Top-amorphous-silicon-grating InGaAs/GaAs nano-ridge distributed feedback laser monolithically grown on 300 mm silicon substrate

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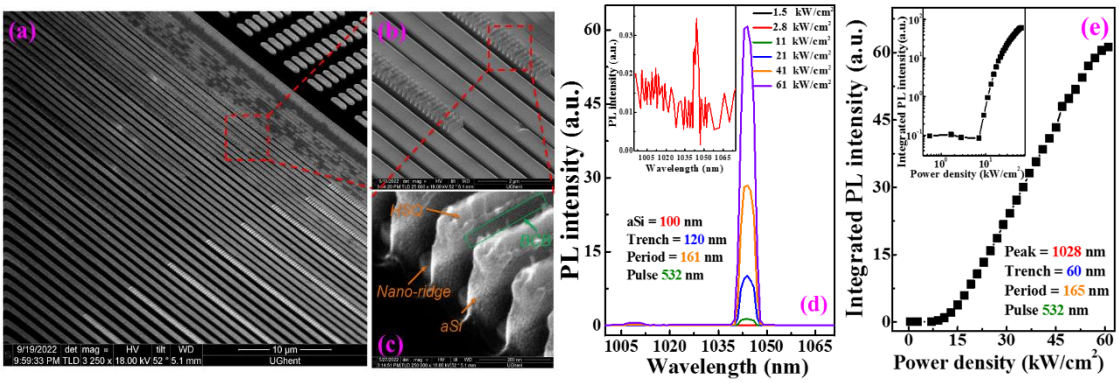
Abstract

The monolithic growth of direct bandgap III-V materials directly on a Si substrate is a promising approach for realizing complex silicon photonic integrated circuits (PICs) including sources and amplifiers. It remains challenging to realize practical, reliable and efficient light emitters however, due to defect formation during the epitaxial process. Exploiting the aspect ratio defect trapping (ART) technique and nano-ridge engineering (NRE), nano-ridges with high crystal quality were achieved. In earlier work we used etched gratings to create distributed feedback (DFB) lasers from these nano-ridges[1]. Here we deposited an amorphous Si grating on the top of nano-ridge. Under pulsed optical pumping, ~ 2.8 kw/cm^2 lasing turn-on threshold is observed, more than 10 times smaller compared to etched grating devices. This low-optical-pumping-threshold again demonstrates the high quality of the epitaxial material and provides an alternative route towards realizing electrically-driven devices.



(a) Tilted scanning electron microscope (SEM) image of DFB laser arrays, (b) Zoomed-in image of DFB laser arrays based on nano-ridges with 60 nm trench, (c) Zoomed-in image of amorphous silicon grating on the top of nano-ridge with 60 nm trench, (d) Photoluminescence (PL) spectrum of DFB laser based on nano-ridges with 120 nm trench under different 532nm pulsed pumping power densities. Inset: PL spectrum of same DFB laser under 2.8kW/cm^2 pumping power density, (e) Light in (pumping power density) - light out (integrated PL intensity) curve of DFB laser based on nano-ridges with 60 nm trench in linear and logarithmic (inset) scale.

[1] Y. shi, et al, "Optical pumped InGaAs/GaAs nano-ridge laser epitaxially grown on a standard 300-mm Si wafer", Optica, 2017, 4(12), 1468-1478.