Photoluminescence from $Ge_{0.92}Sn_{0.08}$/Ge multiple-quantum-well on silicon substrates

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GeSn material system has recently drawn a great deal of attention for efficient Si-based light emitters [1, 2]. By incorporating Sn into Ge to modulate the band structure, the energy band can be transferred from indirect to direct with a Sn content of 6-10%. As a result, efficient electron-hole recombination can occur to achieve stimulation emission in the material. Recently, enhanced photoluminescence (PL) from GeSn alloys has been observed [1]. First lasing action at low temperature from direct bandgap GeSn alloys has been reported [2], but the threshold is too high to be acceptable. Thus it is desirable to reduce the threshold for practical applications. Here we present the growth and photoluminescence of low-dimensional GeSn/Ge multiple-quantum-well (MQW) on Si substrate as a first step for developing GeSn/Ge MQW lasers.

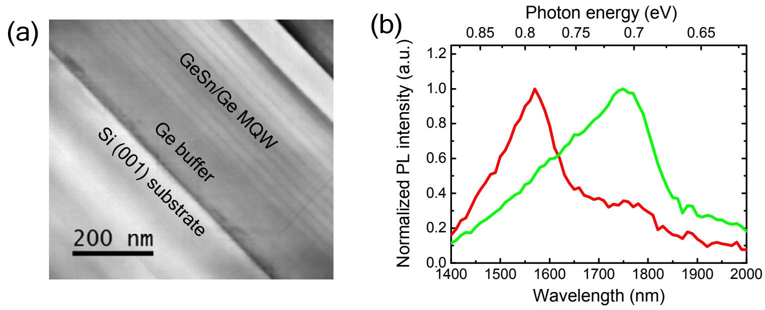

Fig. 1 (a) XTEM image of the $Ge_{0.92}Sn_{0.08}$/Ge MQW structure. (b) Room temperature PL spectrum of the $Ge_{0.92}Sn_{0.08}$/Ge MQW structure compared with that of a reference Ge-on-Si film.

The sample used in this study was grown by molecular beam epitaxy with a special low-temperature growth technique. Ten pairs of $Ge_{0.92}Sn_{0.08}$/Ge quantum wells with a thickness of 10/15 nm were pseudomorphically grown on a 200-nm-thick, fully strain-relaxed Ge buffer on Si substrate. Figure 1(a) shows the cross-sectional transmission electron microscopy (XTEM) image of the grown $Ge_{0.92}Sn_{0.08}$/Ge MQW, showing smooth and flat GeSn/Ge interfaces. Figure 1(b) shows the room-temperature PL spectrum of the $Ge_{0.92}Sn_{0.08}$/Ge MQW sample compared with that of a reference Ge-on-Si film. The emission peak, associated to the direct transition energy, shifts from 1570 nm to 1750 nm, mainly attributed to the introduction of Sn in the material. The obtained PL peak energy of 0.708 eV is significantly larger than that obtained from bulk $Ge_{0.92}Sn_{0.08}$ film [3], many due to the quantum confinement. These results confirm the feasibility of low-dimensional GeSn/Ge (MQW) for light-emitting materials on silicon.

References

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