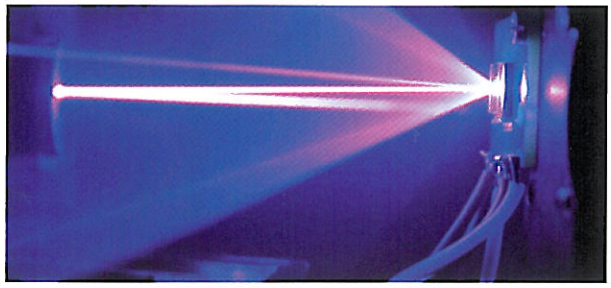
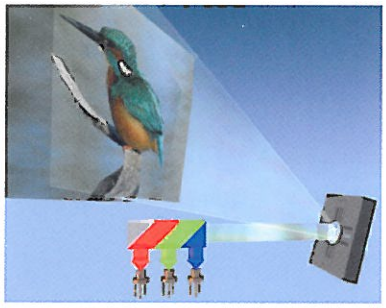
Wafer level testing of MEMS mirrors with PSD

After a dip due to the telecom crash almost 10 years ago the interest for very small scanning mirrors, so called MEMS (Micro-Electro-Mechanical Systems) mirrors, has increased dramatically the last few years. These mirrors can now not only be found in telecom applications but have found its way into several other fields such as bar code scanners, optical spectrometers, confocal microscopes and displays.

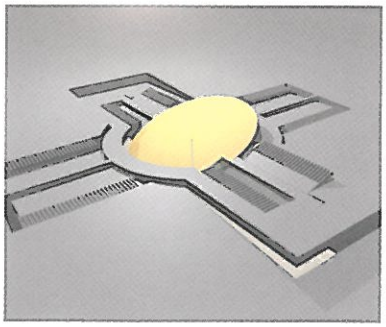


A recent product which is about to reach the market are projectors with small enough footprint to be incorporated in a mobile phone. Such a projector can be realized by a laser-projection display system which basically consists of three laser sources (red, green and blue), some optics and a double axis scanning micro mirror. By exact and rapid control of the micro mirror the laser beams can project large moving images despite the very compact design.



High performance devices

At Fraunhofer-ISIT such scanning micro mirrors are developed and manufactured applying standard MEMS technology. The scanners comprise gimbal mounted MEMS mirrors of 1mm diameter with elastic torsion suspensions. Oscillations of the MEMS mirror are driven by electrostatic actuation of stacked vertical comb-drives either in quasi-static or in resonant operation.



Outstanding features of the scanners are high scan frequencies of up to 100 kHz, scan angles of up to 100 degrees and very high oscillatory stability.

Hermetical package

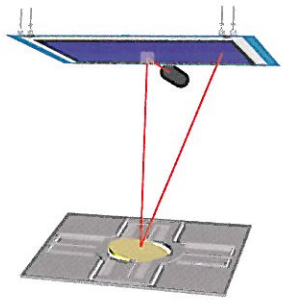
The scanning mirrors are hermetically packaged in a vacuum environment on wafer level using a patented fabrication process.

Actuating the scanning mirrors in a local vacuum environment offers significant advantages over former atmospheric pressure actuation concepts. Gas damping is almost completely reduced enabling the large angle scanning and high scan frequencies even at low electrostatic driving voltages. The hermetic packaging also offers a durable protection against contamination by particles, fluids or gases, something that makes the scanners not only useful for micro-projection displays but also in more harsh environments like in endoscopes to be sterilized by autoclave treatment or in automotive MEMS scanner applications, where hermetic encapsulation is a precondition.

Wafer level testing

In order to ensure that the MEMS scanners meet the specifications of customers, Fraunhofer-ISTS has developed a post processing wafer level test system based on SiTeks PSD 2L45_SU24.

A laser beam is projected onto a MEMS mirror via a beam splitter which is fixed on the PSD surface. The mirror reflects the beam onto the PSD where the frequencies and amplitudes of the two scanning directions are measured. Also the nonlinear behaviour of the torsion suspensions and the oscillatory stability can be analysed.



By using the large and fast 2L45, a PSD with an active area of 45 x 45 mm^2, the MEMS mirrors can be characterized over their entire scan angle region at high speed.

This test system has been installed as a module on a commercially available wafer prober and enables the reliability and high speed required for semi-automatic wafer-level testing in production.