

Spatial Light Modulators (SLM)

One-megapixel SLM.

Device

As an example of the Fraunhofer IPMS' SLM technology, a matrix device comprising about 1 million micromirrors is shown with an optically active area of $33 \times 8 \text{ mm}^2$. The matrix can be reprogrammed at a frequency of 2 kHz, providing each torsionally suspended micromirror with an individual deflection.

The device configuration and size can be adapted to customer needs. A Customer Evaluation Kit is available to help explore new applications, consisting of a smaller matrix (64,000 mirrors), a driver board and software.

Architecture

The devices are so called MOEMS (Micro Opto Electro Mechanical System). Micromirrors are fabricated with a pitch of $> 10 \mu\text{m}$ using thin film technology on top of a planarized CMOS backplane. The circuit provides electrodes underneath the mirrors to supply each mirror with individual voltages. The voltage difference between the electrode and the mirror generates an electrostatic force that deflects the mirror towards the electrode.

The mirror material is a highly reflective aluminium alloy. Mirrors made from alternative materials and coatings for high reflectivity for very demanding applications are available or under development.

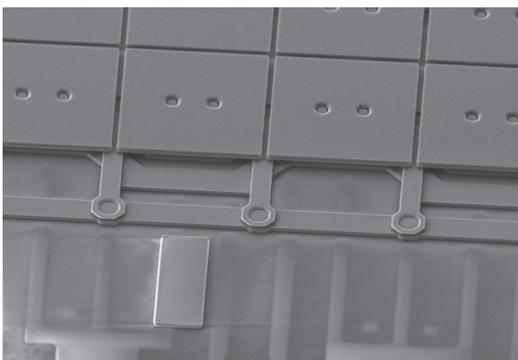
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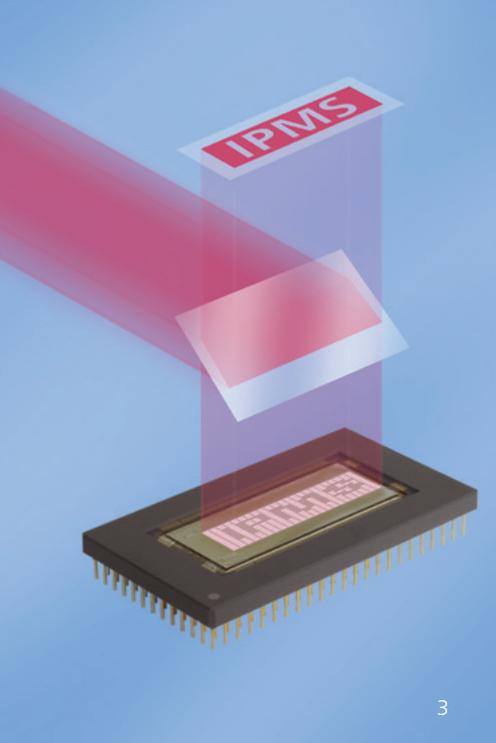
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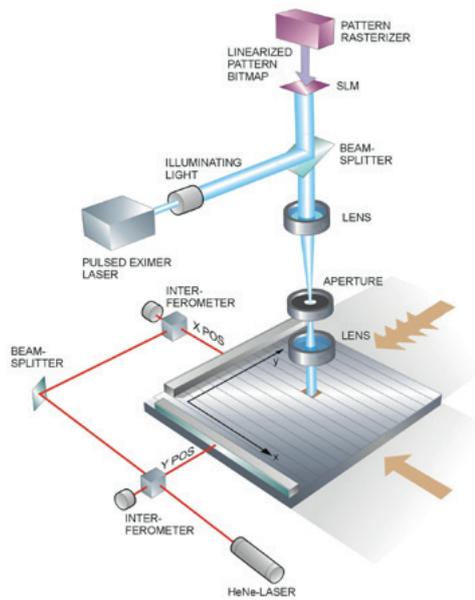
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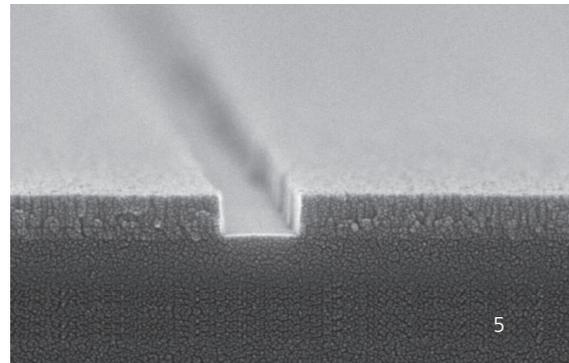
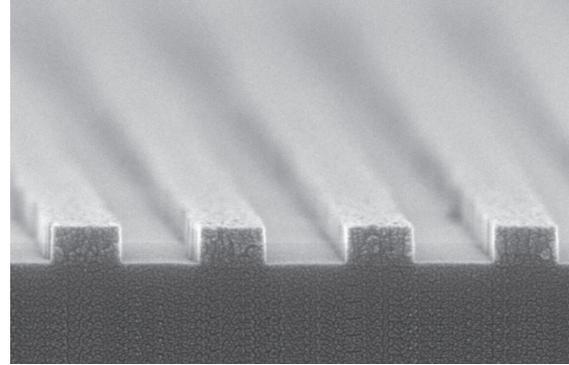
SEM image of $16 \times 16 \mu\text{m}$
micromirrors.



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Applications

SLMs can be applied wherever a homogenous beam's entire cross-section needs to be modulated simultaneously. SLMs from Fraunhofer IPMS are optimized for short pulses of monochromatic light in a broad wavelength spectrum. Line devices (one-dimensional mirror arrangements) operate under continuous wave (cw) illumination.

Micro lithography

As an application example, one-megapixel matrix devices of Fraunhofer IPMS are used in high end mask writing tools in the semiconductor industry.

Laser Direct Imaging (LDI)

SLMs can be used for Laser Direct Imaging in a way similar to mask writing microlithography: the substrate, e.g. a PCB panel, is exposed by SLM based pattern projection. The fabrication of masks as in conventional lithography processes is obsolete – each panel can even have individual features, e.g. for individual connections, serial numbers, etc., or for on-the-fly correction of overlay or scaling mismatch.

Further applications

- Laser marking
- Metrology
- Optical computing
- Laser surgery
- Shaped illumination

Data of one-megapixel SLM

Parameter	Value
Matrix size	2048 x 512 mirrors
Pixel size	16 x 16 μm^2
Frame rate	2 kHz
Mirror edge deflection	0 - 180 nm
Wavelength	248 nm
Average beam power	up to several Watts
Data voltage	0 - 25.5 V
Data inputs	256

3 Projection principle: a beam splitter directs a beam onto the SLM, the beam is modulated and projected to a screen (top), where it generates the image.

4 Schematic: Use of an SLM in a laser mask writer.

5 Lines and spaces generated by SLM.