Formation and characterization of multilayer GeSi nanowires on miscut Si (001) substrates

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Semiconductor nanowires have attracted enormous attention as building blocks for nanoscale electronics, photonics, energy conversion and storage due to their unique electronic, optical and phonon properties [1,2] . Particularly, Si-based nanowires were broadly studied due to their compatibility with the sophisticated Si technology. Laterally arranged GeSi nanowires could be readily formed during heteroepitaxy of Ge on miscut Si (001) substrates with 8o off toward <110>, which were oriented along the miscut direction.By multilayer growth of GeSi nanowires separated with Si spacers, three-dimensionally self-assembled GeSi nanowires were first obtained on the similar miscut Si (001) substrates. In addition, Raman spectra and photoluminescence spectra were obtained from the multilayer GeSi nanowires. These self-assembled GeSi nanowires can be readily embedded in Si matrix and compatible with the sophisticated Si technology.

I. AFM Image

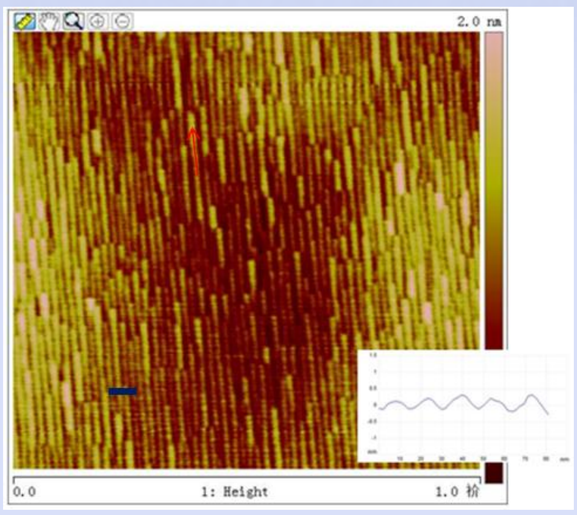

Figure 1. AFM image($1\times1\mu m^2$) of ten layers of GeSi nanowires after 0.8 nm Ge deposition on a vicinal Si (001) substrate with ~8° off toward ⟨110⟩ at 560 °c.

II. Raman Spectra

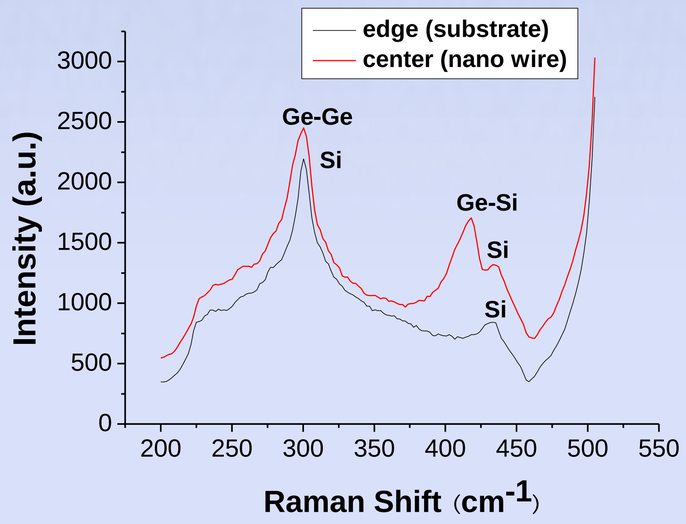

Figure 2. Raman spectra of Si substrate and SiGe nanowires.

I(Ge-Ge)=597.2

I(Ge-Si)=767.5

$$\frac{I(\text{Ge-Ge})}{I(\text{Ge-Si})} \cong \frac{1-x}{2x}$$

Ge%=60.9%

III. PL Spectra

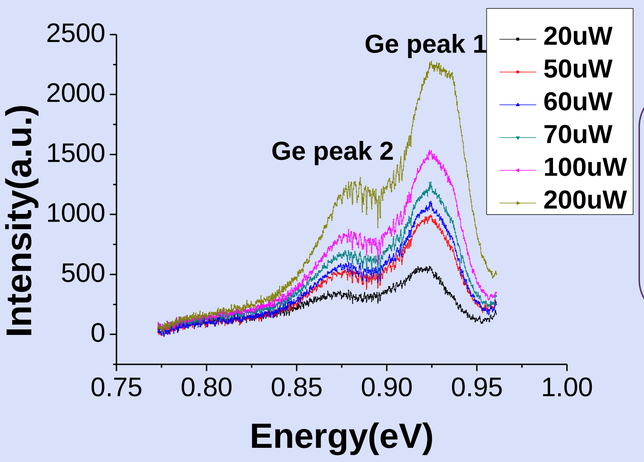

Figure 3. Power dependence of integrated intensity of PL peak from ten layers of SiGe NWs.

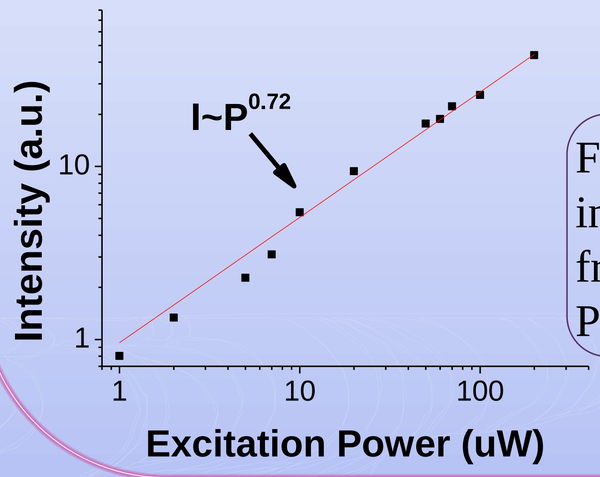

Figure 4. Power dependence of integrated intensity of PL peak from ten layers of SiGe NWs. Peak is around 0.91eV, $I\sim P^{0.72}$.

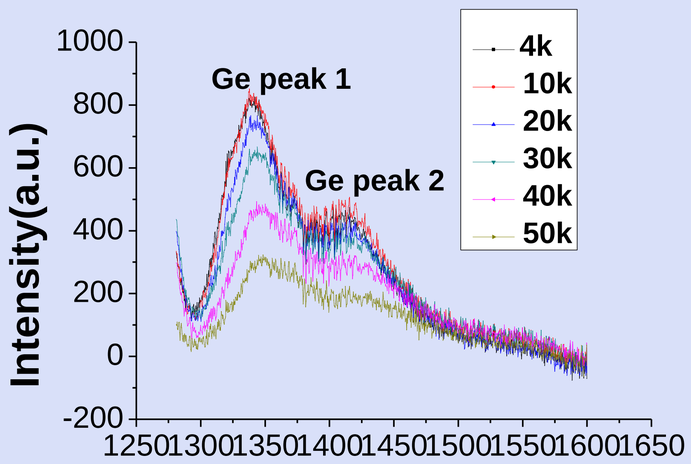

Figure 5. Temperature dependence of integrated intensity of PL peak from ten layers of SiGe NWs. Excitation Power is 50 uW.

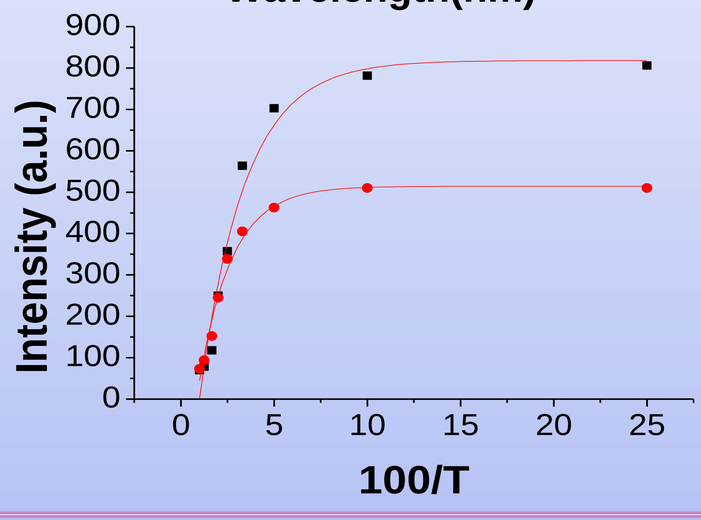

Figure 6. Peak of black blocks around 0.91eV, $I\sim e^{-100/1.8T}$; peak of red dots around 0.86eV, $I\sim e^{-100/1.8T}$. Excitation Power is 50 uW.

IV. Conclusions

1. Three-dimensionally self-assembled GeSi nanowires were first obtained .
2. Raman spectra was done, compositions of the quantum wires were obtained.
3. PL spectra was done, the dependence of intensity , excitation power and temperature was obtained.