Photoluminescence studies of silicon self-assembled quantum dots

Abstract :

Silicon self-assembled nanodots have been fabricated on corning (7059) and quartz glass substrates using a magnetron sputtering method at different experimental conditions, including the deposition time, RF power and substrate temperature. It was observed that, as the deposition time increases, PL intensities increased with deposition time. However, the full width at half maximum of individual spectra was observed to decrease with time. This occurs because the nature of PL is such that an improvement in the number of carriers (electron and holes) results in enhanced PL intensities. An increase in the deposition time allows more silicon attached to substrate and forming the nanodots, thus increasing the number of atoms as well as carriers. The effect of RF power was indicated by increasing trends in PL intensities. Higher deposition power appeared to increase the ratio of Si atomic concentration and, hence, an increasing number of silicon nanodots. On the other hand, the results showed that, the PL intensity decreased as the substrate temperatures were increased caused by an activated non-radiative recombination process and decrease of crystal quality. It was also observed that the peak of PL wavelength centered at 693 nm or 1.78eV energy bandgap did not differ much from those peaks obtained by varying the RF power and substrate temperature. The suggested that deposition time up to 5 min, RF power of 200 W and substrate temperature of 400°C as optimum conditions for the growth of dome-shaped silicon nanodots, with sizes between 40-80 nm. Generally the shifts in PL intensities are attributed to the structural changes which occurs during the growth processes.