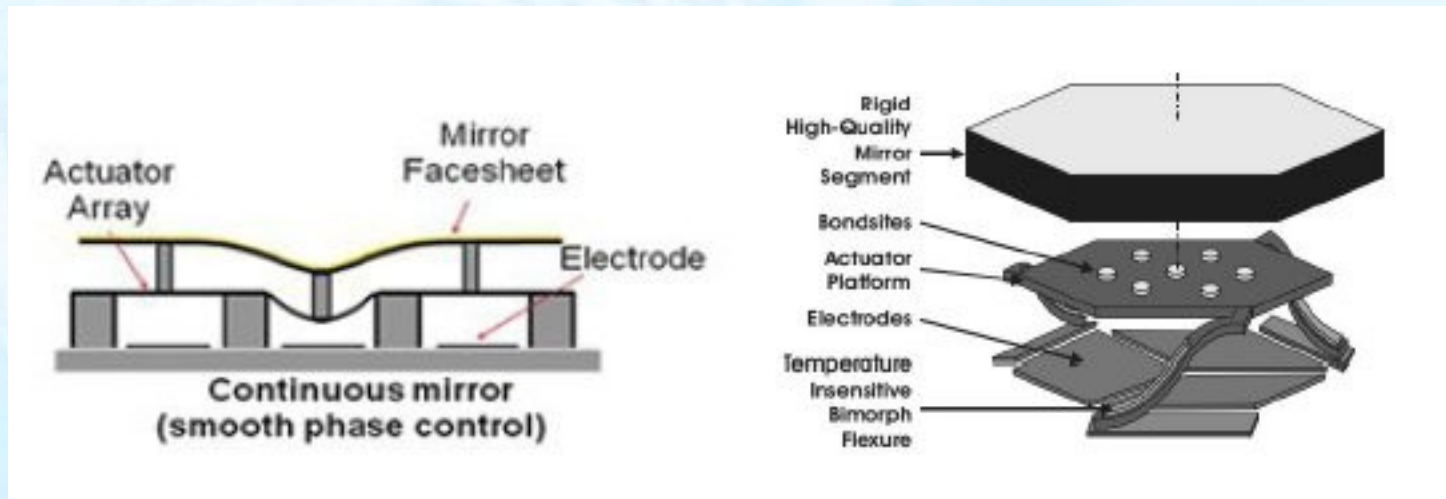
Membrane (electrostatic and magnetic)



Bimorph



Micromachined



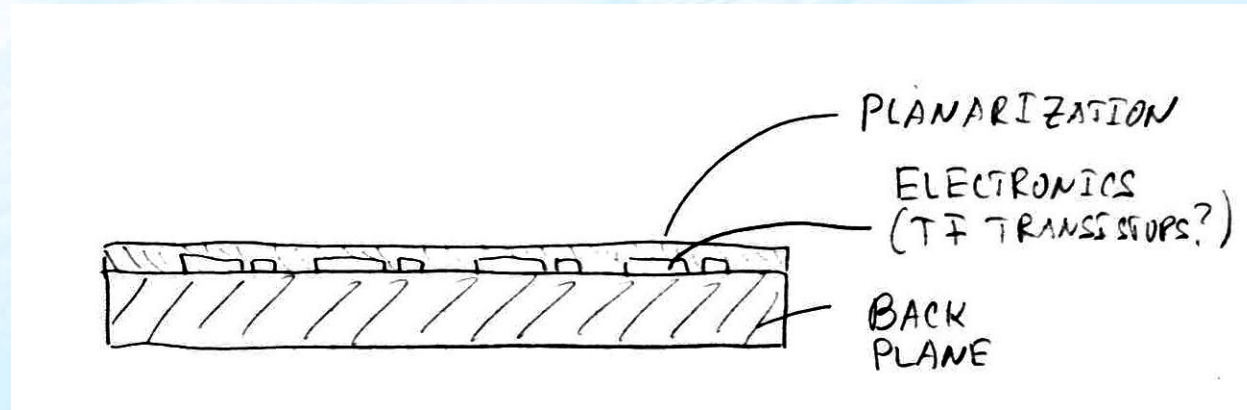
50k+ obstacles

- Direct actuator addressing:
one actuator = one wire
- High voltage actuators (except magnetic)
- Modal response (membrane, bimorph)
- Limited application

50k+ solutions

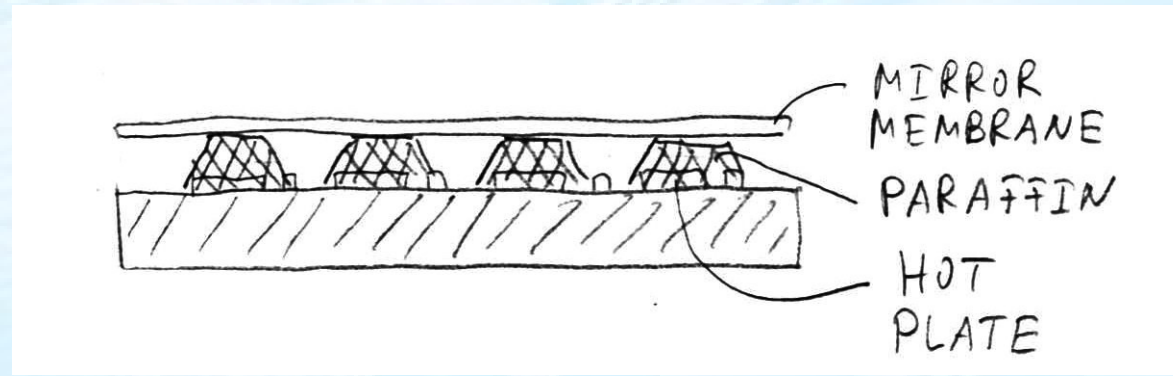
- On-DM multiplexing
- Low voltage control
- Zonal response, sacrificing low spatial frequencies

Backplane



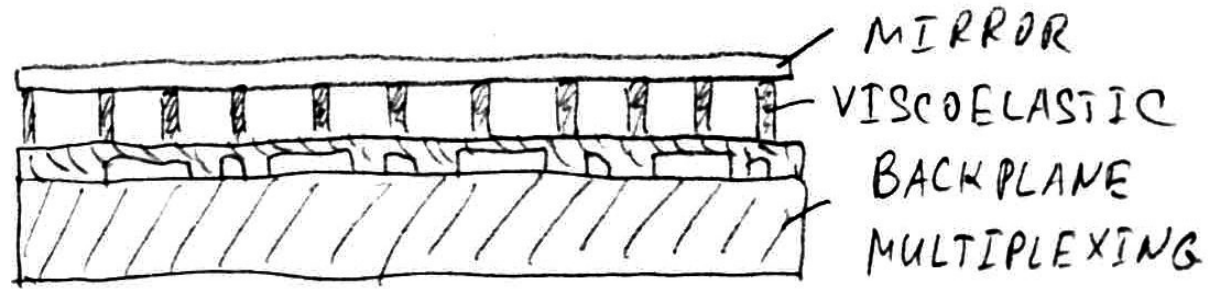
- Silicon: expensive, limited size, high voltage
- Thin film transistors on glass: cheap (?), large, low voltage

Paraffin



- Low voltage
- High power dissipation (1-10 mW per channel)
- Large forces, stroke,
- Slow (1 ms)

Patterned viscoelastic



- Critical parameters: elastic support, viscoelastic stiffness vs membrane stiffness.
- Very thin membrane, ~1% viscoelastic fill factor
- Voltages in the range 0 ... 50 V
- Fabrication issues
- Vacuum ??

Fabrication procedure

(both paraffine and viscoelastic)

- Separate fabrication of the backplane and membrane (similar to the approach used for OKO membrane mirrors)
- Bonding of the electronics part to the membrane part via very soft patterned viscoelastic
- Etching of the membrane part to release the membrane

- Micromachining techniques for fabrication of integrated light modulating devices

Dissertation Electrical Engineering, Mathematics and Computer Science 2003-03-31

Author: Sakarya, S.

Promotor: French, P.J. ·
 Vdovin G.

60

Pixelated membranes

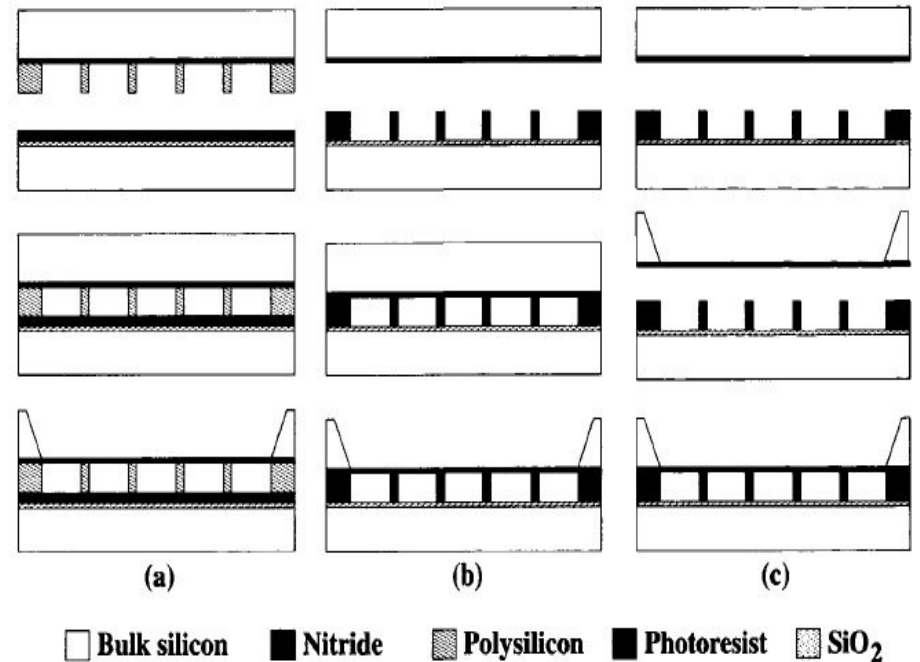


Figure 4.11: Approaches toward fabrication: (a) Polysilicon grid structure, (b) Photoresist grid structure, (c) pre-etched die with photoresist structure.

Project state

- STW proposal in preparation (OKO + Leiden Observatory)
- Two PhD students in Leiden, 4 years, TU Delft, DIMES involved
- Looking for industrial and third party support. Need 25%, can be in kind.
- Any other option is possible, including pure commercial development