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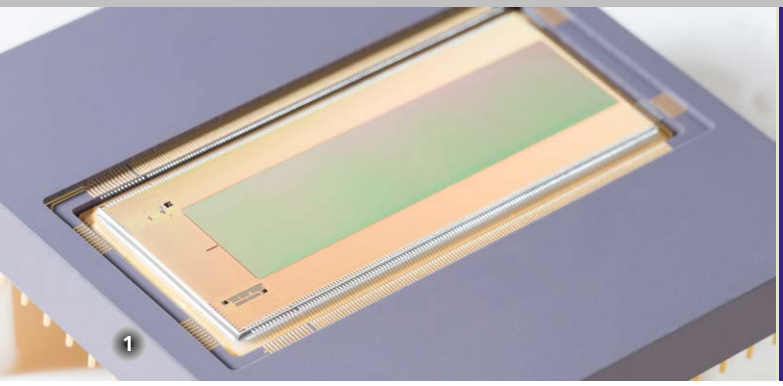
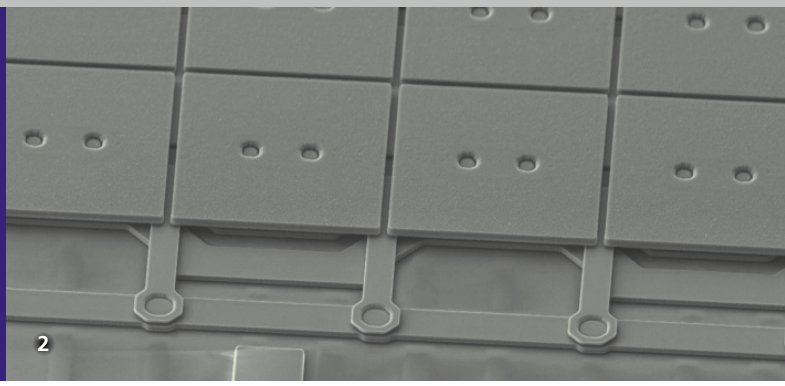
FRAUNHOFER INSTITUTE FOR PHOTONIC MICROSYSTEMS IPMS





1 *One-megapixel SLM.*
2 *SEM image of 16 µm × 16 µm micromirrors.*

SPATIAL LIGHT MODULATORS (SLM)

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The device

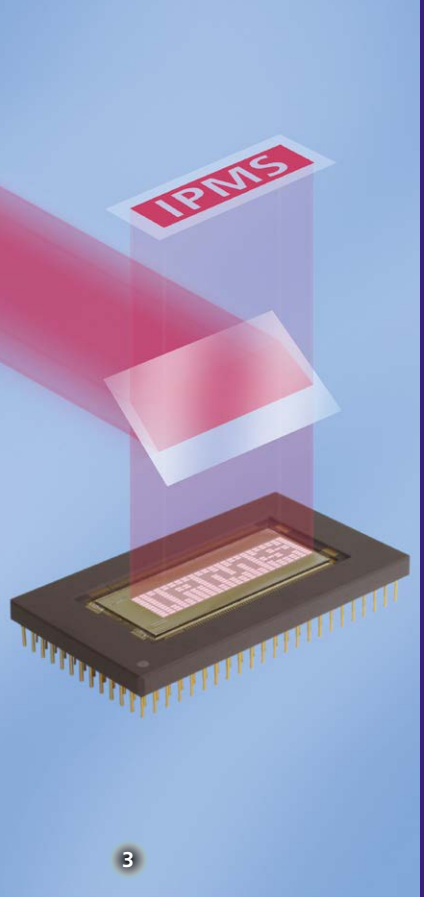
As an example of the Fraunhofer IPMS SLM technology, a matrix device comprising about 1 million micromirrors is shown with an optically active area of 33 × 8 mm². The matrix can be reprogrammed at a frequency of 2 kHz, providing each torsionally suspended micromirror with an individual deflection.

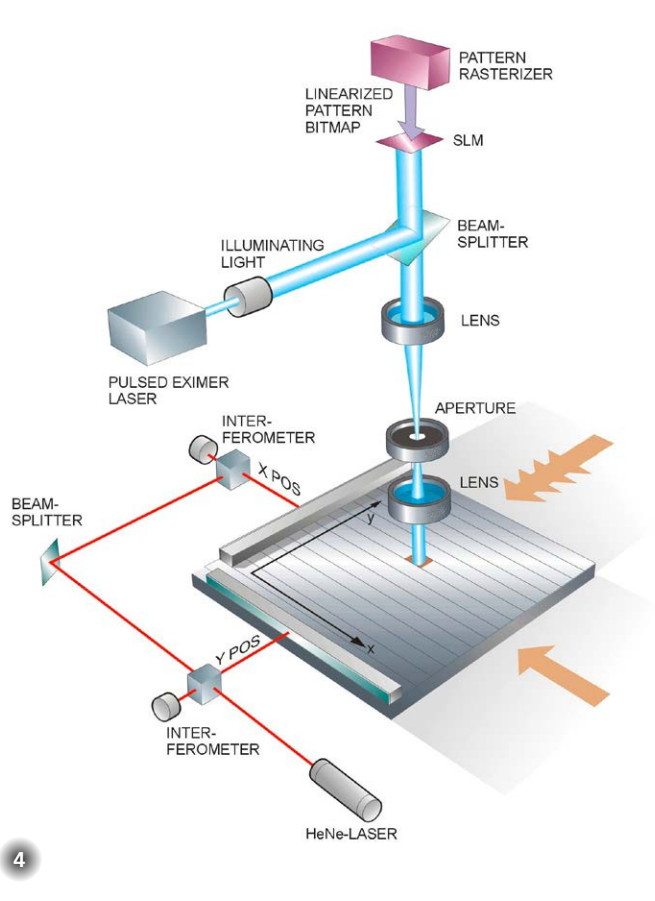
The device configuration and size can be adapted to customer needs. A Customer Evaluation Kit is available to help explore new applications, consisting of a smaller matrix (64,000 mirrors), a driver board and software.

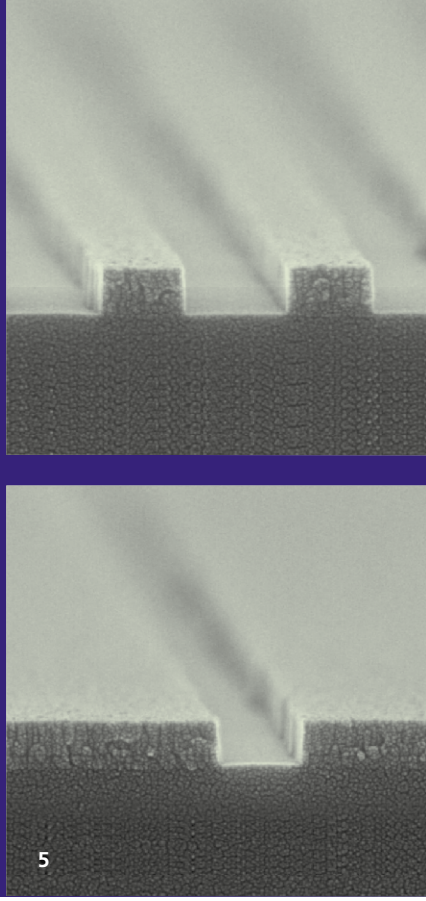
Architecture

The devices are so called MOEMS (Micro Opto Electro Mechanical System). Micromirrors are fabricated with a pitch of >10 µm 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.







Applications

SLMs can be applied wherever a homogenous beam's entire cross-section needs to be modulated simultaneously. Fraunhofer IPMS SLMs 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, an one-megapixel matrix from Fraunhofer IPMS is currently used in the Sigma series high-end mask writers made by Micronic Mydata, Sweden.

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	Remark
Matrix size	2048 × 512 mirrors	
Pixel size	16 × 16 µm²	
Frame rate	2 kHz	
Mirror edge deflection	0 - 180 nm	up to 350 nm possible
Wavelength	248 nm	up to ca. 1500 nm possible
Average beam power	40 mW	elevated power possible; wavelength dependent
Data voltage	0 - 25.5 V	analogue
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 using SLM based photolithography.