SUPPORTING INFORMATION

Ultra-compact position-controlled InP nanopillar LEDs on silicon with bright electroluminescence at telecommunication wavelengths.

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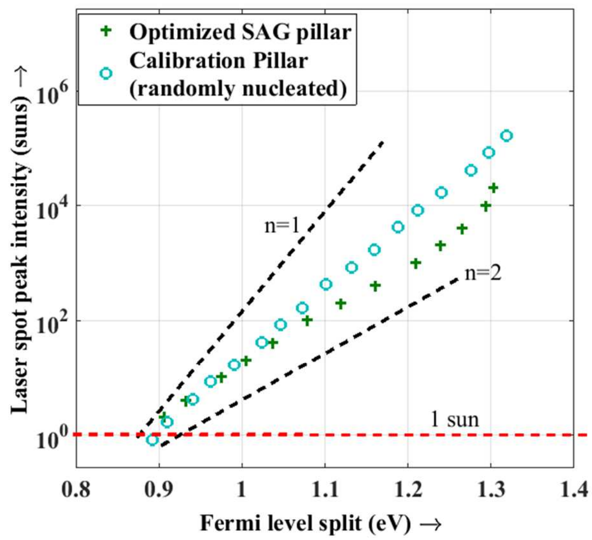
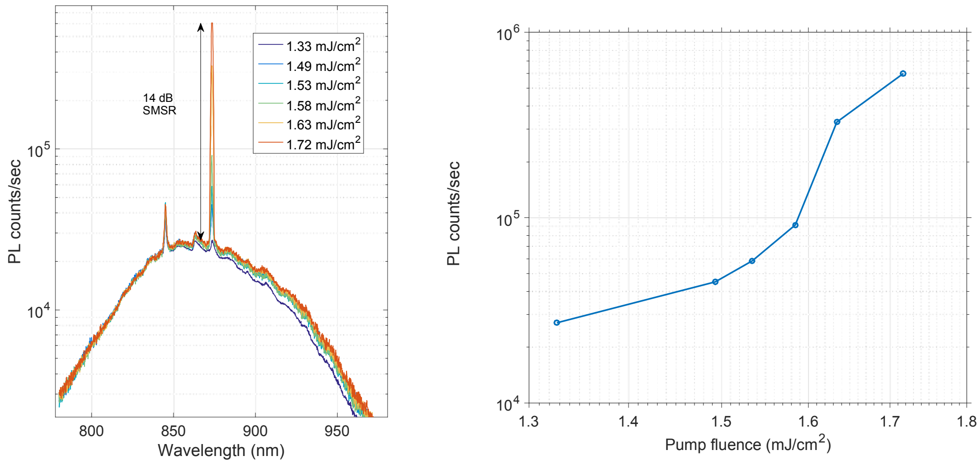
S1. Calibrated IV (CIV)



The calibrated I-V is measured through pump pendent PL measurement on single undoped InP pillars. The theory of the calibrated I-V can be found in [1]. The data compares the CIV characteristics of a site-controlled and spontaneously nucleated nanopillar. The peak intensity of the spot is along the y-axis in Suns. This leads to an inferred Fermi level split of 0.85-0.9 eV at 1 sun, for both kinds of nanopillars, making their quality comparable.

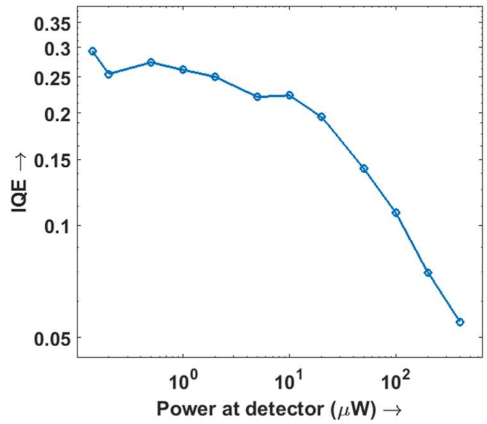
[1] Tran, T.-T.D et al. Nanoletters **014**, *14* (6), pp 3235–3240

S2. Lasing Characteristics



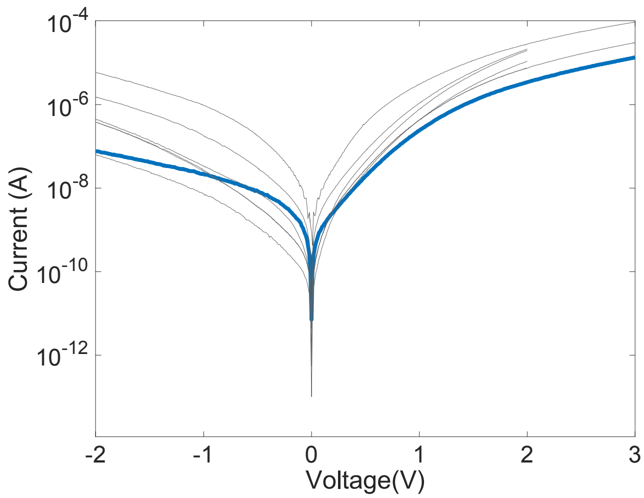
A mode-locked Ti:sapphire laser delivering 140 fs pulses was used to pump a single nanopillar. The pump wavelength was fixed at 750 nm with a repetition rate of 80 MHz. The FWHM of pump laser spot was focused down to 2.5 µm. The emission spectra of a InP nanopillar at different pump powers, at room temperature, are shown here. A sharp lasing peak, with 14 dB sideband suppression is observed. A clear threshold around 16 mJ/cm^2 can be seen in the L-L curve.

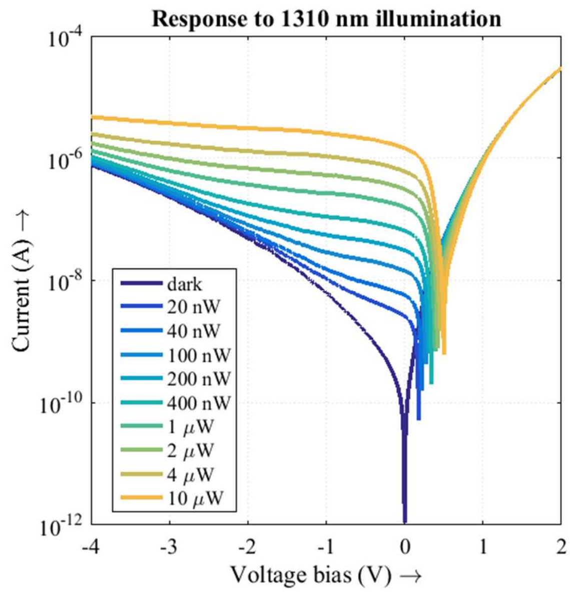
S3. Multiquantum well IQE



The internal quantum efficiency was measured as a ratio of room temperature and low temperature PL intensities. The quantum well sample shows a maximum IQE of 25-30%. The IQE shows high values even at low excitation due to effective confinement of carriers in the MQW. The IQE shows a droop at high excitation due to Auger non-radiative recombination associated with increased carrier density.

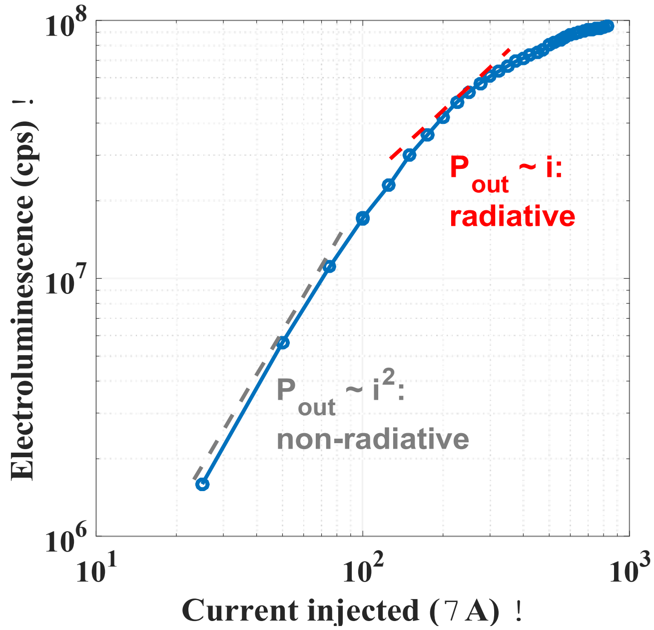
S4. Electrical characteristics





Electrical characteristics were measured from several single and ensemble nanopillar diodes at room temperature. Typically, single pillar devices show a series resistance ~40KΩ. In some single nanopillar devices, we measured a low dark current ~1 nA (-1V) at room temperature. The response of these devices to laser illumination at 1310 nm was studied. The device show photoresponse with Voc = ~0.5 V, and I_{SC} of 10^{-6} A.

S5. Light-current characteristics



DC measurements under ambient conditions reveal two regimes of light emission at pump current below 100 □□, the injected carriers recombine non-radiatively, leading to a quadratic dependence of light output on current. At higher current, the carrier density is sufficient to allow radiative dominant current, with a linear dependence before quantum well saturation at high pump level.

S6. Measurement set-up for L-I-V