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ITE

Gallium Arsenide Second-Window Quantum-Dots Lasers GSQ IST-1999-10450

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PROJECT DESCRIPTION

We propose to demonstrate in-plane and vertical cavity diode lasers operating at 1300nm using (Ga, In) As quantum dot emitters. These devices based on GaAs substrates are expected to exhibit superior characteristics compared to the classical GaInAsP on InP based devices, with the advantage of lower cost, compatibility with the well established GaAs processing technology, improved reliability and decreased temperature sensitivity. The project will demonstrate 1300nm optical links based on this all GaAs technology and compare the performances with 1300nm GaAs devices.

OUR ROLE IN THE PROJECT

Analysis of geometry and distribution of (Ga,In)As quantum dots (QD) by means of transmission electron microscopy (TEM)

RESULTS

Laser structures were prepared by means of molecular beam epitaxy (MBE) by a team of EPFL . The aim of our research was to determine by means of TEM techniques the quality and **areal density** of quantum dots (QDs). Both plan-view and cross-sectional TEM samples were analysed [1-2]. This results are very useful to optimize the growth process. In Fig. 1a a plan-view of InAs QDs grown on GaAs is shown. Symmetrical dark forms is the strain contrast around the dots, which in this case is the evidence of proper QD growth. The dots can be treated as lens-shaped precipitates embedded in the GaAs matrix. The image allowed to count the aerial density of QDs which in this case is 450/square micrometer. Plan-view images inform us about the density and distribution of QDs but the information about the vertical shape is missing. This can be found on cross-sectional images. Fig. 1b and 1c show bright-field (BF) and dark-field (DF) cross-sectional TEM images of QDs, respectively. From Fig. 1a we can assume that thickness of a thin foil being a cross-section of QD heterostructures is below 50 nm. In a BF image shown in Fig. 1b a contrast on QDs is dominated by strain contrast, which can be significantly decreased using DF images (Fig. 1c). From such an image a shape of dots can be assessed. Assuming that the QD located rightmost on the image (Fig. 1c) was totally included in a thin foil (so we see its projection), we can measure its width. It is approximately 25 nm.

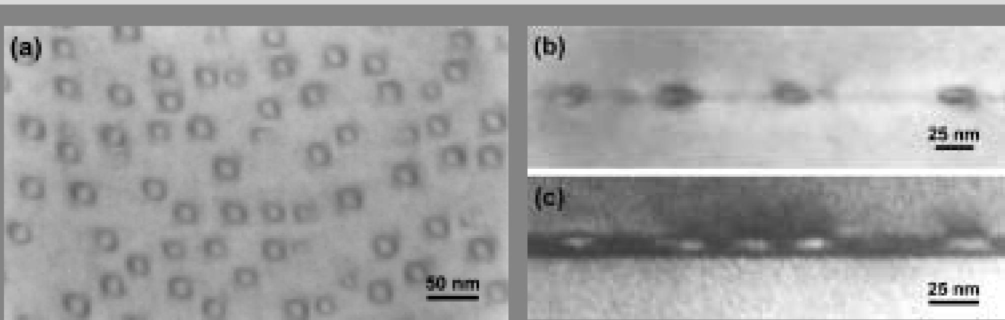

Fig. 1. InAs quantum dots grown on GaAs: **a)** plan-view image. Cross-sectional TEM images **b)** bright field; **c)** dark field

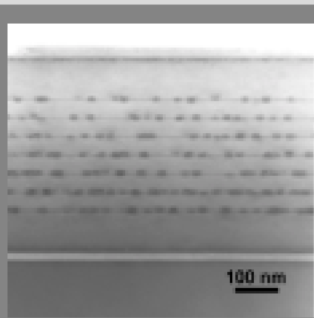

Fig.2. Quantum dots multilayer structure

Publications

[1] Chen J.X., Markus A., Fiore A., Oesterle U., Stanley R.P., Carlin J.F., Houdre R., Ilegems M., Lazzarini L., Nasi L., Todaro M.T., Piscopiello E., Cingolani R., Catalano M., Katcki J., Ratajczak J.: "Tuning InAs/GaAs Quantum Dot Properties under S-K Growth Mode for 1.3 um Applications" *Journal of Applied Physics*, vol. **91** (2002), p. 6710.

[2] Katcki J., Ratajczak J., Phillipp F., Muszalski J., Bugajski M., Chen J.X., Fiore A.: "Electron microscopy study of advanced heterostructures for optoelectronics", *Materials Chemistry and Physics*, 2003, accepted for publication.

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