Advances in Nano Research, *Vol. 2, No. 4 (2014) 211-217*
DOI: http://dx.doi.org/10.12989/anr.2014.2.4.211

Strain-induced islands and nanostructures shape transition's chronology on InAs (100) surface

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(Received December 3, 2014, Revised January 8, 2015, Accepted January 26, 2015)

Abstract. The self-assembled strain-induced sub-micrometric islands and nanostructures are grown from In-As-Sb-P quaternary liquid phase on InAs (100) substrates in Stranski-Krastanow growth mode. Two samples are under consideration. The first sample consists of unencapsulated islands and lens-shape quantum dots (QDs) grown from expressly inhomogeneous liquid phase. The second sample is an n-InAs/p-InAsSbP heterostructure with QDs embedded in the *p-n* junction interface. The morphology, size and shape of the structures are investigated by high-resolution scanning electron (SEM) and transmission electron (TEM) microscopy. It is shown that islands, as they decrease in size, undergo shape transitions. Particularly, as the volume decreases, the following succession of shape transitions are detected: sub-micrometric truncated pyramid, {111} facetted pyramid, {111} and partially {105} facetted pyramid, completely unfacetted "pre-pyramid", hemisphere, lens-shaped QD, which then evolves again to nano-pyramid. A critical size of 5±2 nm for the shape transformation of InAsSbP-based lens-shaped QD to nano-pyramid is experimentally measured and theoretically evaluated.

Keywords: strain-induced; pyramids; quantum dots; shape transition; III-V semiconductors

1. Introduction

In the last two decades, self-organized nanostructures, especially quantum dots (QDs) grown epitaxially on a semiconductor substrate have been the subject of intense research. Using several technologies, crystal growers have managed to tailor the size, the shape, and the material composition of such structures according to demands coming from their future application in optoelectronic devices, electronic storage and other semiconductor devices, for quantum computation and spintronics (Bimberg *et al.* 1998). In Stranski–Krastanow growth mode (Stranski and Krastanow 1938) the size, geometric structure and composition of self-organized QDs are

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http://www.techno-press.com/?journal=anr&subpage=7 ISSN: 2287-237X (Print), 2287-2388 (Online)

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