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Application News

SPM-Nanoa™ Scanning Probe Microscope (Atomic Force Microscope)

8K High Pixel Resolution Observation Leading You into the Nano World ! Simultaneously Achieves Both Large-Area Observation and High Definition Analysis

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User Benefits

- Simultaneous large-area observation and high definition analysis are possible by 8K high pixel resolution observation.
- Minute differences in roughness can be captured by surface roughness analysis utilizing high definition images.

■ Introduction

The scanning probe microscope (SPM (AFM)) is widely used in the fields of nanoparticles and soft materials as a tool that enables simple and nano-level high resolution observation in the ordinary atmosphere. In recent years, new materials which have both macro- and micro-scale structures have appeared, and simultaneous structural observation of both is demanded. However, in large-area observation by conventional SPM, high definition analysis was difficult when images were enlarged due to the limited pixel count of the existing technology.

This article introduces an example in which both large-area observation and high definition analysis were achieved simultaneously by using the SPM-Nanoa, a new Shimadzu SPM that realizes 8K high pixel resolution observation.

■ SPM-Nanoa

The scanning probe microscope (SPM) is a type of microscope in which the 3-dimensional topography or local physical properties of a sample are observed/measured at high magnification by scanning the sample surface with a tiny probe called a cantilever. SPM-Nanoa is a new SPM with an advanced and high sensitivity detection system and automatic observation function as standard features, leading you into the nano world more simply and more quickly. The SPM-Nanoa provides powerful assistance for work ranging from observation of the topography of micro regions to measurement of physical properties. Fig. 1 shows the appearance of SPM-Nanoa. The advantages of the SPM-Nanoa can be summarized in the following three points.

① Automatic Observation : Adjusts Laser Beam, Adjusts Parameter Settings During Observation, and Performs Image Processing Automatically

② Extensive Functionality : 8K Images Enable High-Resolution Observation of Large Areas

③ Saves Time : Various Support Functionality Achieves Fast Observation

In this article, we introduce 8K high pixel resolution observation, which is one of the functions of ② Extensive Functionality. In general, the sharpness of images differs depending on the pixel count, as higher definition images are obtained as the pixel count increases. Because the SPM-Nanoa enables observation at a high pixel resolution of 8192 × 8192 in the XY plane, high definition analysis is possible even with enlarged images.

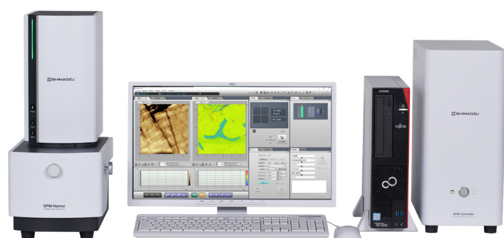

Fig. 1 SPM-Nanoa™ Scanning Probe Microscope

■ 8K High Pixel Resolution Observation of Niobium Vapor-Deposited Film

The surface of a niobium vapor-deposited film was observed with 8K high pixel resolution. Table 1 shows the observation conditions. Although Niobium (Nb) is mainly used as steel additives and in Nb-based superalloys, compounds including Nb have also attracted attention as electrode materials for lithium ion batteries. Fig. 2 shows the surface topography obtained by 8K high pixel resolution observation, and Fig. 3 shows 8x digitally enlarged images of a smooth area (white box), slightly convex area (black box), and convex area (orange box) in that observation region. In addition, the surface roughness of these regions was analyzed using these enlarged images. Table 2 shows the result of a calculation of the arithmetic mean height Sa.

Table 1 Observation Conditions

Instrument	: SPM-Nanoa scanning probe microscope
Scanner	: HT scanner (10 µm)
Observation mode	: Dynamic mode
Observation field	: 8 µm × 8 µm
Pixel count	: 8192 × 8192

In Fig. 2, a smooth area and locally convex areas can be seen, and the Sa of the total observation region was calculated as Sa : 3.34 nm. 8K high pixel resolution observation made it possible to analyze the surface roughness from high definition images, in which the size of 1 pixel was approximately 1 nm, while observing a large field of 8 µm × 8 µm.

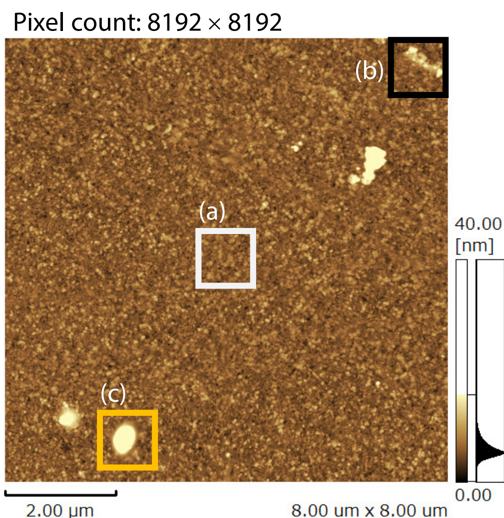

Fig. 2 Surface Topography Image of Nb Vapor-Deposited Film by 8K High Pixel Resolution Observation

Table 2 Arithmetic Mean Height Sa

	Total region	(a)	(b)	(c)
Sa[nm]	3.34	2.68	4.93	14.22

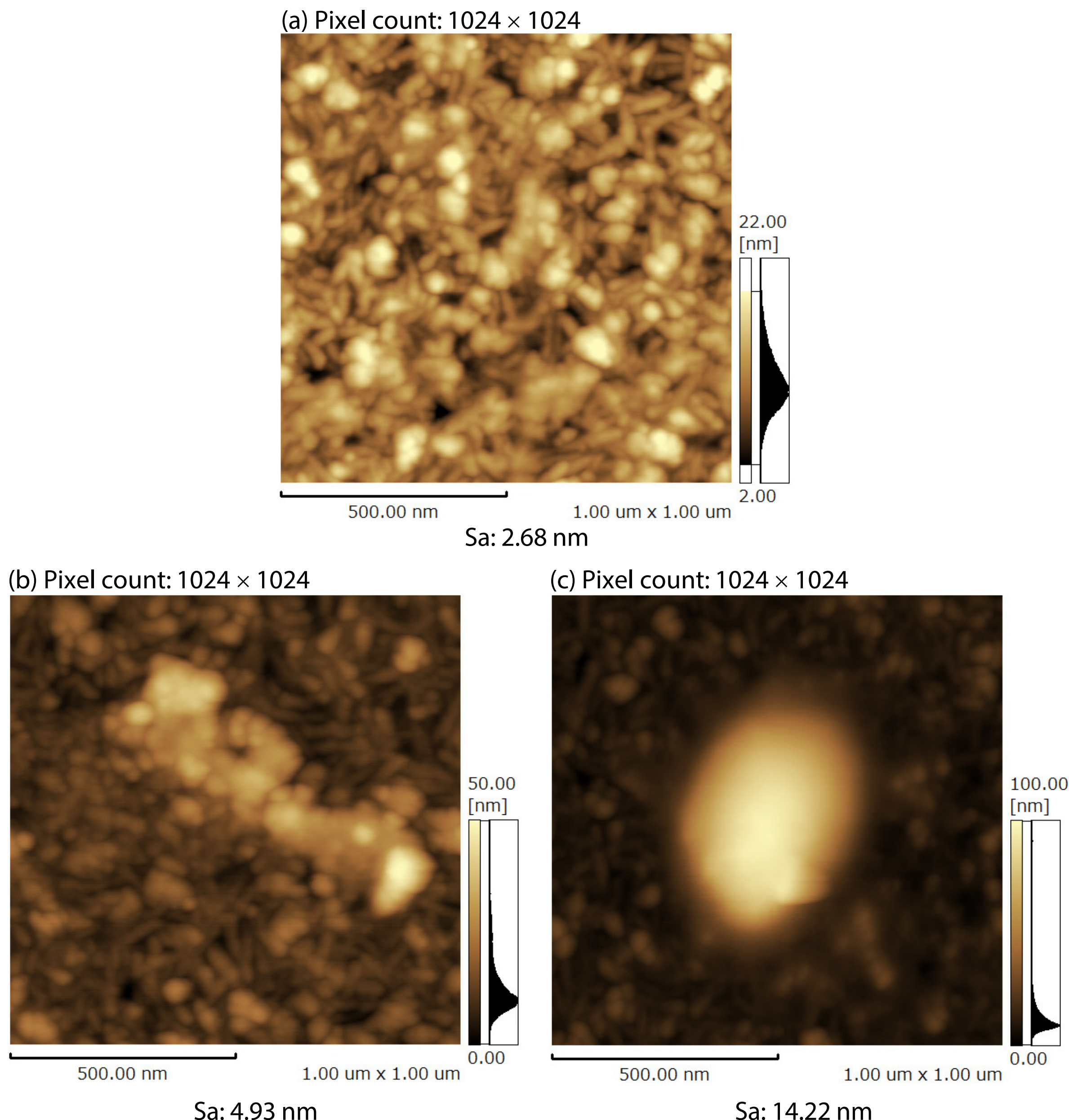

Fig. 3 Surface Topography Image of Nb Vapor-Deposited Film in 8x Digital Enlargement Observation and Arithmetic Mean Height Sa
(a) Smooth Area, (b) Slightly Convex Area, (c) Convex Area

From Fig. 3(a), it can be understood that the area which appears smooth consists of nano-level vapor-deposited particles. In this area, which does not include local convex features, Sa: 2.68 nm. The area in Fig. 3(b) also consists of vapor-deposited particles, but a small convex shape exists in the upper part of the image, and as a result, Sa: 4.93 nm, which is a larger value than that of Fig. 3(a). In Fig. 3(c), the shape of a large convex part among the vapor-deposited particles was clearly captured, and its effect was expressed in a large Sa of 14.22 nm.

As illustrated by this example, observation with 8K high pixel resolution made it possible to enlarge and analyze images of arbitrary areas over a large observation field with a single observation, which was not possible with conventional SPM.

■ Conclusion

8K high pixel resolution observation by the SPM-Nanoa scanning probe microscope simultaneously achieves both large-area observation and high definition analysis. As demonstrated in this experiment, minute differences in surface topography could be captured by a surface roughness analysis utilizing high definition images acquired with this instrument. The SPM-Nanoa leads you into the nano world with new functions which are not available in conventional SPM.

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