Integration of InP Nanowire Lasers on (001) Silicon Substrate by Selective Epitaxial Growth

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Abstract— The co-integration of nanolasers with silicon photonic circuit could potentially solve the most challenging obstacle of silicon photonics, i.e., a lack of light sources due to the indirect bandgap of the silicon material. Although a wide range of IIIV-on-Si nanolasers demonstrations could be found in literature, in most of the cases, nanolasers are first processed on III-V substrates, and then removed to be placed on a silicon substrate. This complex and low-yield integration strategy makes these nanolasers practically infeasible. Selective epitaxial growth could be the optimal approach, which provides precise position control and very high yield.

To implement such epitaxial integration method, a fundamental scientific problem has to be solved, that is the huge lattice constant mismatch between IIIVs and silicon (8.1% for InP on silicon) and also the polarity difference at the interface. Previously we reported a polytypic InP nano-cavity laser which is epitaxially grown on (001) Silicon by using step-surface-germanium seed layer [1]. However, the yield is lower than expected, mainly due to the incomplete annihilation of anti-phase-boundaries (APBs). In this work, we present the further improved of yielding and material quality by using 'V-groove' templates, in which APBs can only form at the trench corners which will be blocked by burring the corner before heteroepitaxy. Sub-pJ lasing threshold at room temperature has been achieved.

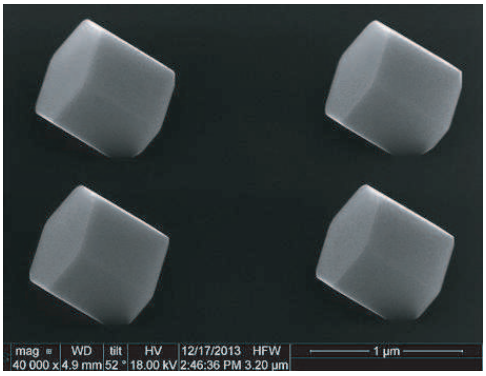

Figure 1: A tilted SEM picture of an array of InP nanowires selectively grown on silicon. Good uniformity in terms of wire diameter and length could be easily identified.

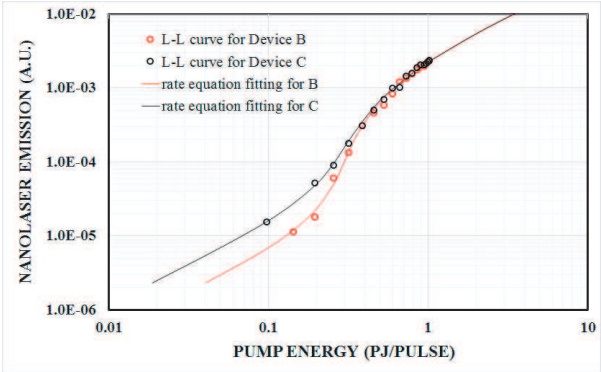

Figure 2: The light in-light out curve of two InP/Si nanolasers measured at room temperature. The circles are measured points and the solid curves are the rate equation fittings, from which the threshold are derived as 0.26 pJ and 0.19 pJ, respectively.

REFERENCES

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