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Preparation of Highly Ordered TiO_2 Nanohole Arrays Using Anodic Porous Alumina

T. Yanagishita[1], K. Nishio[1,2], and H. Masuda* [1,2]
[1]Kanagawa Academy of Science and Technology
Sagamihara, Kanagawa 229-1131, Japan
[2]Tokyo Metropolitan University
Hachioji, Tokyo 192-0397, Japan
*E-mail: masuda-hideki@c.metro-u.ac.jp

TiO_2 has attracted growing interest for the fabrication of various types of functional devices, such as photoanodes, photocatalyst, and chemical sensors. In addition, TiO_2 is a candidate for the fabrication of optical devices, represented by photonic crystals, due to its high refractive index and high transparency in the visible wavelength region. Control of the geometrical structure of TiO_2 on the nanoscale is essential to realize the functional nanodevices. Anodic porous alumina, which is one of typical self-ordered nanochannel material formed by anodization of Al in an acidic solution, has attracted increasing interest as a key material for fabrication of nano-meter structures.[1] In the present report, we described the fabrication of highly ordered TiO_2 nanohole array by replication process using anodic porous alumina as templates. Highly ordered alumina templates were prepared by long-range self-ordering[1,2] or pretexturing[3] process of Al. The preparation of TiO_2 nanohole array was carried out through the electrodeposition.[4]

Figure 1 shows the typical SEM images of the TiO_2 nanohole array prepared using naturally occurring long-range ordered anodic porous alumina templates. The sample was observed after the heat treatment at 450 ºC for the crystallization. The hole period of TiO_2 nanohole array could be controlled by adjusting the forming conditions of the alumina template.

Figure 2 shows the typical cross-sectional SEM image of the TiO_2 nanohole array. In the case of the sample in Fig. 2, an ideally ordered alumina template was used. From the cross-sectional image, it can be confirmed the uniform-size holes with high aspect ratio were arranged ideally over the sample. Each hole was perpendicular to the surface and parallel to each other. The aspect ratio (depth divided by hole diameter) was 16

The obtained TiO_2 nanohole array will be applied to photoanodes, photocatalyst, and two-dimensional photonic crystals with wide band gap.

References

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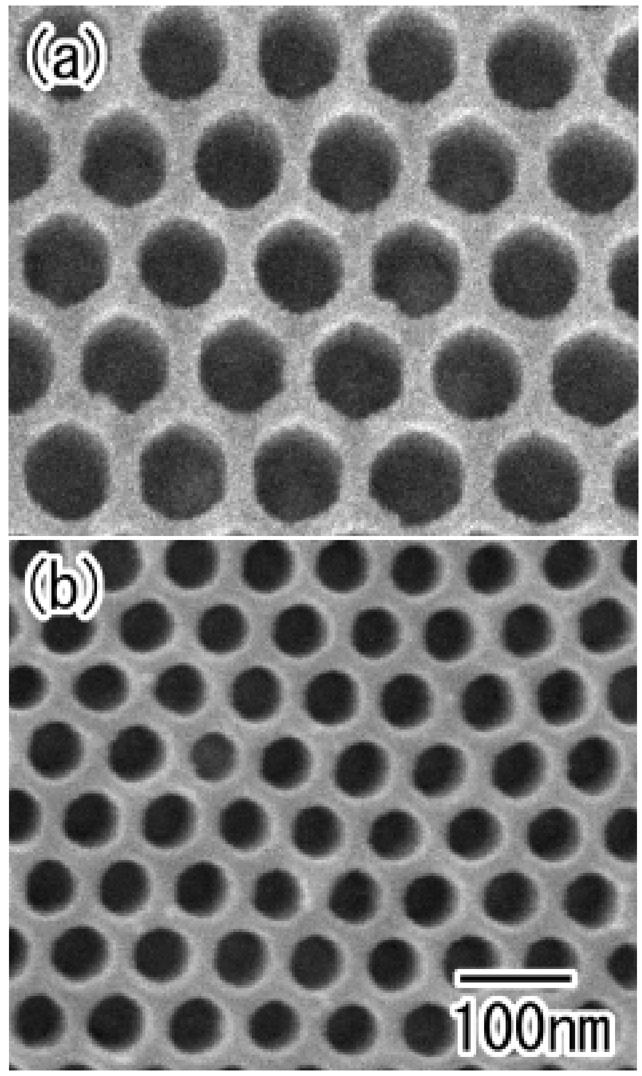

Fig. 2. SEM image of TiO_2 nanohole array with hole periods of 100 nm (a), 63 nm (b). The diameters of holes were 75 nm and 50 nm, respectively.

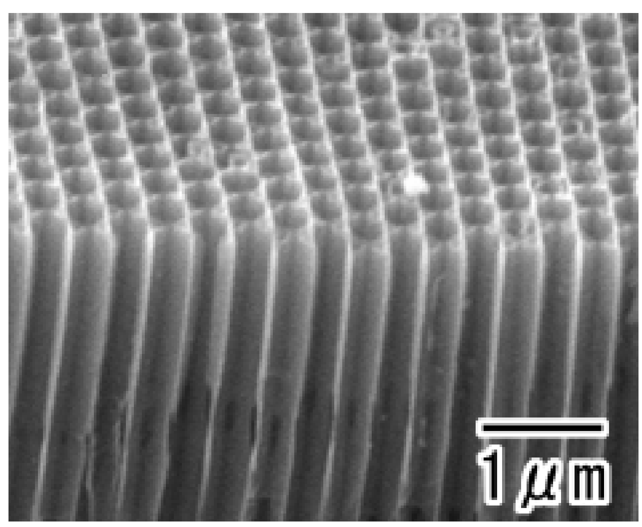

Fig. 1. Cross-sectional image of TiO_2 nanohole array. The diameter and period of the holes were 430 nm and 500 nm, respectively.