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(1) Title of the paper

High Quality InP Localized Growth on Silicon for Photonics Applications

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(7) State if poster presentation is preferred
Oral presentation is preferred, but poster is also acceptable

High Quality InP Localized Growth on (001) Silicon Substrate for Photonics Applications

Over the last decade, “silicon photonics” has evolved from a relatively new topic to one of the most competitive research field. It holds great promises to many applications, such as optical interconnects, sensing, and next generation commercial electronics. Great achievements have been made, although the indirect bandgap nature of silicon hinders the realization of active devices. Besides the efforts of bonding IIIVs materials on silicon for active applications, the possibility of integrating IIIVs on silicon in the epitaxy level reattracts enormous interests from the material science society. In this work, we present recent results of localized InP growth on exactly [001] oriented silicon substrate.

In order to accommodate the large lattice mismatch between InP and silicon, we start the epitaxial growth from a (001) silicon substrate covered by a patterned SiO_2 buffer. Modified shallow trench isolation (STI) process available in the IMEC 130 nm CMOS line is utilized to fabricate nano-scale holes and trenches in the SiO_2 layer. Thanks to the defect necking effect of a high aspect ratio trenches, most of the threading dislocations that propagates upwards in the trench will be annihilated by the trench sidewall, leaving the InP defect-free in the upper part of the trench. After the localized epitaxial growth that was carried out in a metalorganic vapour phase epitaxy (MOCVD) reactor, the material quality is analyzed by photoluminescence (PL) and transmission electron microcopy (TEM).

Fig. 1a shows the schematics of the SiO_2 mask: trenches that are aligned along different orientations will be filled by InP during the growth. Fig. 1b shows the PL image recorded by an ordinary silicon camera. Several images are joined together to give the full view of the PL emission from all the trenches. It is very interesting to find that the material quality is highly trench orientation dependent, and a rotation periodicity of 45° can be found. InP that is grown in [110] and [100] oriented trenches give the lowest PL intensity, while the InP grown in the [130] orientation family gives extremely high PL intensity. TEM analysis of the [130] oriented trench (see Fig. 1c) shows that all the dislocations and anti-phase boundaries (APBs) are confined in the bottom trench, and the large lateral overgrown InP “cap” on top is ideal for IIIV active devices integrated on silicon.

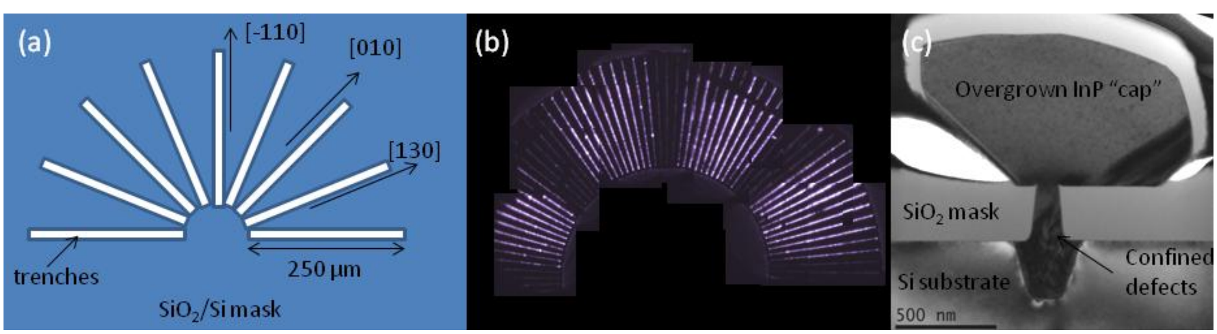

Figure 1. (a) Schematics of the SiO_2 mask that covers the silicon substrate. (b) Camera image of the PL emission from different trenches. (c) TEM image of the InP that is grown in the [130] oriented SiO_2 trench.

We also performed InP growth in circle-shaped trenches. Short but thick InP nanowire cavities are successfully obtained, and it is striking to find that although the direct contact of InP on silicon tends to introduce high optical loss, lasing has been achieved by optical pumping under room temperature.