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Light emission from SiGe nanocrystals in SiO2 produced by ion implantation

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In this project, we explored the fabrication of SiGe quantum dots (QDs) in a silica matrix by ion implantation. Ion implantation is an important fabrication tool in the semiconductor industry, and can be used to make compounds beyond the chemical solubility limit and allows the study of a range of concentrations of Si and Ge. The relative concentration of Ge in SiGe alloys has a direct influence on the bandgap, and by changing the Ge content, different emission wavelengths can be achieved and adjusted according to the requirements of applications. As an initial step, samples were implanted with Si+ at 40 keV into a 1 μm thermally-grown SiO2 film on a Si (001) substrate to achieve a peak concentration of 17.5 at. % with respect to SiO2. The implantation energy placed the implanted Si peak 50 nm below the surface. Samples were subsequently implanted with 55 keV Ge+ with 0.5-7.0 peak at. %, giving the same implantation depth as Si, and thermally annealed to promote cluster growth/crystallization. For the second set of samples, Ge+ implantation was done after 1100oC annealing, necessary for Si QDs growth. Our photoluminescence (PL) results indicate that emission peak positions and intensity depend strongly on the fabrication sequence. Both sets of samples present emission around 780 nm and 1050 nm. We observe that PL intensity decreases in both sets of samples when the Ge amount is increased, and the sample with no annealing between the implants exhibits more intense PL. Time-resolved PL revealed dynamic behaviour with at least two time constants, both in the 100-700 microsecond range, with longer lifetimes for higher Ge concentrations. Raman spectra (Ge-Si peak at 405 cm-1) revealed that Ge incorporation in Si QDs is detected only in the sample with Ge content of 7.5 peak %.

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SiGe alloys

Keyword-2

optoelectronics

Keyword-3

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