Realization of hole gas accumulation in p-Si/i-Ge core-shell nanowires by controlling boron doping concentration

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Abstract:

One-dimensional (1D) structure with nanoscale diameters such as nanowires has excellent potential for the application of next-generation semiconductor devices such as transistors, solar cells, sensors and so on. Core-shell nanowires fabricated by Si and Ge with high carrier mobilities have been suggested as building blocks to be as the channel materials for realizing vertical-type metal-oxide-semiconductor field-effect transistors (MOSFETs) with high speed and low energy consumption [1]. Impurity doping in the core or shell is essential to give a function in MOSFETs whereas impurity scattering need to be considered. Characterization of impurity doping and stress in the core-shell nanowire structures can show the relationship between the core and shell with various diameters and thickness [2]. In this work, we used chemical vapor deposition (CVD) methods based on the vapor-liquid-solid (VLS) growth mechanism to fabricate p-Si/i-Ge nanowires with different B_2H_6 gas flux from 0 sccm to 0.5 sccm. The structure showed good crystallinity that performed by transmission electron microscopy (TEM) with EDX measurement as shown in Fig. 1. Stress and doping effect in the core-shell structures were characterized by X-ray diffraction (XRD) measurements, showing that Si layer has tensile stress applied by Ge layer and Ge has compressive stress applied by Si layer. Micro-Raman scattering measurements were carried out at room temperature (RT) with 532 nm excitation light, demonstrating hole gas accumulation in the i-Ge shell region of p-Si/i-Ge core-shell nanowires, which is useful for high-performance field-effect transistors.

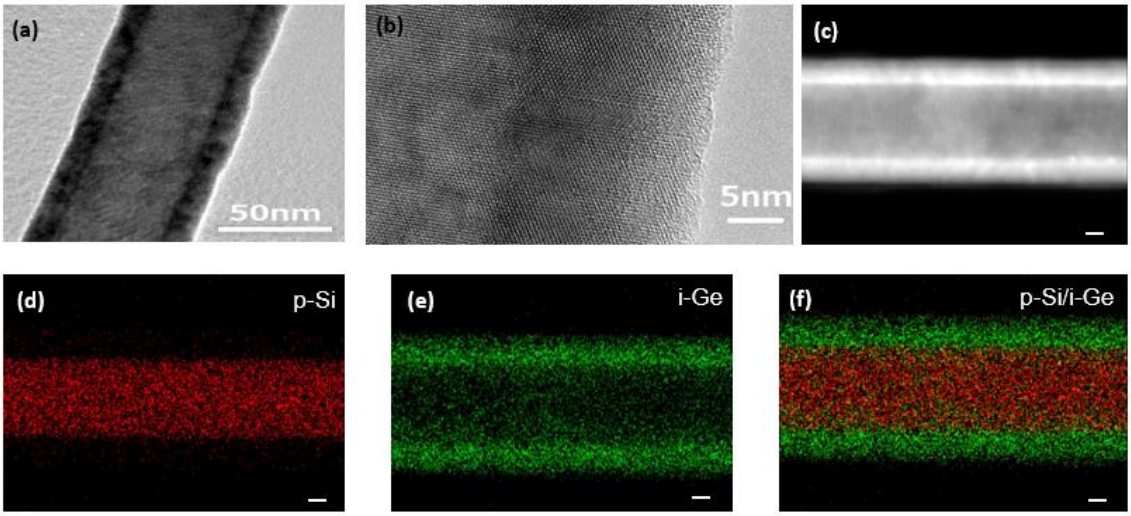

Figure 1. p-Si/i-Ge core-shell NWs TEM images (a) low resolution and (b) high resolution; (c) STEM image; (c)-(f) EDX images; The scale bars are 10 nm.

References:

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[2] N. Fukata, M. Yu, W. Jevasuwan, T. Takei, Y. Bando, W. Wu, Z. L. Huang, ACS Nano, 9, 12182-12188 (2015).