ADVANCED NANOSCALE METROLOGY WITH AFM

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ABSTRACT

As the design rule becomes smaller, precision metrology becomes difficult to meet the demand from the industry. Traditional metrology tools, such as stylus profiler, optical microscope, and CD-SEM are running out their resolution. Atomic Force Microscope (AFM) has gained attention as a new candidate for nanoscale metrology tool. However, most conventional AFM systems use a piezo tube actuator, which has significant background curvature and crosstalk between x-y-z axes, making them unsuitable for metrology application.

We have developed a new AFM, where the z scanner is separated from the x-y scanner. The x-y scanner scans only the sample in x-y plane, while the z scanner scans only the probe in z-axis. For x-y scanner, we used a single module parallel-kinematics flexure stage, which has high orthogonality and minimum out-of-plane motion. A stacked piezo actuator was used for z-scanner, which has high force and fast response. We also devised a unique beam bounce detection method such that the z-servo system can have high bandwith.

With the new AFM, we were able to measure extreme features, which were very difficult or impossible to measure previously. Fig. 1 shows 0.18μm wide, 0.5μm deep trenches in 1:1 aspect ratio 3D rendering. Fig. 2 shows a Pole Tip Recession (PTR) in a MR head, where the PTR is only 9nm. Both are unprocessed raw data.

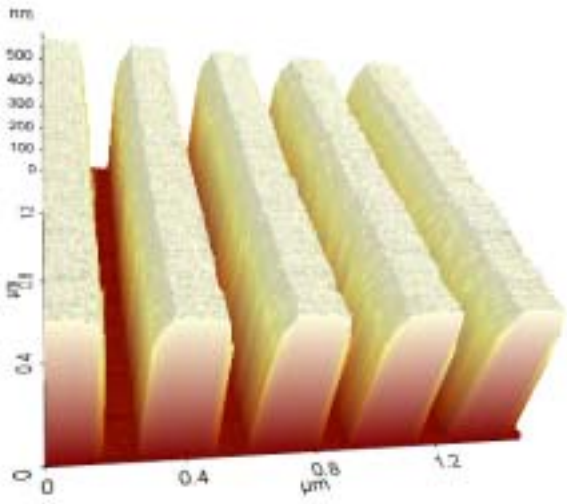

Fig.1 AFM image of 0.18μm wide, 0.5μm deep trenches shown in 1:1 aspect ratio 3D rendering

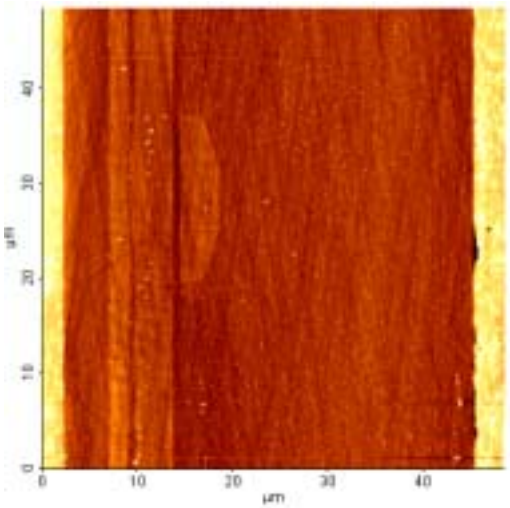

Fig. 2 AFM image of a Pole Tip Recession (PTR) in a MR head. The PTR is 9nm, and the pole appears 2nm higher than its surroundings.