MBE Growth and Analysis of InAs QDs on (411) and (221) GaAs substrates.

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From the human need for more efficient and smaller technology, the low dimensional systems (LDS) come up to replace or improve the existent devices[1-3], which has achieved the highest points in efficiency and the smallest dimensions that can provide by itself. Focusing on the most attractive of the LDS: the quantum dots (QDs)[4] have been widely studied in a huge variety of systems because of their atom-like properties. In order to refine the actual technology the quality of the QDs must be improved.

It has been reported that the buffer layer (BL) growth on (411)A substrates can present corrugation which is strongly dependent on the growth parameters and structure[5]. This property can be exploited for promoting the self-organization of the QDs in the same way as it has been used on other orientation surfaces.

In this study we present the self-assembling of InAs nano-islands grown by Stranski-Krastanov mode on (411)A, B and (221)A, B GaAs substrates and (100) for comparison purposes. We stacked a 0.1-µm-thick GaAs protective layer (Pl), 0.5-µm-thick GaAs BL, grown varying 2 parameters; deposition temperature: T_{BL} = 610 and 700°C, and As pressure P_{As} = 3.1, 4.5 and 6.0 x10^{-6} mbar, at a growth rate of 0.3 µm/hr and deposited a 3-monolayer (ML)-thick InAs layer at 470°C with 0.05 ML/sec.

Regardless of the behavior during the island formation, the result after the deposition demonstrates that the island density is much higher on (411)A than on (100) as shown in Figure1. Both surfaces show semi-spherical shape of the islands as well. In addition to this, the shape quality of the islands and also the density decreases while increasing the P_{As}, more specifically describing about the scattering in the height distribution which seems to be strongly dependent on the As pressure (Figure2), this effect can be caused by the surface roughness due to the excess of As, which creates slopes and rises the possibility of InAs nucleation in that area, similar to the coalescence between islands[6]. It is also clear that the dimensions of the islands are small enough, less than 50 nm of diameter size for the (411)A sample and less than 40 nm for the (100), to study optical properties showing the quantum confinement effect.

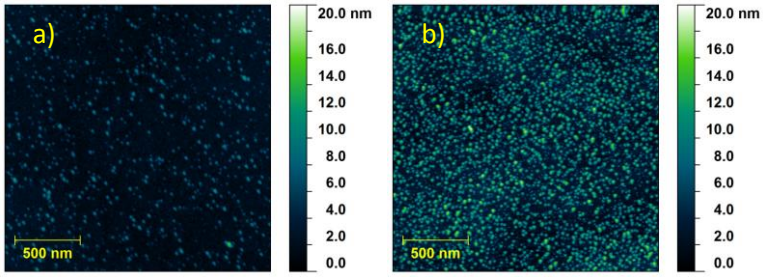

Figure1. AFM images of the nano-islands grown with P_{As} = 3.1 x10^{-6} mbar on a) (100) and b) (411)A GaAs substrate.

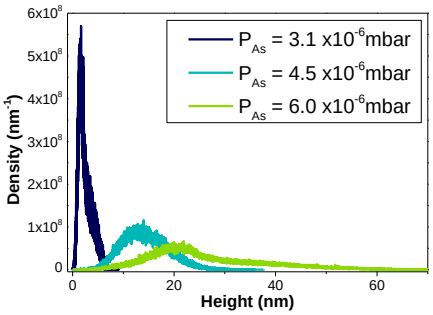

Figure2. Histogram of nano-island height that shows the general behavior of the islands while increasing the P_{As}.

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