Effects of Fabrication Process of Anodic Aluminum Oxide on Selective Growth of Si Nanowire Arrays

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Abstract

We reported on the effects of fabrication process of anodic aluminum oxide (AAO) on selective growth of Si nanowire arrays. The selective growth of Si nanowires on Si substrate patterned with AAO template without presence of metallic catalysts opened new pathway to produce intrinsic Si nanowires. One of the keys to promote the selective growth of Si nanowires is the control of Si surface at the bottom of AAO template. During AAO fabrication, the Si surface could be anodized if the consumption of Al is complete. To evaluate the effects of anodization process on selective growth, the anodization current was aimed to be switched off at several points, which were estimated based on the current ratio \( R \) formulated below,

\[
R = \frac{I_o - I_{so}}{I_o},
\]

where \( I_o \) and \( I_{so} \) are the anodization currents which started decreasing and are switched off, respectively. It was found that the current ratio \( R \) of 10% was favorable for selective growth and produced high density of 1µm-long Si nanowire arrays as shown in Fig.1. Transmission electron microscopy clarified that the Si nanowires were epitaxially grown. With long anodization with \( R \) more than 30%, the selective growth was unfavorable and density of Si nanowire array was modest. This study will be utilized to optimize the growth conditions for homogeneous epitaxial Si nanowire array growth.

Figure 1: a) Cross-sectional SEM images depicting selection growth with AAO template fabricated with \( R \) of 10%

b) 60°-tilted SEM image showing the Si NW after removal of AAO template fabricated with \( R \) of 10%