Photoluminescence in Single Nanometer-thick Quantum Wells of Crystalline Silicon

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Single nanometer-thick layers of crystalline silicon (c-Si) confined by amorphous SiO_2 have been prepared by chemical and thermal processing of ELTRAN silicon-on-insulator wafers. The quantum wells of c-Si thus formed have sharp interfaces and exhibit a marked band gap increase with decreasing layer thickness, d, for $d < 3$ nm [1]. The photoluminescence (PL) from these ultra-thin single wells also shows an increase in peak energy with decreasing d. Comparison with theory based on a first-principles calculation [2] shows that the increase in PL peak energy is not as rapid as that predicted for the c-Si energy gap. It is also sub-linear in comparison to the measured band gap variation [1]. This difference is attributed to recombination of confined electron-hole pairs at the c-Si/SiO_2 interface rather than within the quantum well, similar to what has been observed previously in oxidized silicon nanocrystals [3].

References

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