



Morphology control and electron field emission properties of high-ordered Si nanoarrays fabricated by modified nanosphere lithography

Ling Xu^{a,b,*}, Wei Li^a, Jun Xu^a, Jiang Zhou^a, Liangcai Wu^a, Xian-Gao Zhang^a, Zhongyuan Ma^a, Kunji Chen^a

^a Nanjing National Laboratory of Microstructures and Department of Physics, Nanjing University, No. 22 Han Kou Road, Nanjing 210093, China

^b Jiangsu Key Laboratory for Biomaterials and Devices, Southeast university, Nanjing 210096, China

ARTICLE INFO

Article history:

Available online 3 August 2008

Keywords:

Silicon nanoarray
Nanosphere lithography
Electron field emission

ABSTRACT

High-ordered silicon nanoarrays were prepared using direct nanosphere lithography combined with thermal oxidation. Atomic force microscope (AFM) images of the silicon arrays show that the patterns of polystyrene (PS) template are well transferred to the silicon surface. The size and morphology of the nanoarrays can be controlled effectively by varying the plasma-therm reactive ion etching (RIE) or thermal oxidation parameters. The field emission studies revealed that the typical turn-on field was about 7–8 V/ μm with emission current reached 1 $\mu\text{A}/\text{cm}^2$. It is also found that the field emission current is highly dependent on the morphology of these Si nanoarrays.

© 2008 Elsevier B.V. All rights reserved.

1. Introduction

In recent years, silicon nanostructures have received considerable attention due to their unique properties and potential application in a variety of optoelectronic field including flat-panel displays and sensors. There are many techniques available for the formation of silicon nanoarray, such as electron-beam lithography [1], nano-imprinting [2,3], electrochemical etching [4], as well as X-ray lithography [5]. However, all these fabrication methods require either high-cost apparatus or complicated processing steps. Recently nanosphere lithography, which is to use nanosphere monolayer as a mask of lithograph to fabricate ordered nanostructure have attracted a lot of attention [6–8]. This technique combines the bottom-up and top-down approaches and seems to be a more efficient and inexpensive method for fabrication of periodic nanostructures with feature size in the sub-100 nm region and over large areas.

In this letter, we present the fabrication and morphology control of high-density 2D periodic nanoarrays of silicon using direct nanosphere lithography combined with a conventional semiconductor technology of thermal oxidation. The technique is compatible with conventional silicon process and suitable for large-scale industrial application. The morphology and structures

of nanoarrays were studied using atomic force microscope (AFM). The field emission characteristics of silicon nanoarrays were also investigated by using a conventional parallel-plate setup.

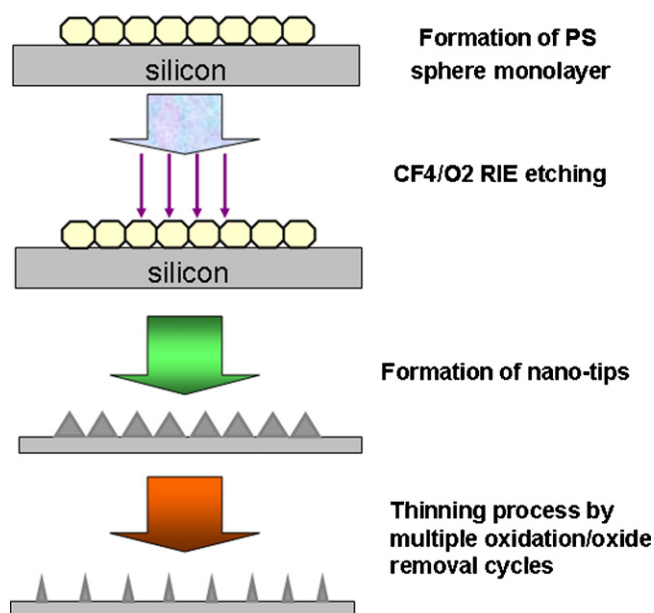


Fig. 1. Schematic graphs of preparation strategy for large area ordered Si nanoarrays.

* Corresponding author at: National Laboratory of Solid State Microstructures and Department of Physics, Nanjing University, No. 22 Han Kou Road, Nanjing 210093, China. Tel.: +86 25 83594836; fax: +86 25 83595535.

E-mail address: okxuling@gmail.com (L. Xu).

2. Experimental

Formation of silicon nanoarrays were using direct nanosphere lithography combined with thermal oxidation. The schematic graphs were shown in Fig. 1. In brief, first a large monolayer of

polystyrene (PS) spheres with highly ordered areas (more than 1 cm^2) was formed on the water surface using a method reported by Giersig et al. and Ren [6–8], then lifted off from the water surface, and transferred onto a silicon wafer. The spheres used in our investigation were 220 nm in diameter and were purchased

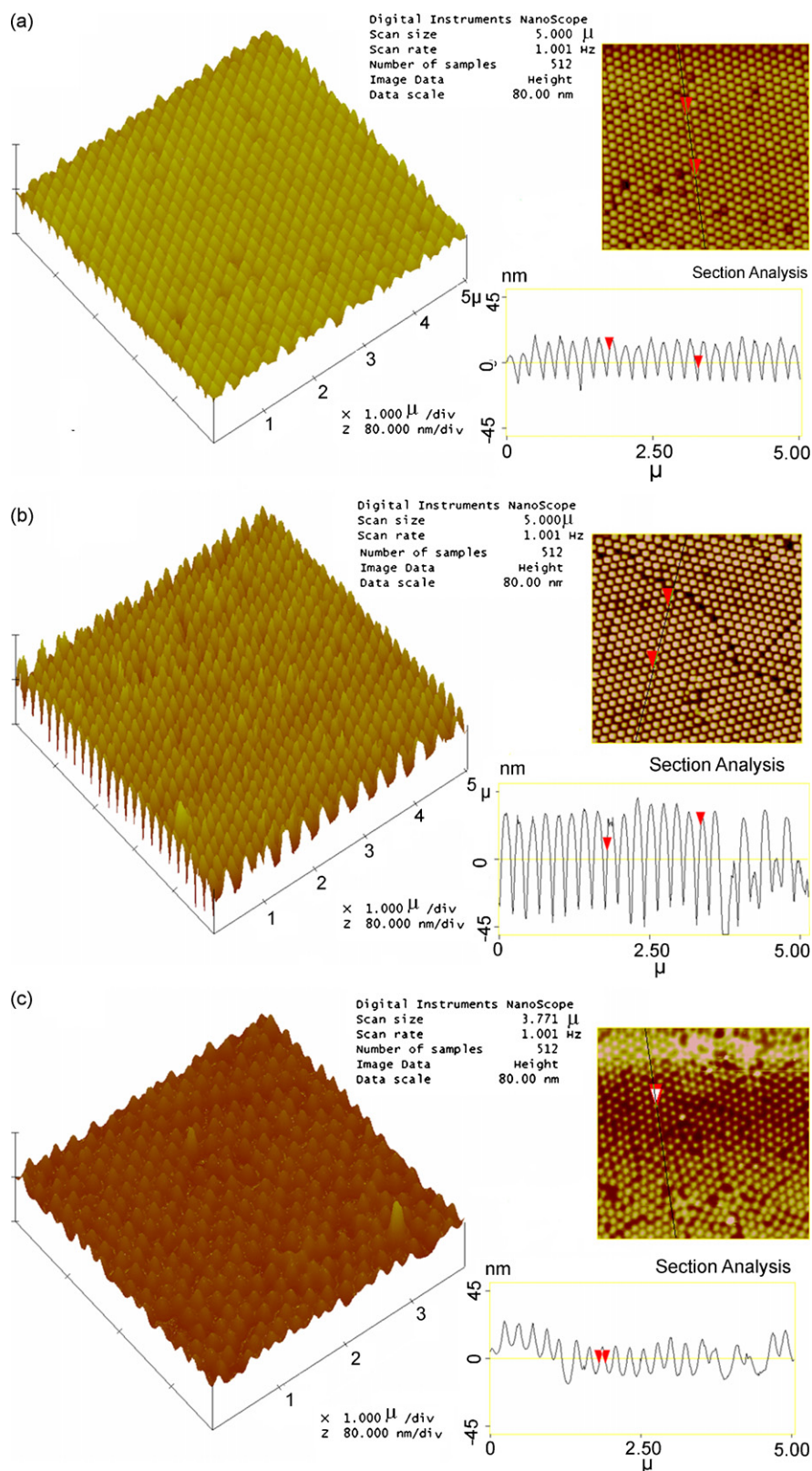


Fig. 2. AFM image of the morphology and the cross-section of Si nanoarrays after CF_4 RIE for (a) 2 min, (b) 3 min and (c) 5 min (CF_4 gas flow at 40 sccm, rf power 200 W).

Download English Version:

<https://daneshyari.com/en/article/5367570>

Download Persian Version:

<https://daneshyari.com/article/5367570>

[Daneshyari.com](https://daneshyari.com)