Scan in arbitrary direction using Probe-rotating Atomic Force Microscopy

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Abstract

Atomic force microscopy (AFM) has become the essential equipment in nanotechnology due to the ability to image various material characteristics at nanoscale in various condition even in liquid. In particular, the mechanical and electrical characteristics which require mechanical contact can be easily obtained with AFM. However, since the AFM uses the scan direction dependent probe, scan in arbitrary direction is limited and is carried out only by rotating sample methodology which loses the continuity of image and requires long image time. As a results, the characterization of the anisotropic properties such as the friction of graphene [1] using AFM is a time consuming work. Therefore, the probe rotating AFM which probe rotates instead of sample was suggested [2,3] and its feasibility was proven as in Fig.1. Although some advancements in performance such as the reduction of offset due to rotation and lateral scan were accomplished, the quality of image of lateral scan which determines the frictional characteristics was not good.

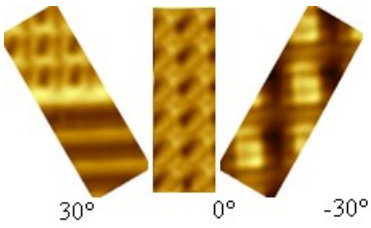
In this work, we investigated the cause of the deterioration of quality of lateral scan image and figured out that it was resulted from the crosstalk of deflection and torsion in detection sensor. We enhanced the quality of lateral scan image using the new methodology [4]. Moreover, the circular direction which is the expanded scan pattern of lateral scan was achieved and the image was obtained as in Fig. 2. Due to the advantage of the structure of probe rotating against sample rotating, it is possible to scan in arbitrary patterns composed of longitudinal, lateral, and circular while keeping the continuity of scan image. It is also expected that characterization of the material property in any direction and at any point can be obtained.

References

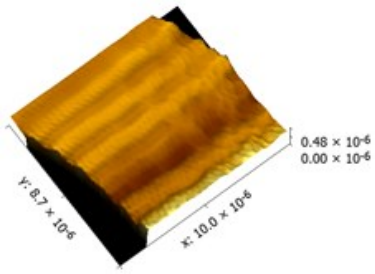
[1] C. Lee, Q. Li, W. Kalb, X.Z. Liu, H. Berger, R. Carpick, J. Hone, Science 328 (2010) 76
[2] S.H. Lee, Rev. Sci. Instrum. 85 (2014) 033708
[3] S.H. Lee, Mater. Res. Soc. Symp. Proc. 12 (2014)
[4] S.H. Lee, Nanotechnology, submitted.

Figures

1)



2)



1) Images obtained by scans in various directions [2], 2) Image obtained by the circular scan of which direction is lateral to probe at contact point.