Enhancing the mobility of scalable quantum networks based on InAs nanowires with a double buffer approach

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One dimensional high mobility and so coupling semiconductors have potential to be a base of next generation quantum devices, and particularly, InAs nanowires present outstanding properties that make them suitable for this application. So far, high crystal quality NWs have been achieved by VLS growth, but scalable growth techniques should be explored to ultimately fabricate commercial devices.

Recently, InAs NW networks on GaAs have been successfully grown by the scalable selective area growth (SAG) technique[1], but the inherent strain between substrate and nanowire (NW) is responsible of dislocation formation acting as scattering centres negatively affecting the material's mobility. Other studies have proven that the addition of a buffer layer can potentiate elastic strain contributions, reduce dislocation formation and thus, improve electronic transport of the devices [2].

In this study, we performed strain engineering based on a double buffered approach to minimize strain fields within the InAs channel and we improved the nanowire-substrate interface quality also by substituting conventional thermal annealing for atomic hydrogen during the GaAs substrate preparation, for native oxide removal.

Our results reveal that a two-fold optimization of growth temperature (Fig. 1a, steps iii and iv) can effectively trap dislocations away from the InAs channel (Fig. 1b) while keeping high compositional purity on the InAs channel (Fig. 1c). As a result, we achieve a doubling of field-effect mobility compared to similar nonoptimized SAG counterparts[3].

References

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Figures

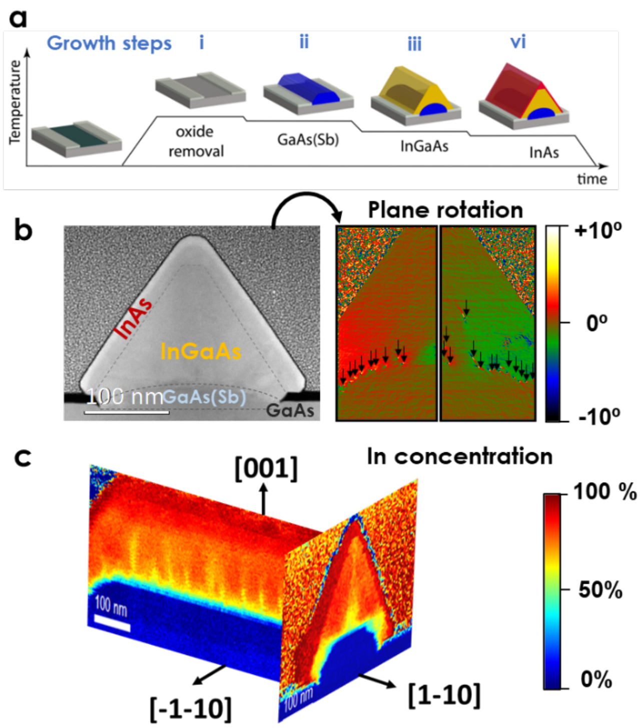

Figure 1: a Growth steps of double buffered InAs NWs. **b** STEM image and plane rotation map on a

NW cross section showing dislocations confined away from the InAs interface (arrows). **c** EELS compositional map of In relative atomic composition (vs. Ga).