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Atomic structural and morphological and evolution of InAs quantum dots within GaAs capping layer

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The structural and morphological properties of 4nm-thick InAs/GaAs quantum dots (QDs) with open surface and GaAs capping layer are evaluated using x-ray scattering, high-resolution transmission electron microscopy(HR-TEM), and photoluminescence methods. The QDs without capping layer are under compressive strain with non-uniform status. This strain is gradually relaxed from −7% to −2.3% toward QD apex. However, the QDs with GaAs capping layer is under hydro-static pressure and therefore, the in-plane lattice spacing is nearly matched with GaAs substrate with 0.4% compressive strain status. Moreover, this small strain can propagate toward surface region of capping layer upto 15nm thickness and this vertical evolution of strain field might include self-formed non-uniform strain status at the surface GaAs capping layer.

The QDs without capping layer have {136} low angle facets with droplet shape, however capped QDs have flattened apex with {111} high angle facets. Therefore, the QDs within capping layer are transformed to quantum disk with {111} facets. These facets are determined from transverse scans near (0004) Bragg reflection, phase contrast imaging and annular dark field method of HR-TEM.