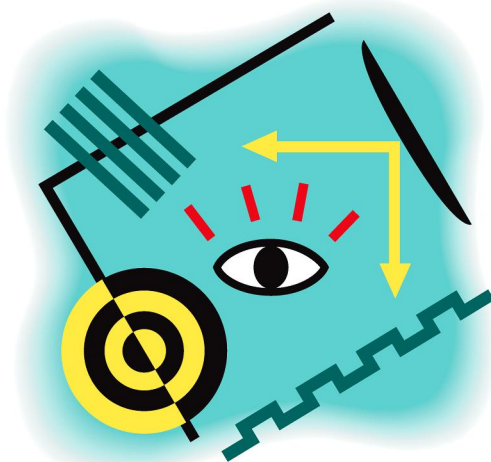


Introduction to PLV Technology



**SILICON
LIGHT
MACHINES**

A **SCREEN** COMPANY

Spatial Light Modulation at Silicon Light Machines

● Grating Light Valve (GLV)

- Demonstrated in 1993
- HDTV display applications in 2000
- Computer to plate (CTP) printing in 2001
- Long-haul telecomm, dynamic gain equalizers (DGE) and re-configurable blocking filters (RBF) in 2002

● Planar Light Valve (PLV)

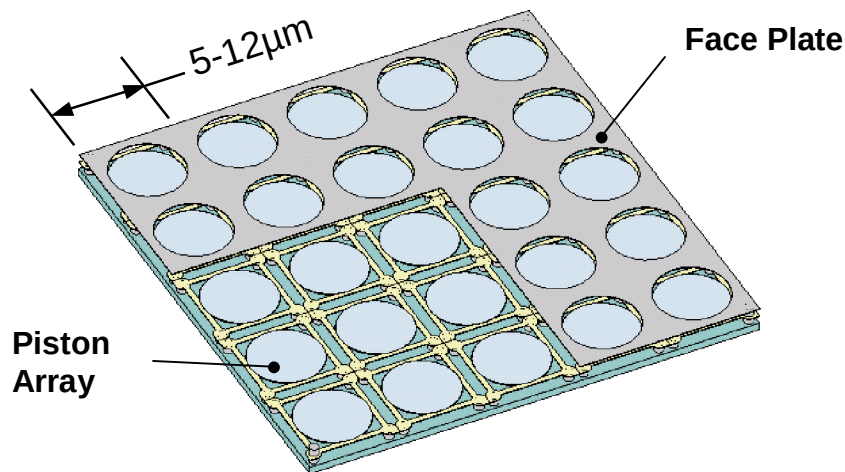
- Conceived, modeled, and patented in 2003
- DARPA contract for DUV maskless lithography 2004

Planar Light Valve Technology



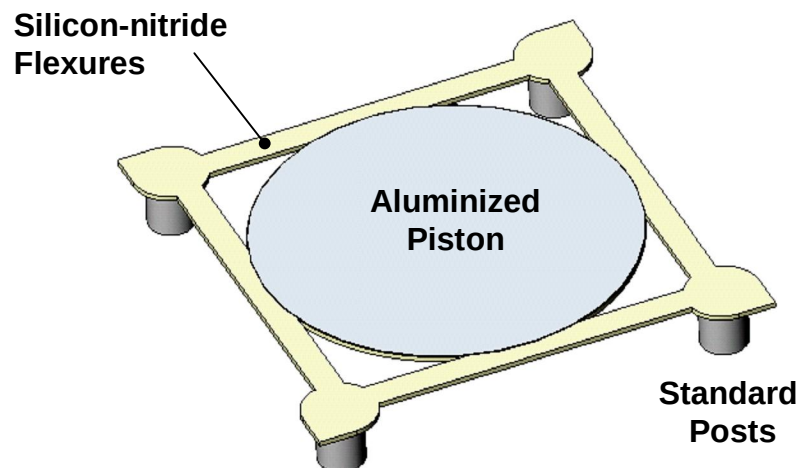
- **Silicon Light Machines conceived a 2D analog of the 1D GLV**
- **New device is based same CMOS process and materials used in the proven GLV technology, but arranges pixels in a 2-dimensional, close-packed array.**
- **New device inherits desirable properties of GLV and extends applications where GLV could not be used.**
- **Different embodiments of device can provide different modulation functionality: Amplitude, Phase, or Both**

Planar Light Valve (PLV)



- Å High contrast
- Å Analog gray-scale
- Å Non-contact
- Å Borderless pixels
- Å High power handling
- Å High reliability

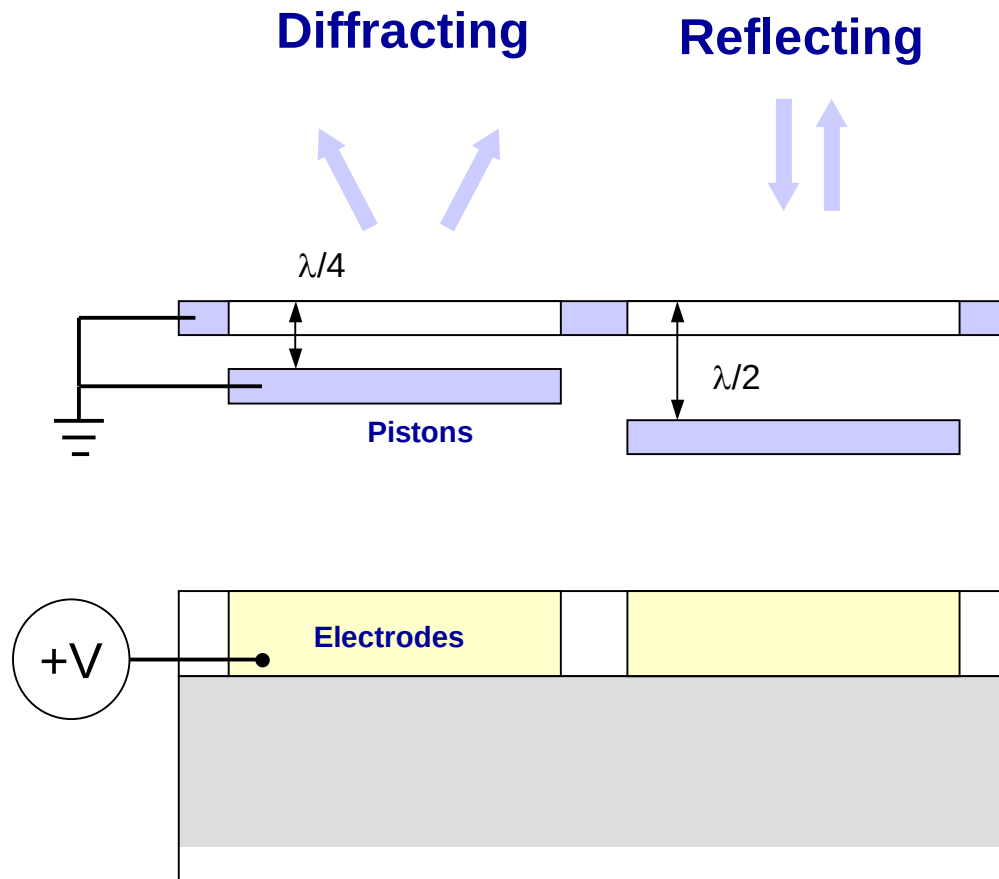
**Inherited
properties
of GLV**



- Å 2D geometry
- Å Smaller pixel size
- Å Larger étendue
- Å 100% fill factor
- Å Very high speed

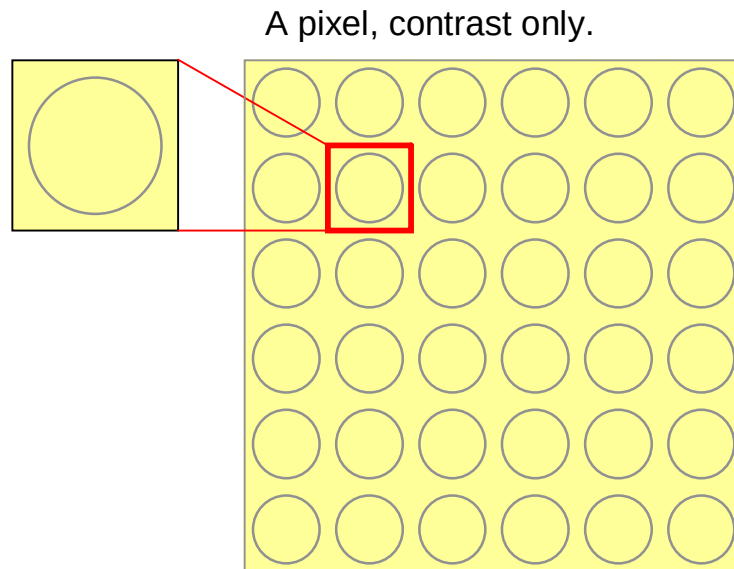
**New
properties
of PLV**

PLV Cross-Section

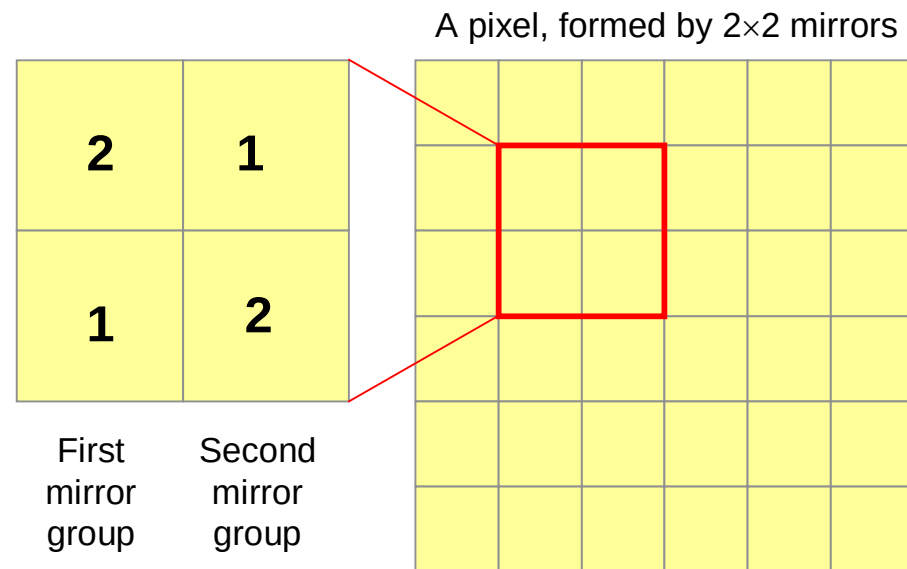


- Device changes from reflective state to scattering state by deflection of the MEMS pistons through quarter wavelength.

Amplitude or Phase Modulation



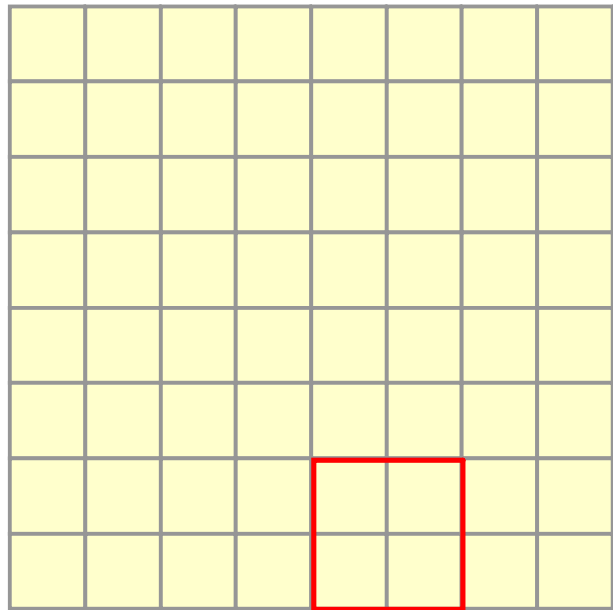
(a) Amplitude Modulator



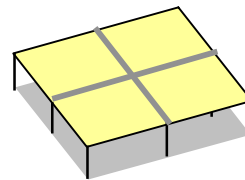
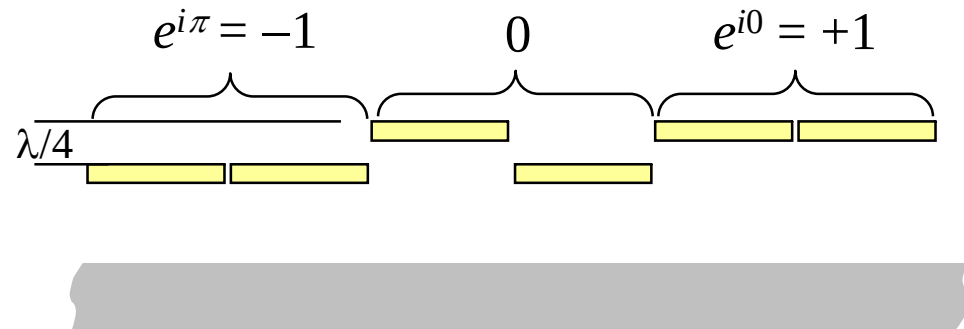
(b) Amplitude+ Phase Modulator

- The piston structure of the PLV can support different embodiments depend on application requirement.
- By altering the piston-faceplate design, the PLV can be straightforwardly modified into a phase modulator.

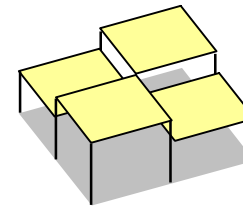
Amplitude and Phase Modulation



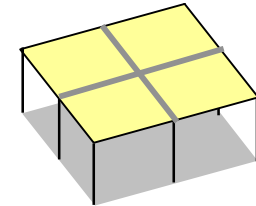
1 pixel with
 2×2 pistons



Reflecting state,
 π phase-shift



Diffracting state



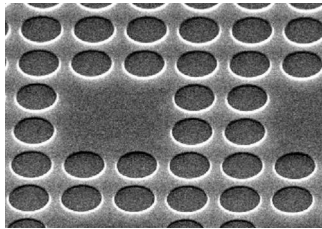
Reflecting state,
0 phase-shift

- Using this PLV structure, a single pixel can assign arbitrary amplitude and phase.

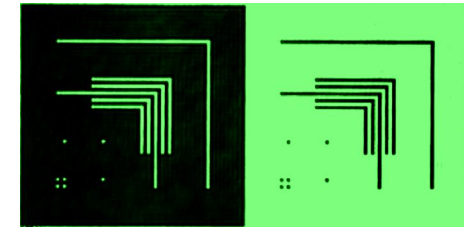
PLV Development Summary



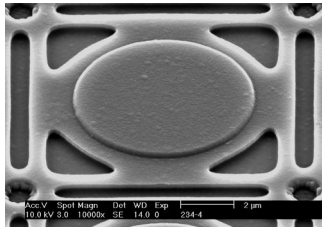
Static
PLV



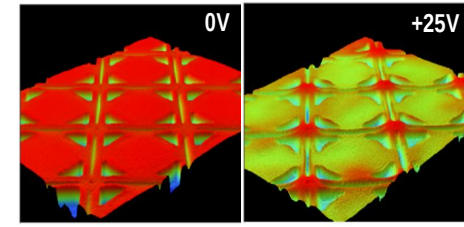
- Static (non-MEMS) PLV surface
- Single etch depth
- Demonstrate 500:1 contrast
- 532nm images generated



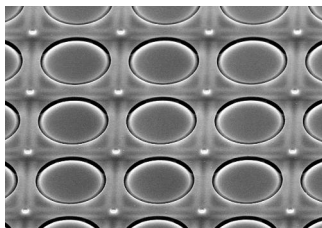
Piston
s Only



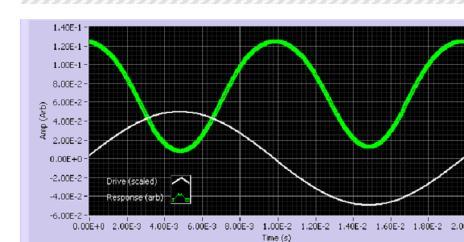
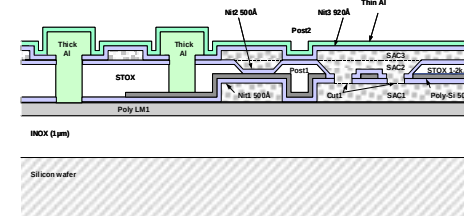
- Piston MEMS layer only
- Used existing GLV process
- Piston mechanics validated
- Light modulation results



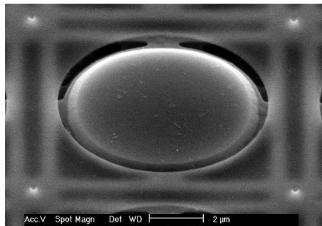
Non-
electrical
PLV



- Non-electrical device
- First double-layer device
- Piston + face plate
- No piston conductor



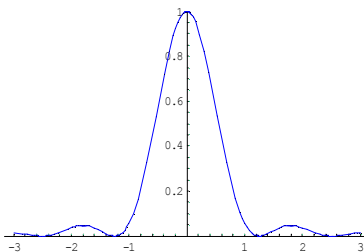
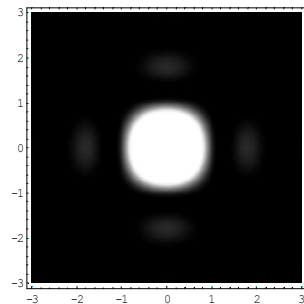
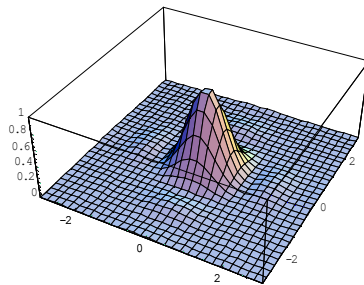
Electrically
Active PLV



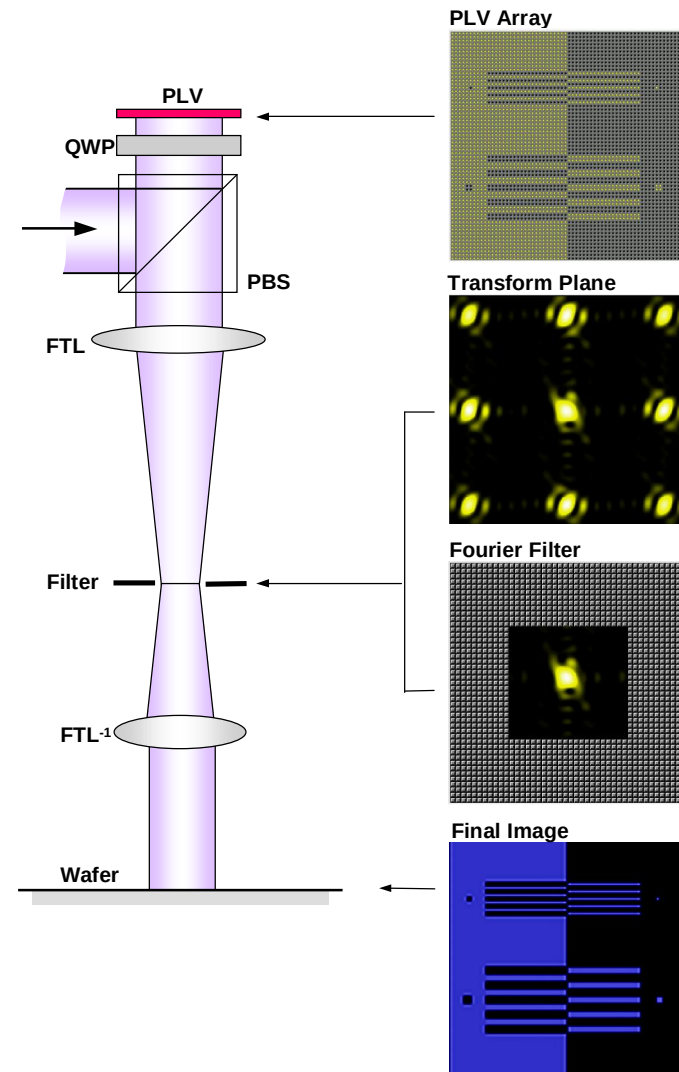
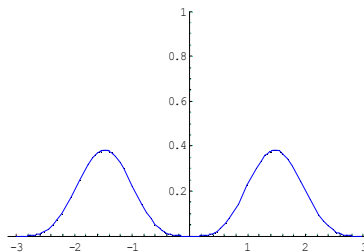
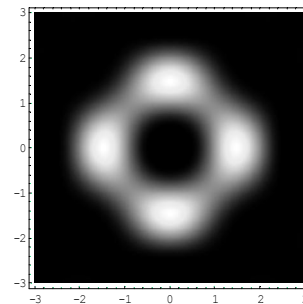
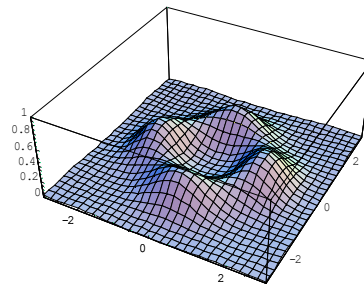
- First electrically active PLV
- Integrated membrane conductor
- Successfully demonstrated 9/05
- Design learning rolls into PLV1

Optical Response & Imaging

Reflecting ($\phi=0$)



Diffracting ($\phi=\pi$)





Thank You