Low temperature oxide desorption in GaAs (111)A substrates

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Quantum dots (QD) grown on GaAs(111) substrates are highly potential for entangled photon devices based on the cascade relaxation of biexcitons, as they present a fine structure splitting close to zero [1-3]. For that purpose it is desirable to control the density, the emission energy and the position of the QD. Particularly, control of the position of QD often involves regrowth steps on previously fabricated patterned substrates [4-6]. The patterning is commonly carried out on epitaxial substrates, i.e. substrates where an epitaxial layer has already been grown. Consequently, during the patterning processes previous to regrowth, the epitaxial substrates are exposed to air without any passivizing layer (as the commercial epi-ready substrates have). Moreover, the oxides formed at the patterned epitaxial substrates have to be removed before regrowth at low enough temperature processes for preserving patterned motifs. The aim of this work is to study oxide removal processes on GaAs (111)A substrates previous to epitaxial growth. We have studied conventional thermal desorption and processes based on the reduction of surface oxides by deposition of gallium, indium and exposure to atomic hydrogen.
We have determined low substrate temperatures (T_s) for optimum oxide removal in epi-ready substrates by the different studied processes: T_s= 540 ºC for thermal desorption, T_s= 505ºC for In deposition (without metallic droplet formation) and Ts = 400º C for oxide desorption by exposure to atomic hydrogen. All these processes allow for a subsequent good quality epitaxial growth. These results cannot be directly extended to oxide removal in epitaxial substrates. In this case, we have found that only In deposition and exposure to atomic hydrogen are compatible with regrowth processes on epitaxial substrates. On Fig. 1 we show the Atomic Force Microscopy (AFM) image of 5 nm of GaAs on a GaAs(111)A surfacae where the oxide was removed by In deposition (a) and GaAs QDs grown by droplet epitaxy technique [7] on a 20 nm thick AlGaAs layer after oxide removal by Ga deposition (b).

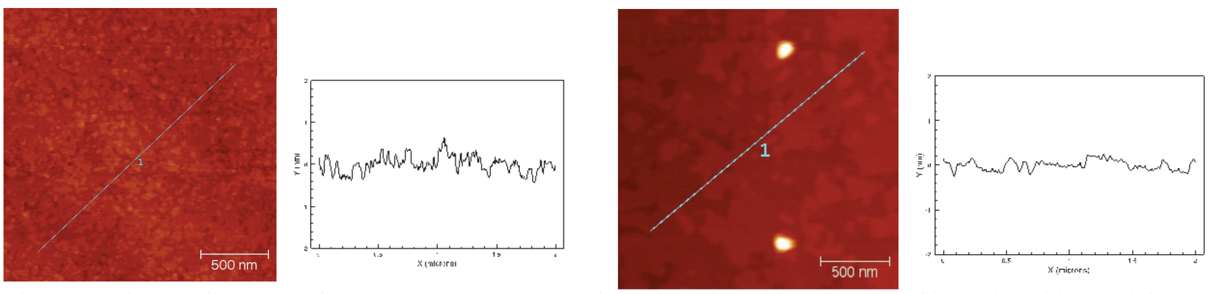

Fig 1: AFM image of (a) 5 nm of GaAs on a GaAs(111)A surface where the oxide was removed by In deposition and (b) GaAs QDs grown by droplet epitaxy technique on a 20 nm thick AlGaAs layer after oxide removal by Ga deposition.

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