GROWTH OF SITE-CONTROLLED InAs QUANTUM DOTS ON PREPATTERNED GaAs (001) SUBSTRATES BY AFM LOCAL OXIDATION

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The precise location of quantum dots is a critical step towards the development of single photon emitters, where a single quantum dot should be located at a specific site within an optical micro cavity [1]. In this work, we present a fabrication process combining AFM local oxidation nanolithography and molecular beam epitaxy (MBE) growth techniques to control the nucleation of InAs quantum dots (QD) on prepatterned GaAs (001) substrates [2].

Our approach basically involves three steps: i) Fabrication of patterned GaAs(001) substrates by AFM local oxidation lithography: The pattern consist of a 2D array of nanometric size oxide dots (see Fig. 1a). The GaAs oxide dots are removed by FH selective etching obtaining 2D arrays of nanometric holes (see Fig. 1b). The design of the pattern can be freely modified to control the final QD density; ii) Preparation of GaAs(001) patterned substrates for further epitaxial growth by a process that preserves the pattern. This process includes GaAs native oxide desorption and GaAs buffer layer growth; iii) InAs deposition on patterned substrates.

Our experimental results show that a high selectivity of InAs nucleation in the nanoholes can be achieved when appropriate growth conditions are used. Therefore, the QD nucleation sites are defined by the pattern (Fig. 2). The number of QD obtained inside each nanohole depends on the geometrical shape of the oxide dot and can be chosen by varying the shape of the oxide dot.

Finally, in order to validate our whole fabrication process, micro-photoluminescence characterization of a single InAs QD obtained by this process will be presented.

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References:

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Figures:

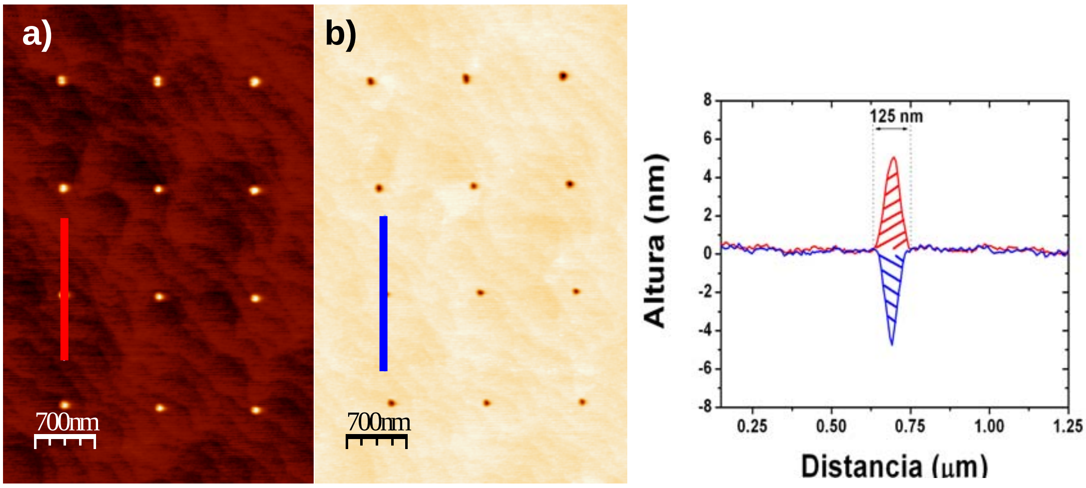

Fig 1: a) Atomic Force Microscopy (AFM) images of oxide dots fabricated by AFM local oxidation nanolithography. b) 2D array of nanoholes obtained after selective FH chemical etching of oxide dots . Notice on profiles shown on the right that the volume of emerging oxide dots are similar to that of the resulted holes.

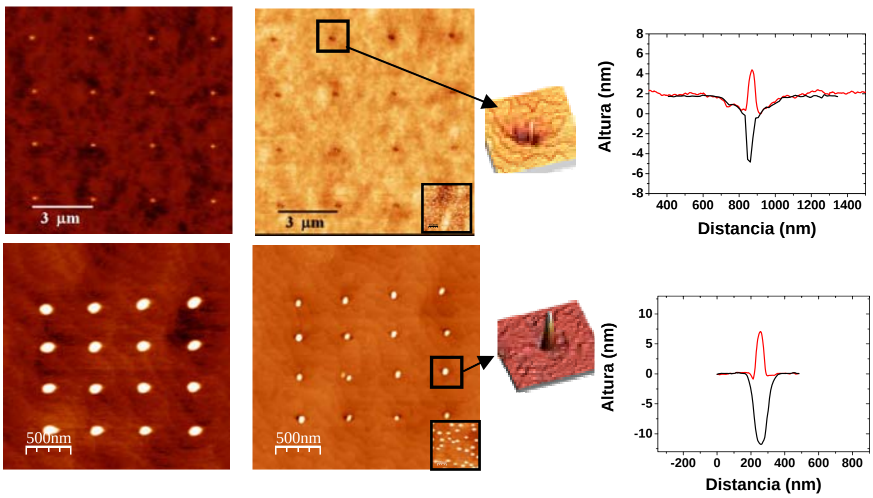

Fig. 2: AFM images of 2D arrays of oxide dots fabricated by AFM local oxidation technique (left) and resulting InAs QDs after growth process (right). Density of QDs can be controlled as desired varying the pattern design.