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Photoluminescence properties by control of the oxygen content and thickness in SiO_x/SiO_2 superlattices prepared by ion beam sputtering

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Nanoscaled structures using the silicon based material play a major role in optoelectonics and semiconductor research. In particular, the control of size and density of Si nanocrystals(nc) is very important. In this point, ion beam sputter deposition(IBSD) is a good candidate for exact control of formation of Si-nc. In this work, we report on the effects of oxygen content and thickness in superlattices(SLs). The stoichiometry parameter x of SiO_x grown by IBSD are measured by in situ x-ray photoelectron spectroscopy(XPS). After deposition, superlattice was rapid thermal annealed for 20 min at 1100oC and hydrogenated for 1 hour at 650oC in order to precipitate Si nanocrystal and passivate. The photoluminescence(PL) spectra in SiO_x/SiO_2 Superlattices show a size-dependent blue shift due to quantum confinement as the stoichiometry parameter $x(1.0<x<1.8)$ of SiO_x is increased. The PL intensity of Superlattices is maximized near x=1.2. Band gap engineering is possible between 1.2eV and 1.8eV by controlling the thickness of SiO_x and SiO_2. The above results give a chance for understanding of quantum confinement and bandgap engineering. The detailed analysis of effects of SLs compared to SiO_x thin films will be discussed.