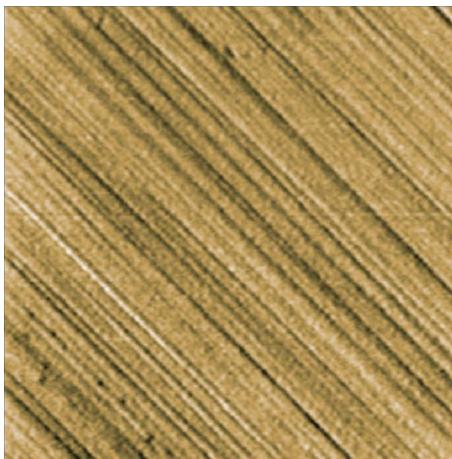


MFM-Measurement of Bits in a Hard Disk

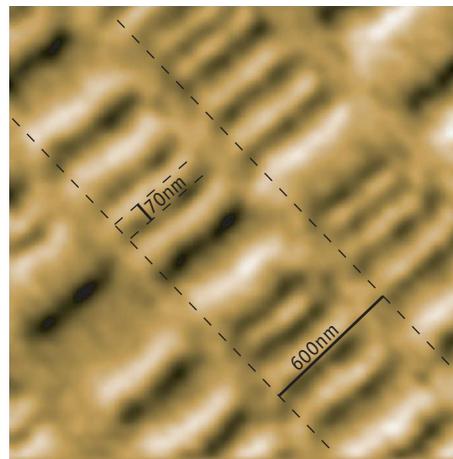
Nanosurf® AFM Application Note

Magnetic storage was first invented by Valdemar Poulsen in 1898, first applied for audio purposes on a plastic strip in the German Magnetophon in 1936, and has since its first use for data storage in 1951 evolved to become the most important means for digital storage in modern computers, particularly in the form of hard disks. The storage medium of the hard disk has two preferential magnetisation directions. The magnetic field of the hard disk write head determines in which of these directions the medium is magnetised. The head writes ones and zeros by reversing or not reversing the magnetisation direction of the medium at regular intervals. Where the magnetisation reverses, a magnetic stray field emanates from the medium, which can be detected by various means.

The Nanosurf Mobile S and EasyScan 2 (with mode extension) can image the magnetic stray field in the MFM (Magnetic Force Microscopy) imaging mode. In this mode, the stray field is detected by sensing the magnetic force it exerts on a magnetically coated cantilever tip. This force causes a change in the cantilever resonance frequency and thereby shifts the phase of the cantilever vibration. The MFM image is measured by recording the phase contrast image when scanning a plane parallel to the surface in the same location, but a few nanometers away from the sample.



Surface topography measurement (dynamic force mode). The recording tracks, as evidenced in the MFM image, run parallel to the grooves.
Scan range $2\ \mu\text{m} \times 2\ \mu\text{m}$ / Z range 5 nm



MFM measurement (phase contrast mode). White and black areas connote magnetisation reversal, where white stands for repulsive forces and black for attractive forces.
Scan range $2\ \mu\text{m} \times 2\ \mu\text{m}$ / Phase range 5°

The measurements shown here were taken with a Nanosurf Mobile S Large Scan head using NanoWorld MFMR cantilevers. The sample was a 10GB single head 3.5" hard disk magnetised in the plane of the medium with a track distance of 600 nm and a bit length of 70 nm, which corresponds to 42k TPI and 363k BPI.