Cross-sectional AFM in SEM

Byong Chon Park[1*], Ju-Yeop Lee[2], Woon Song[1], Dal Hyun Kim[1], Jaewan Hong[2], Jin Seung Kim[3]
[1] *Korea Research Institute of Standards and Science, Daejeon 305-340, Korea*
[2] *Nanofocus Inc, Seoul 152-050, Korea*
[3] *Chonbuk National University, Jeonju 561-756, Korea*
[*] *Email : bcpark@kriss.re.kr, TEL 82-42-868-5105, FAX 82-42-868-5608*

Simultaneous use of two complementary microscopes in one place often gives us unique advantages. The study combining scanning probe microscope and scanning electron microscope(SEM) has begun about 20 years ago for in-situ application, and some types of the system are already available commercially.

We designed a new type of atomic force microscope ('xAFM' as we named it) which allows us to directly take, with SEM, a cross-sectional view of AFM tip-to-sample interaction during AFM operation. To date, the study of such interaction mostly depends on computation or sensor-generating numbers. xAFM will certainly add extra visual information to the conventional ones.

An xAFM has been implemented in a tungsten filament SEM, and recently also in field emission SEM. In xAFM, a sample is cut and mounted so that the cut cross-section faces upward the bottom of the lower pole-piece of the electron column. The tip scans horizontally at the height slightly lower than the cross-sectional surface of the sample. There should be no obstacle in the electron trajectory for the primary beam incidence and secondary electron detection.

With xAFM, we could successfully demonstrate some experiments which show unique features of xAFM. Above all, we intuitively understand the common image artifacts in AFM image, ‘tip-convolution’ due to the finite-sized tip as well as damaged tip (Figure 1 and 2). In both cases, we will not be able to be quite sure without co-taken SEM images as we relate the observed AFM image artifacts to what actually happens. Further we even could not notice that there is an artifact. We also found that xAFM can be useful in studying large amplitude oscillation of AFM cantilever with high quality factor in vacuum, beyond the range that AFM circuitry cannot cover (not shown here because of space).

We expect nano and nano-bio researches will benefit from the unique nano-scale image data that xAFM provides. In the presentation, experimental results obtained so far with the xAFM will be introduced, and the potential applications will also be discussed.

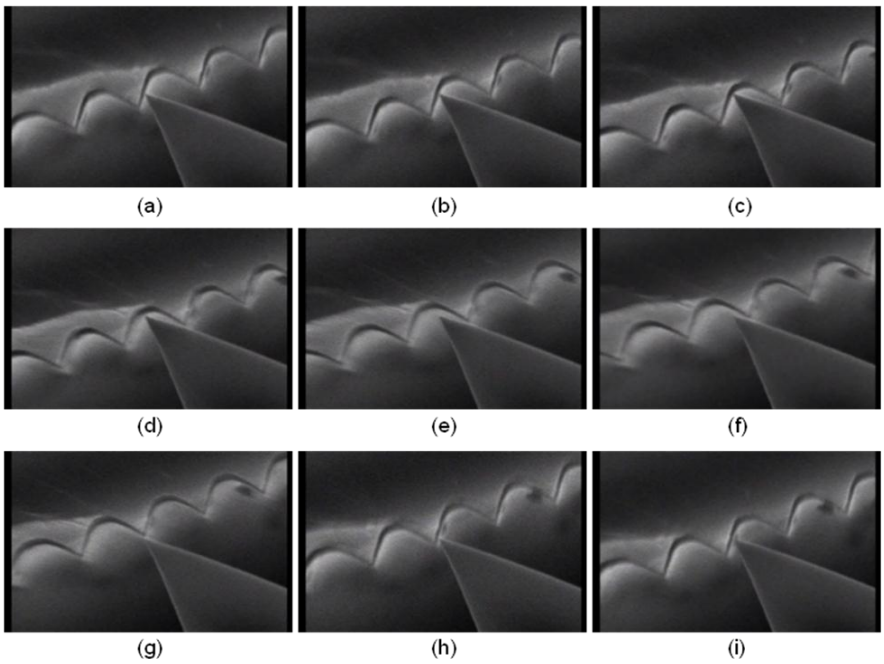

Figure 1: Tip-sample interaction as a tip scan over grating as viewed with xAFM in SEM, which shows the 'tip convolution'. The tip moves from left to right. Tip scans the surface (a-c), then a grating peak scans the tip surface in (d) to (f). Tip end and grating peak meets (g) and then tip scans the surface again in (h) to (i).

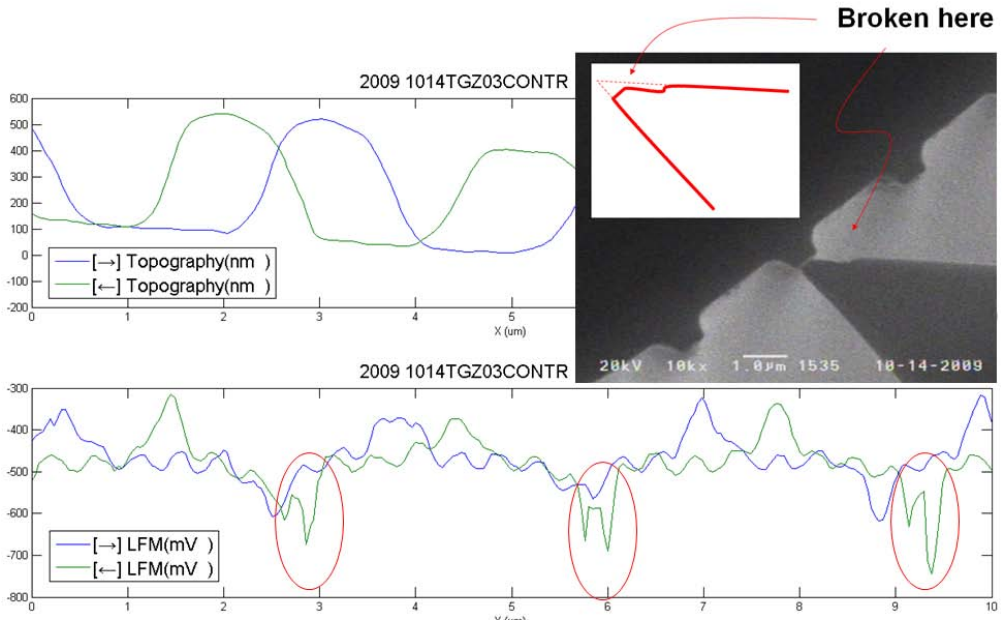

Figure 2: Lateral force microscope image obtained in xAFM in SEM as a broken tip scans over the rectangular grating sample. LFM profiles show 'double dip' (See the red circle) in backward scan, where the broken part of the tip contacts the grating edges while going down. It does not happen in forward scan. The co-taken SEM images confirm our understanding of the observed LFM image.