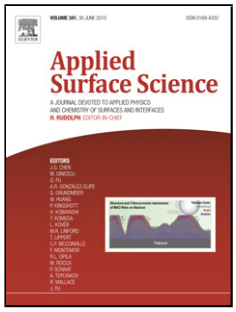

Title: Red-luminescence band: A tool for the quality assessment of germanium and silicon nanocrystals

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Red-luminescence band: a tool for the quality assessment of germanium and silicon nanocrystals

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Highlights

- The manuscript gives a detail analysis of the red photoluminescence (PL) emitted by nanocrystals fabricated by solid state dewetting of thin amorphous Silicon and Germanium layers deposited on thermal SiO_2. The results evidence a nice correlation between the PL intensity and the structural quality of the nanocrystals. This study brings new evidence and better understanding on the origin of the red PL emitted by Si and Ge nanostructures that is ascribed to the radiative transitions between NCs band and interface levels.

Abstract

We present the photoluminescence (PL) emission of Silicon and Germanium nanocrystals (NCs) of different sizes embedded in two different matrices. Formation of the NCs is achieved via solid-state dewetting during annealing in a molecular beam epitaxy ultra-high vacuum system of ultrathin amorphous Si and Ge layers deposited at room temperature on SiO_2. During the dewetting process, the bi-dimensional amorphous layers transform into small pseudo-spherical islands whose mean size can be tuned directly with the deposited thickness. The nanocrystals are capped either ex situ by silicon dioxide or in situ by amorphous Silicon. The surface-state dependent emission (typically in the range 1.74eV - 1.79eV) exhibited higher relative PL quantum yields compared to the emission originating from the band gap transition. This red-PL emission comes from the radiative transitions between a Si band and an interface level. It is mainly ascribed to the NCs and environment features deduced from morphological and structural analyses. Power dependent analysis of the photoluminescence intensity under continuous excitation reveals a conventional power law with an exponent close to 1, in agreement with the type II nature of the emission. We show that Ge-NCs exhibit much lower quantum efficiency than Si-NCs due to non-radiative interface states. Low quantum efficiency is also obtained when NCs have been exposed to air before capping, even if the exposure time