Inorganic Chemistry

Stress Evolution during Ge Nanoparticles Growth in a SiO_2 Matrix

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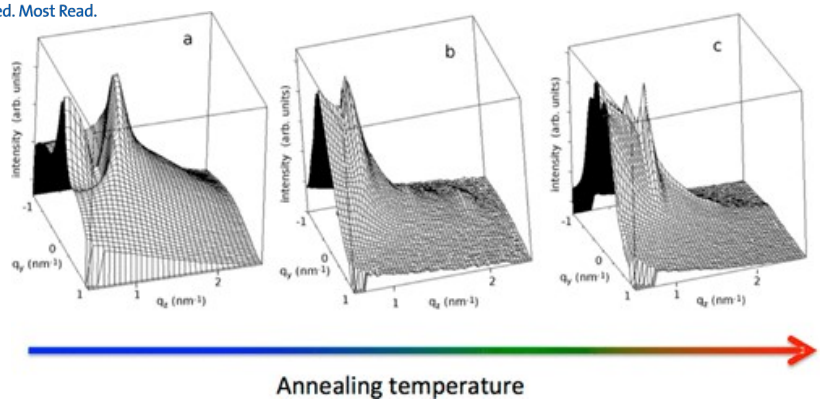
Abstract



Superstructures are explored that were obtained by multilayer magnetron deposition at room temperature of 20 SiO_2 and SiO_2:Ge bilayers, each 2 × 4 nm thick, and subsequently annealed in inert N_2 atmosphere at different temperatures in the range of 500–750 °C. The structural and optical changes induced by annealing and the formation and growth of Ge nanoparticles (nps) from early clusters to their full growth and final dissolution were studied by the simultaneous grazing-incidence small- and wide-angle X-ray scattering, transmission electron microscopy, and (time-resolved) photoluminescence (PL). It is shown that in as-deposited multilayers aggregation of small clusters already occurred, and the clusters were reasonably well intercorrelated in the lateral plane. During annealing at T_a = 550 °C or higher temperatures, Ge nps start to form and remain partly amorphous at lower T_a but crystallize completely at about 600 °C. At even higher temperatures, the Ge nps dissolve and Ge diffuses out almost completely, leaving voids in the SiO_2 matrix. Visible PL from the samples was detected and attributed to defects in the nps/matrix interface layers rather than to the nps itself because PL persisted even after Ge nps dissolution.

Supporting Information

The Supporting Information is available free of charge on the ACS Publications website at DOI: 10.1021/acs.inorgchem.8b02760.

- Line-broadening analysis, Guinier approximation, and structure factor (PDF)

pdf

» ic8b02760_si_001.pdf (209.26 kb)

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Line broadening analysis

The LPA[1] algorithm uses the integral breadth as a measure of the peak wid

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