Characterization of Dopant in Individual Si / Ge Core-Shell Nanowires Investigated by Atom Probe Tomography

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Introduction

In recent years, considerable research has been carried out regarding Si / Ge or Ge / Si core-shell nanowires (NWs) due to their substantial potential in the application of many devices such as metal-oxide field-effect semiconductor transistor and their compatibility with current semiconductor technology [1]. The dopant distributions in the Si / Ge or Ge / Si core-shell NWs directly affect the performance of devices. Therefore, it is important to get clear of the dopant distribution in individual Si / Ge or Ge / Si core-shell NWs.

Laser-assisted atom probe tomography (APT) has proved to be a powerful method to study semiconductor NWs in the atomic-scale resolution [2]. In the previous report, we have report the APT study of B distribution in Ge / Si core-shell NWs [3]. In this study, the B distribution in Si / Ge core-shell NWs was investigated by APT.

Experiment

Si / Ge core-shell NWs were grown on Si (111) substrate by chemical vapor deposition (CVD), with gold nano colloid particles as the catalyst for vapor-liquid-solid (VLS) growth. B atoms were doped during the growth of Si core [4]. Individual Si / Ge core-shell NW specimens for APT analysis were prepared by gallium focused ion beam, with FIB-SEM dual-beam system (Helios NanoLab600i, FEI) as shown in Fig. 1(a). APT analysis was performed using a laser-assisted local electrode atom probe (LEAP4000X HR, AMETEK).

Results

Figures 1(b) and (c) show atom maps of Si / Ge core-shell NW and B distribution in the NW. The Si / Ge core-shell structure was clearly observed in the atom map. Moreover, it was found that B segregated at the Si / Ge interface and B concentration increased gradually from the tip to the bottom of the NW. In this presentation, the details of sample preparation and more analysis data will be shown.

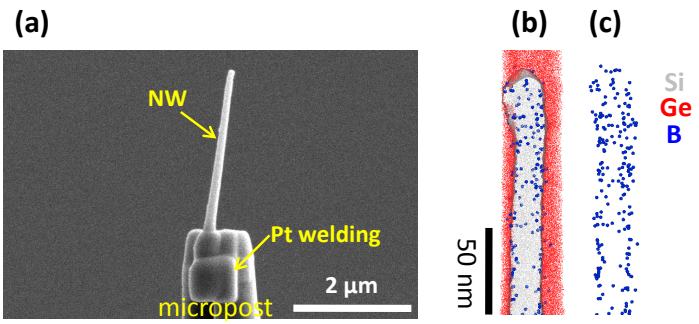

Figure 1(a) A individual NW welded on the micropost. (b) An atom map of side view of Si / Ge core-shell NW (10-nm-thick slice). The 20 at.% Si iso-concentration surface was also shown. (c) B atom maps in the Si / Ge core-shell NW.

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References

[1] Y. Cui et al., *Science* **291**, 851 (2001).
[2] D. E. Perea et al., *Nature Nanotechnol.* 4, 315 (2009).
[3] B. Han et al., JSAP Autumn meeting 14P-2Q-9 (2015).
[4] N. Fukata et al., *ACS Nano* **6**, 8887 (2012).