Scanning Acoustic Microscopy

Operation principle

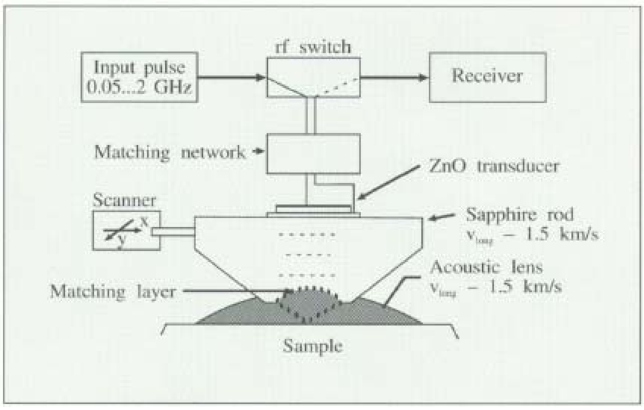

Fig. 1:

The acoustic microscope operates with the pulse reflection method. A special acoustic objective - centrepiece of the microscope - produces, transmits and receives short sound pulses of high penetration rate. It is a sapphire cylinder with a sound transducer (a thin ZnO film) sputtered on its upper face and a cavity polished in the base opposite the transducer. The ZnO film (a piezo-ceramic layer) converts high frequency electromagnetic vibrations into sound vibrations, which are propagated as a plane-parallel wave field inside the sapphire. The cavity focuses the sound field on the sample together with the coupling medium (water). The immersion system cavity/medium is therefore the acoustic lens.

The acoustic objective receives the sound pulses reflected from the sample during the intervals between transmission, the transducer transforms them into electromagnetic pulses and a monitor system displays them as a pixel with defined grey value. To produce an image the acoustic objective scans the sample line by line.
The time required to build up an image depends on the scan rate. For a given deflection of the acoustic objective at 50 Hz and 512 pixels per line, it takes about 10 sec, to produce an image of 512 x 512 pixels with the Evolution PI/II.
With the SAM TEC`s technology 32 Mbytes pixel are possible the image quality is determined by the signal-to-noise-ratio; this increases with the quantity of the transmitter pulses per pixel. For pulse duration of 20 ns, a

repetition rate of 500 Hz and a scanning time of 20 ms per line, 20 pulses per pixel are collected with the unique KSI high-end systems.

The resolution of the acoustic microscope is not easy to specify. It is determined by aperture and acoustic wavelength, like every fraction-limited image.

The acoustic wavelength is the result of frequency and sound velocity and depends on the material as well as on the waveform of the sound field (longitudinal, transversal, Rayleigh wave) inside the materials.

The maximum possible diffraction has been experimentally determined. It was possible to clearly separate grating channels of an optical grating 0.4 µm apart (Fig.2). This means that the resolution of surface images produced by the acoustic microscope is comparable with that of a light microscope.

Resolution test sample

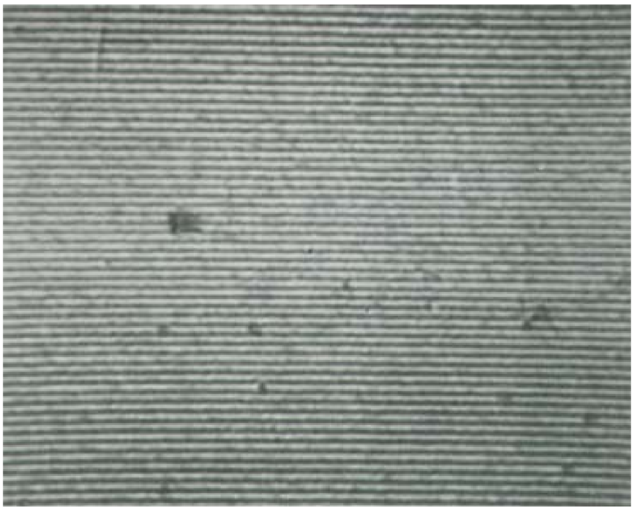

Fig. 2: Acoustic image of an optical grating used as a test of resolution. Distance between lines: 0,4 µm, Frequency: 2 GHz, 2000x

At lower frequencies the pattern was not resolved at all, but at 1,7 GHz, and above it can be seen quite well.

SAM resolution test sample: A fused quartz target with chrome plated features, down to 456 lines/mm (USAF Target 1952)

Light microscope image:

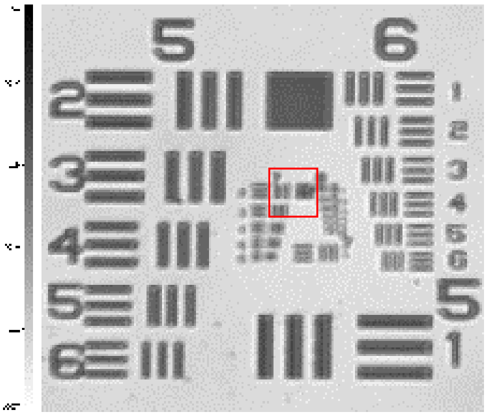

Fig. 3

Evolution PII SAM resolution test image with magnification 2000x

Detail of the sample (see red area of light microscope image)

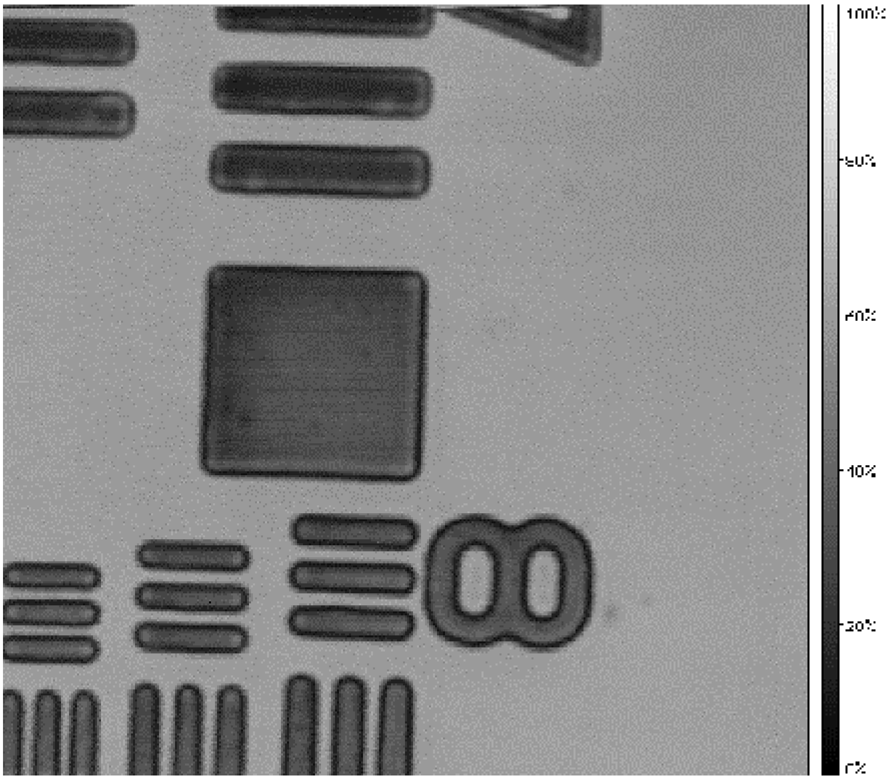

Fig. 4