

Application note: MEMS Measurements

The **MicroMap 5000** analyzes MEMS and surfaces down to a few micrometer of size, using a ccd array and microscopic imaging. The object is illuminated by a laser beam through the microscopic lens, and the reflected light from the object interferes with an internal reference beam, giving 25 or 30 high quality interferograms per second. These interferograms give information on surface shape and surface displacements.

The MicroMap 5000 can be used to measure both vibrations and static deformations in two different ways; in real time mode or by optical phase shifting. In the real time mode, the displacements are shown as fringes overlaid on the object image. This way, resonance vibration modes are easily seen when scanning through broad frequency bands, and static deformation can be monitored real time as they appear. When phase shifting is used, vibrations and static deformations can be displayed as 2D and 3D graphics, as shown below. Vibrations can also be displayed as animations, giving an excellent quantitative and qualitative presentation of the vibration. Visit www.optonor.no to see this.



Static deformations

Figure 1 shows deformations of a 3x3 mm silicon membrane. The membrane was deformed by gas pressure, and the MicroMap 5000 reveals a small and quite irregular deformation across the membrane. Displacement data is available for all points on the surface, and deformations along lines across the object can also be displayed. The deformations can also be monitored real time by fringes overlaid on the object image. Sensitivity with the phase shifting routine is less than 1 nm.

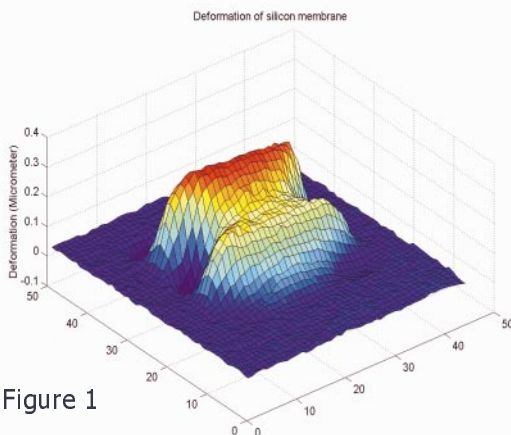


Figure 1

the MicroMap 5000 normally controls the vibration excitation of the specimen. Vibration amplitudes below one nm can be resolved, and frequencies ranging from near DC and up to several Megahertz can be measured.

Single frequency vibrations

Figure 2 shows a 1x1 mm structure vibrating at 9820 Hz. The figure shows the deflection for a given vibration phase value. By displaying the deflections for all phase values 0-2pi continuously, we see an animation of the object vibration. Such animations can be viewed at our home page www.optonor.no.

When using phase shifting vibration recordings,

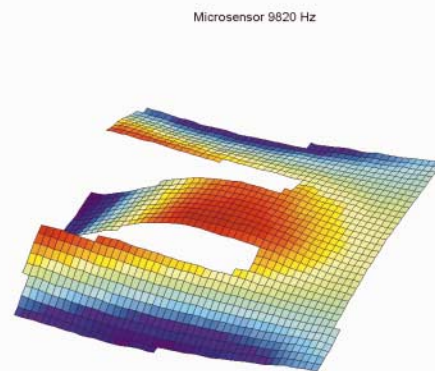


Figure 2

Surface contouring

Figure 3 shows the surface topography of a metal ball from a ball bearing. The scratch in the surface is approximately 140 nanometer deep.

Surfaces down to a few micrometer of size can be analyzed with the MicroMap 5000.

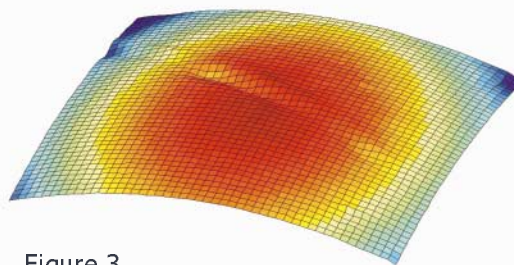


Figure 3

MicroMap 5000 - understanding your MEMS design

The MicroMap 5000 is a powerful tool for research and development engineers in the development and design of MEMS and other small structures. Most MEMS, like pressure sensors, gyros, accelerometers, pumps, valves etc., have their functionality directly connected to the dynamic or static displacement properties of the microstructure. The MicroMap 5000 is an excellent tool in the analysis of such structures, both for static deformations and deflections as well as for vibrations and contouring. The system is very robust and can be used in normal laboratory environments without a vibration isolated table.

With the full field facility of the MicroMap 5000, the real time measurement function and the 2D and 3D graphics display, animations included, you get information which can be the key to better functionality of your new MEMS design.

The MicroMap 5000 can also be adapted to production control of MEMS and microstructures.

Specifications, standard system for vibration and deflection measurements

Size of optical head:	10 cm diameter, 40 cm height	Operating system:	Windows 98/NT
Weight of optical head:	3 kg	Imaging objectives:	40 X – 4.3 X
Laser:	5mW HeNe	Laser class:	III A
Frame grabber:	Matrox	Minimum object size:	< 0.1 mm full field
Min. vibration frequency:	< 30 Hz	Maximum object size:	> 3 mm (The VibroMap 1000 can be used for larger objects.)
Max. vibration frequency:	Unlimited (real time meas.) 25 kHz standard for quant. measurements. Up to 10 MHz non-standard for quantitative measurements	Vibration ampl. resol.	< 1 nm
		Static deformation resol.	< 1 nm
		Surface topography resol.	< 1 nm
Object surface:	Surface preparation normally not required. Both specular and rough surfaces can be measured.		
Measurement environments:	Normal laboratory environments. No vibration isolation required. No rotating machinery or other noise sources should be allowed near the testing site.		

See also our other products for the following applications:

Vibration measurements of macro structures - Contouring - Deformation measurements - Nondestructive testing NDT - Sound wave measurements - Stress and Strain measurements

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