Enhanced Emission of Quantum System in Si-Ge Nanolayer Structure

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Abstract

It is very interesting that the enhanced peaks near 1150 and 1550 nm are observed in the photoluminescence (PL) spectra in the quantum system of Si-Ge nanolayer structure, which have the emission characteristics of a three-level system with quantum dots (QDs) pumping and emission of quasi-direct-gap band, in our experiment. In the preparing process of Si-Ge nanolayer structure by using a pulsed laser deposition method, it is discovered that the nanocrystals of Si and Ge grow in the (100) and (111) directions after annealing or electron beam irradiation. The enhanced PL peaks with multi-longitudinal-mode are measured at room temperature in the super-lattice of Si-Ge nanolayer quantum system on SOI.

Experiment Fabrication Method Experiment Result **(Published:** Huang et al. Nanoscale Research Letters (2016) 11:462)

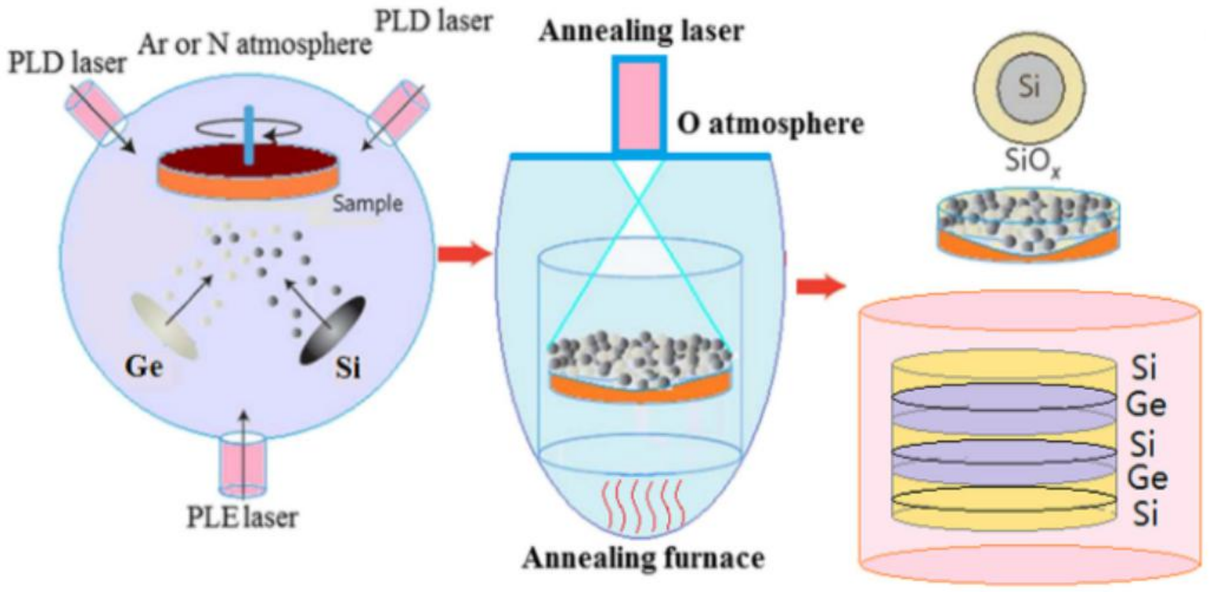

Fig. 1 Fabrication system with PLD device, in which the Si-Ge layer quantum system and super-lattice structures are prepared after annealing

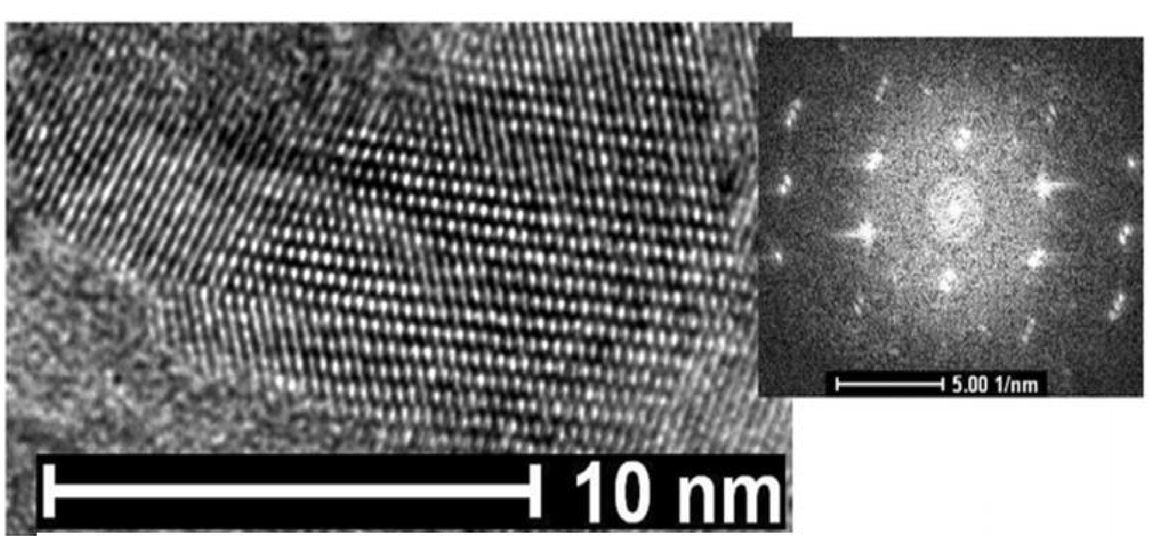

Fig. 2 TEM image of Ge crystal in the (111) direction prepared by using PLD method and its FFT pattern

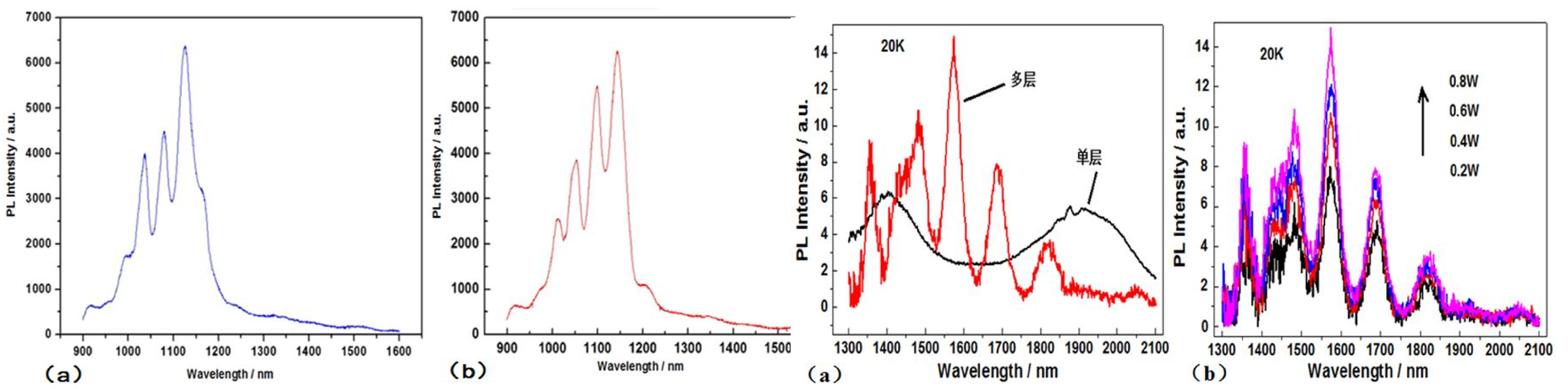

Fig. 3 PL Spectra of the Si-Ge layer quantum system and super-lattice structures are prepared after annealing

Conclusion

In summary, the Si-Ge nanolayer quantum system in the (100) and (111) directions were fabricated by using PLD process, on which the PL emission of quasi-direct-gap was measured at room temperature and 20 K. It is interesting that the sharper intensive peaks with multi-longitudinal-mode near 1150 nm and near 1500 nm were observed at room temperature and 20 K on the super-lattice structure of Si-Ge nanolayer quantum system, which have the characteristics of direct-gap band material with the band-gap energy useful for technological application. We have built the physical model of quasi-direct-gap emission with a three-level quantum system to explain the simulation and experimental results. It is a new road to obtain a new direct-gap band emission in four-group materials and to develop Si-Ge laser on a silicon chip.

References

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Acknowledgements

This work was supported by the National Natural Science Foundation of China (Grant No.11264007, 61465003).