Photoluminescence and Fine-Scale Structural Property of Si-Based Nanosheet Bundles Synthesized by IP6 Treatment of $CaSi_2$ Crystals

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Introduction: The Si-based nanosheet bundles have been synthesized by extraction of the Ca atoms from $CaSi_2$ crystals [1]. The bandgap broadening due to the quantum confinement effect in two dimensional Si nanosheet layers is observed, and the superlattice-like layered structural model is proposed to describe the Si-nanosheet bundle structures [2]. It is required to clarify fine scale structural property to understand the quantum confinement phenomenon of the Si nanosheet bundles. In this study, the photoluminescence and structural properties of the bundles were characterized.

Experiments: Si-based nanosheet bundles have been synthesized from $CaSi_2$ powders and $CaSi_2$ microwalls on Si substrates by inositol hexakisphosphate (IP6, $C_6H_{18}O_{24}P_6$) aqueous solution [1]. PL signals were detected with a cw 532 nm second harmonic generation (SHG) Nd:YVO_4 laser as the excitation source and a high sensitive CCD sensor.

Results and Discussion: Figure 1 shows the PL spectra of the Si-based nanosheet bundles rooted on the Si substrates, and reveals that quantum effect is observed confined with the layer thickness of about 1 nm [3]. According to the crystal structure of Tr6-$CaSi_2$, the thickness of 1 nm is corresponding to the lattice spacing of (003) planes. Figures 2(a) and (b) show cross-sectional TEM images of the Si-based nanosheets with the residual Ca/Si atomic ratio of 0.39 and 0.15, respectively. Even the Ca atoms are extracted from the crystals, the layered structure of the $CaSi_2$ template material remains. It is considered that the crystallographic periodic structure of the $CaSi_2$ would cause the superlattice-like layered structure of the nanosheets.

Acknowledgements

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References

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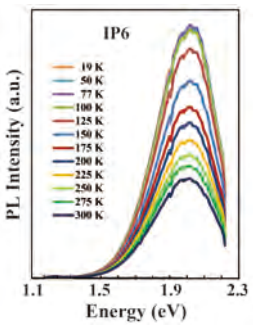

Fig. 1 PL spectra of the Si-based nanosheet bundles.

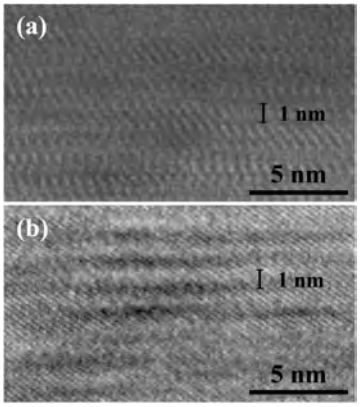

Fig. 2 cross-sectional TEM images of the Si-based nanosheets with the residual Ca/Si atomic ratio of 0.39 and 0.15, respectively.