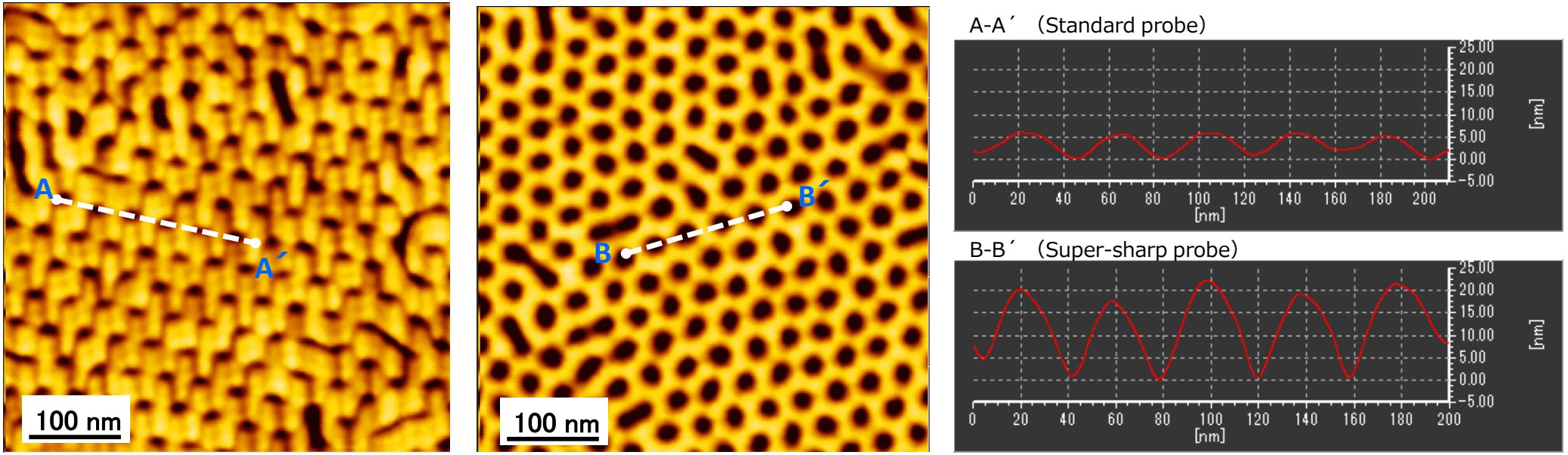
High-Resolution and Accurate AFM Imaging of Nanostructured Copolymer Prepared by Directed Self-Assembly Using a Super-sharp Probe

SHEET No. 017



(a) Standard probe (b) Super-sharp probe (c) Cross-section profiles

Fig. 1: Standard AFM imaging vs. enhanced AFM imaging of a nanostructured polystyrene/PMMA copolymer via DSA
Hitachi AFM5500M; Scan mode: SIS (Sampling Intelligent Scan)

The directed self-assembly (DSA) of block copolymers is a promising nanomanufacturing technique since it allows for the generation of various well-designed nanostructures such as patterned holes or pillars via controlling the ratio of two copolymer components.

Fig. 1 (a) shows AFM imaging using a standard probe of a polystyrene/PMMA copolymer prepared by the DSA. Those supposedly round-shaped holes are not well resolved, and they are distorted like small stripes. From the corresponding cross-section profile (A-A') in Fig. 1 (c), the measured width and depth of those holes are less than 10 nm and 5 nm, respectively. The standard AFM probe has a tip radius of 7 nm. Therefore, it is suspicious that AFM probe was able to fully reach the bottom of those holes. Fig. 1 (b) shows enhanced AFM imaging of the same sample using a super-sharp probe whose radius is approximately 2 nm. In addition, the Hitachi-proprietary Sampling Intelligent Scan (SIS) was utilized as it renders a better tracking of high-aspect-ratio surface features. As shown in Fig. 1 (b), round holes are observed. Both the width and depth of those holes are approximately 20 nm, as shown in the cross-section profile (B-B').

Several microscopy techniques can be considered for characterizations of copolymers via the DSA. For quantified topography measurement by the SEM, special sample preparation is needed in support of the required cross-section imaging of the sample. On the other hand, those optical methods such as scanning laser microscopy and coherence scanning interferometer are constrained by the diffraction limit and thus do not offer a sufficient spatial resolution for copolymers via the DSA because they usually exhibit fine surface structures at sub 100 nm scale. In this application brief, it is demonstrated that AFM measurement using a super-sharp probe enables the accurate, easy, and nondestructive measurements at nanometer scale.

Author: M. Iyoki , Hitachi High-Technologies Corporation

Nanomaterial

High-Resolution and Accurate AFM Imaging of Nanostructured Copolymer Prepared by Directed Self-Assembly Using a Super-sharp Probe

Science for a better tomorrow

Recommended configuration	Remarks
AFM5500M	
・Cantilever: SSE-FMR（Super-sharp probe）	Made by Nanotools
SIS（Sampling Intelligent Scan）	

AFM5500M