Demonstration of hole gas accumulation control in Ge/Si core-shell nanowires

°Kotaro Nishibe[1,2], Xiaolong Zhang[1,2], Toshiaki Takei[2], Thiyagu Subramani[2], Wipakorn Jevasuwan[2] and Naoki Fukata[1,2]

(1. Univ. of Tsukuba, 2. NIMS)

E-mail: NISHIBE.Kotaro@nims.go.jp

Silicon and germanium nanowires (SiNWs and GeNWs) are anticipated for the realization of next-generation metal-oxide-semiconductor field-effect transistors. Impurity doping is one of the key techniques for the NWs devices, while the retardation of carrier mobility due to impurity scattering has to be taken into account. Core-shell NWs composed of Si and Ge are key structures for realizing high mobility transistor channels, since core-shell structures separate the carrier transport region from the impurity doped region, resulting in the suppression of impurity scattering.

Ge/Si core-shell NWs structures shown in Fig. 1 were rationally grown on a Si substrate by CVD.[1,2] Selective doping and band-offset in Ge/ Si core-shell NW structures can realize a type of high electron mobility transistor (HEMT) structure in one-dimensional NWs by separating the carrier transport region from the impurity-doped region. Precise analysis using Raman spectroscopy of the Ge optical phonon peak, showed a conclusive evidence of hole gas accumulation in Ge/Si core-shell NWs.

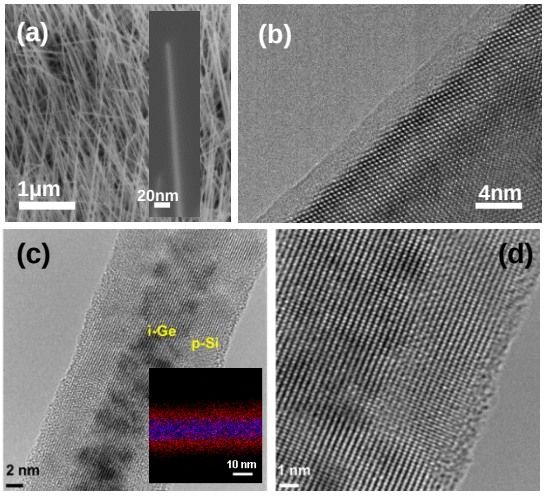

Fig.1 (a) A SEM images of GeNWs. (b) A high-resolutional TEM image of GeNWs. (c) A TEM image and (d) high-resolutional TEM image of i-Ge/p-Si core-shell NWs. An EDX image of i-Ge/p-Si core-shell NW is also shown as an inset.

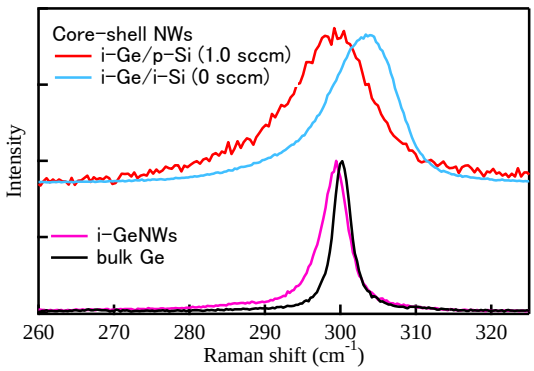

Fig. 2. Comparison of the Ge optical phonon peaks observed for i-Ge/p-Si (1.0 sccm) core-shell NWs, i-Ge/i-Si (0 sccm) core-shell NWs, i-GeNWs, and bulk Ge. The B_2H_6 gas fluxes of p-Si layers were changed from 0 to 1.0 sccm. The shell growth time is 2 min.

References

1. N. Fukata et al., ***ACS NANO* 2012**, 6, 8887. 2. N. Fukata et al., ***ACS NANO* 2015**, 9, 12182.