**New contact approach for optical loss reduction in nano-ridge laser diodes grown on 300 mm silicon wafers**

Davide Colucci[1,2], Peter Swekis[2], Debi Prasad Panda[2], Didit Yudistira[2], Reynald Alcotte[2], Yves Mols[2], Joris Van Campenhout[2], Robert Langer[2], Dries Van Thourhout[1], Bernardette Kunert[2]
[1] Ghent University, [2] imec

Nano-ridge engineering (NRE) is a unique technique for the monolithic integration of III-V semiconductor devices on silicon wafers using metalorganic vapor-phase epitaxy [1]. This technique allows to realize extremely low threading dislocation densities in the active III-V material and, in turn, has enabled the fabrication of hundreds of electrically pumped nano-ridge lasers on 300 mm Si wafers within the CMOS pilot line at imec [2].

In such devices, sparse p-contact plugs on top of the nano-ridge are used to reach optical losses down to 20 cm-1, owing to the beating of the multiple modes guided inside the ridge. This phenomenon is, however, strongly dependent on the nano-ridge cross-section and, therefore, on any process variation. In this work, we have explored different nano-ridge geometries to reduce the optical losses even in the case of a continuous metal contact on top of the ridge.

A finite difference eigenmode solver was used to extrapolate the effective refractive index of the fundamental TE mode guided in the ridge, and related absorption, for five different geometries (Fig. 1a). Among them, the etched-fin nano-ridge shows the lowest losses, with values below 1 cm-1 (Fig. 1b) for fin widths below 150 nm and heights above 200 nm (achievable considering preliminary epitaxial experiments, see Fig. 1c). Notably, the InGaP passivation layer is preserved in this approach. Moreover, moving to a denser contact scheme will allow the device to operate with lower current densities, avoiding hot spots and, hence, improving reliability.