

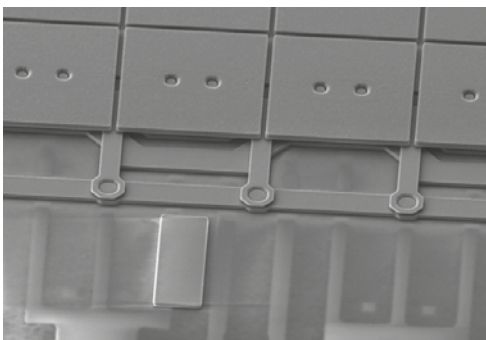
Spatial Light Modulators (SLM)

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.



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

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.

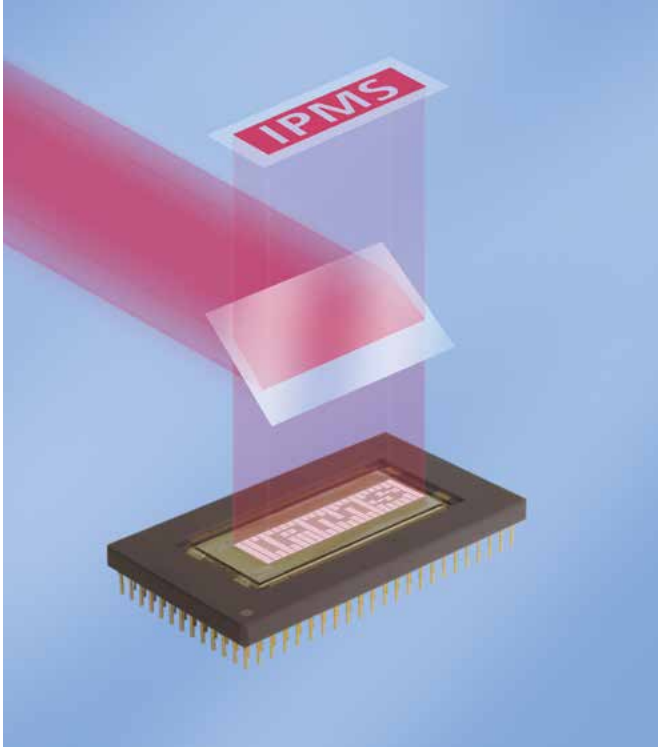
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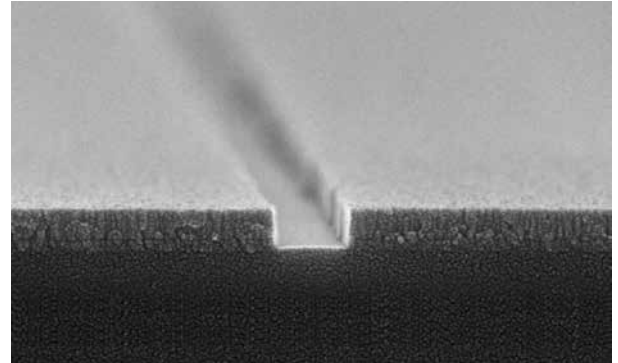
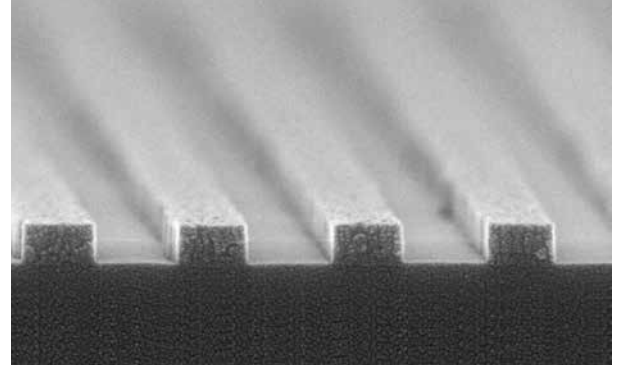
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Projection principle: a beam splitter directs a beam onto the SLM, the beam is modulated and projected to a screen (top), where it generates the image.



Lines and spaces generated by SLM.

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.

Microlithography

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)

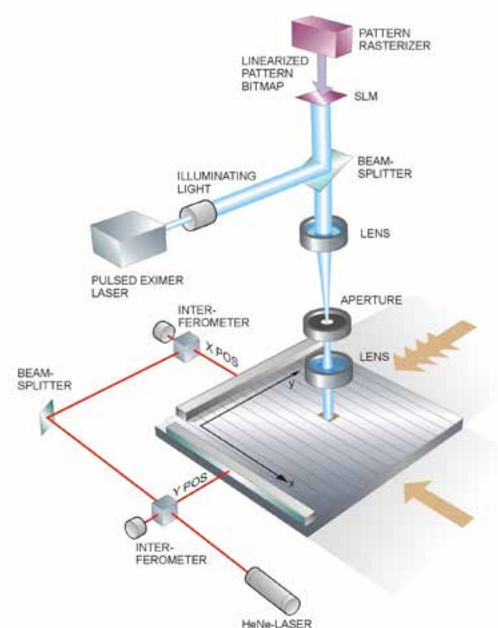
SLMs can be used for Laser Direct Imaging in a way similar to mask writing microlithography: the substrate, e.g. a PCB panel, is exposed by SLM based pattern projection. The fabrication of masks as in conventional lithography processes is obsolete – each panel can even have individual features, e.g. 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 |



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