The tip-sample interaction in SubSurface-AFM

G.J. Verbiest, T.H. Oosterkamp, and M.J. Rost
Kamerlingh Onnes Laboratory LION, Leiden, The Netherlands
Verbiest@physics.leidenuniv.nl

In tapping mode AFM the drive force is kept constant and you "feel" the surface through the amplitude reduction caused by the tip-sample interaction. If the amplitude is reduced by the tip-sample interaction, you will also see a phase shift. By either setting a reduced amplitude or phase shift you can sense the surface and learn about its height profile.

In SubSurface AFM you sent an ultrasound acoustic wave through the sample. This acoustic wave is Rayleigh scattered [1] by defects in the interior of the sample. In order to see where the defects are, you want to measure the resulting amplitude and phase at the sample surface with a cantilever. However, the tip-sample interaction causes additional phase shifts and amplitude variations, which is the basic principle of tapping mode AFM. But if the cantilever does not have any amplitude reduction or phase shifts while approaching the surface, it might be possible to directly see the amplitude and phase of the ultrasound wave that travelled through the sample. Non-Contact AFM provides a technique to do this.

We present both a numerical and experimental study of NC-AFM on a surface vibrating at ultrasonic frequencies. Understanding the measuring principle of SubSurface AFM is the key to get 3D information of your sample. By using NC-AFM we hope to get insight into the following question: "What is the best way to measure the vibration amplitude and phase of the ultrasound wave that has travelled through the sample?"

[1] G.J. Verbiest et al., Nanotechnology 23 (2012) 145704