Properties of InAs nanocrystals in silicon formed by sequential ion implantation.

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Optical and structural properties of InAs nanocrystals fabricated by co-implantation of In and As ions in Si-c (100), followed by thermal annealing are investigated. In the first sample named Si/AsIn the implantation of As ions was followed by In ion implantation, whereas in the second sample named Si/InAs the order of implantation was inverted. RBS spectra of these samples taken before and after annealing show that the depth profiles of implanted ions depend strongly on the order of implantation. XRD measurements confirm the presence of InAs crystallites oriented along the crystallographic axes of the silicon matrix irrespective of the order of implantation. Low-temperature photoluminescence measurements show a large PL band in the region 0.83-1.03 eV for the sample Si/AsIn. No PL was observed in the sample Si/InAs. The optical absorption spectrum of Si/AsIn sample shows a large absorption band in the region 0.74-1.1 eV, whereas the spectrum of sample Si/InAs contains two distinct absorption bands at 0.59 eV and 0.99 eV. This may indicate a bimodal distribution of sizes of InAs nanocrystals in the Si/InAs sample. The absorption and photoluminescence bands arise from the blueshifted bandgap absorption/emission of InAs nanocrystals, this blueshift being dependent on the size of the nanocrystals. These results indicate that in the case of As ions implanted first, the InAs nanocrystals are smaller than for the case of In ions implanted first. This effect may be explained by the low solubility of In ions in the silicon matrix, which results in agglomeration of In ions during the implantation. When As ions are implanted afterwards, the In clusters are partially transformed into InAs nanocrystals which grow in size during the annealing. Hence, the order of ion implantation is found to influence the size and distribution of the resultant nanocrystals.

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