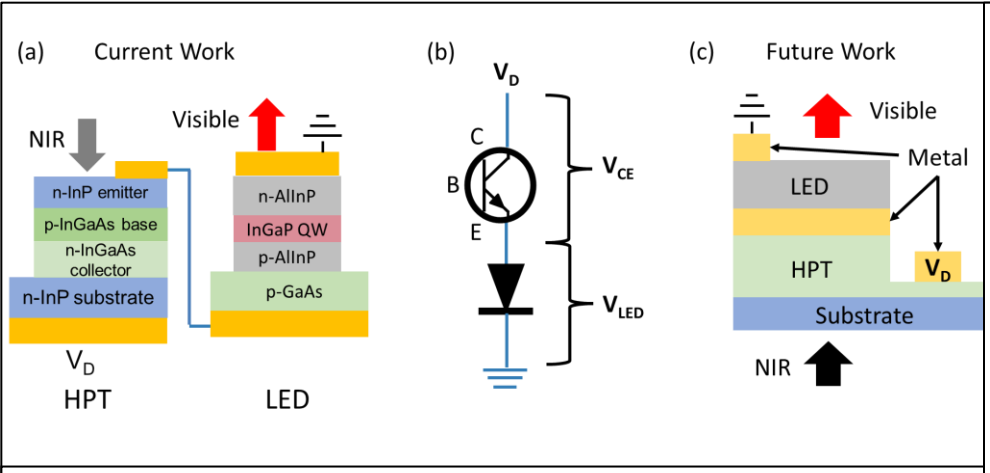

Figure 1: (a) Schematic of the NIR upconverter components in series, as demonstrated in this work. (b) Circuit diagram of the NIR upconverter where V_D, V_{LED}, and V_{CE} refer to voltage drops across the full device, the LED, and HPT, respectively. (c) Schematic showing future work where the LED will be metal-metal bonded to the HPT with the LED substrate removed.

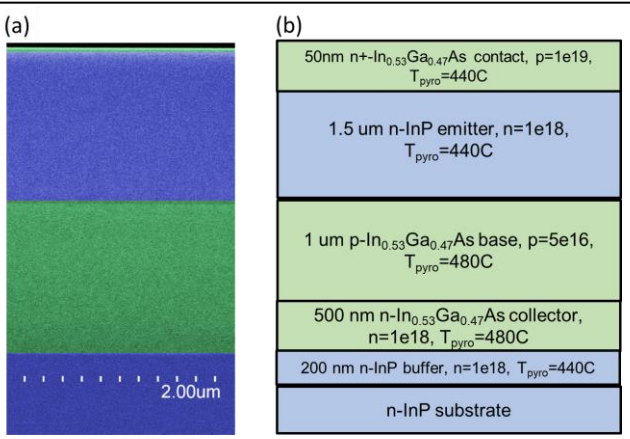

Figure 2: (a) False color cross-sectional SEM of the HPT and (b) stack diagram of the HPT growth labeling the layer composition, thickness, growth temperature, and nominal bulk doping.

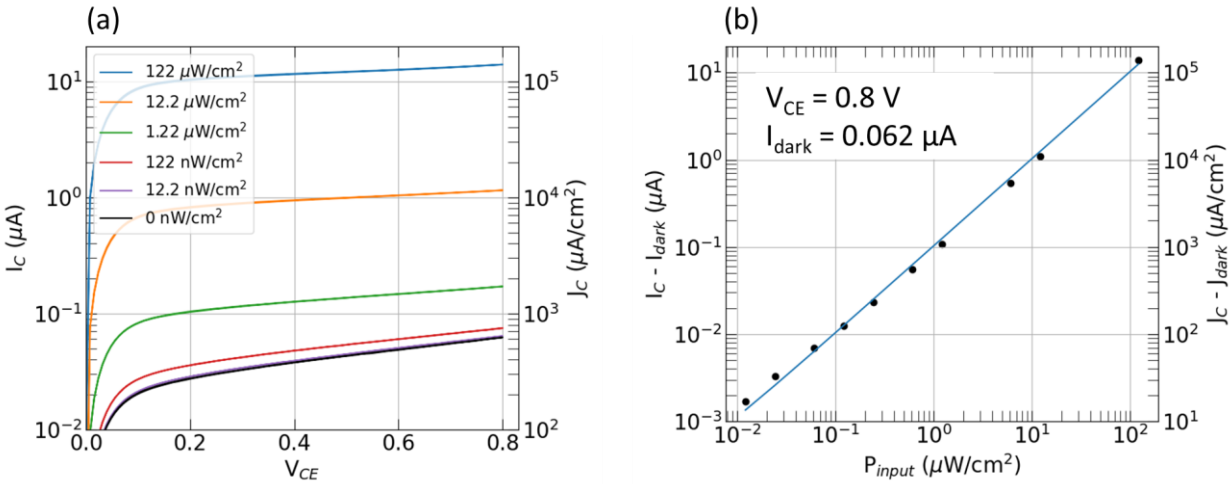

Figure 3: (a) IV characteristics of the HPT under different input powers (λ=1.55 μm). An input power density as low as 12.2 nW/cm^2 generates a current signal I_C that is distinguishable from the dark current. (b) Current above dark current vs input power (V_{CE} = 0.8V) showing linear response.

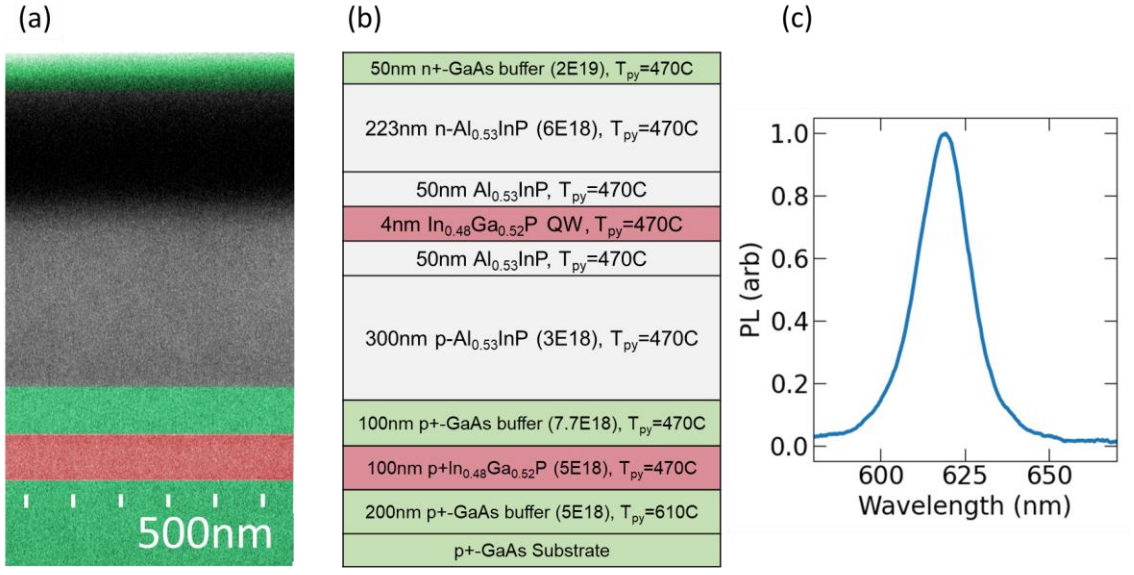

Figure 4: (a) False-color cross-sectional SEM of the visible LED. (b) Stack diagram of the LED growth labeling the layer composition, thickness, growth temperature, and nominal bulk doping. (c) PL spectrum of the RTA'd LED.

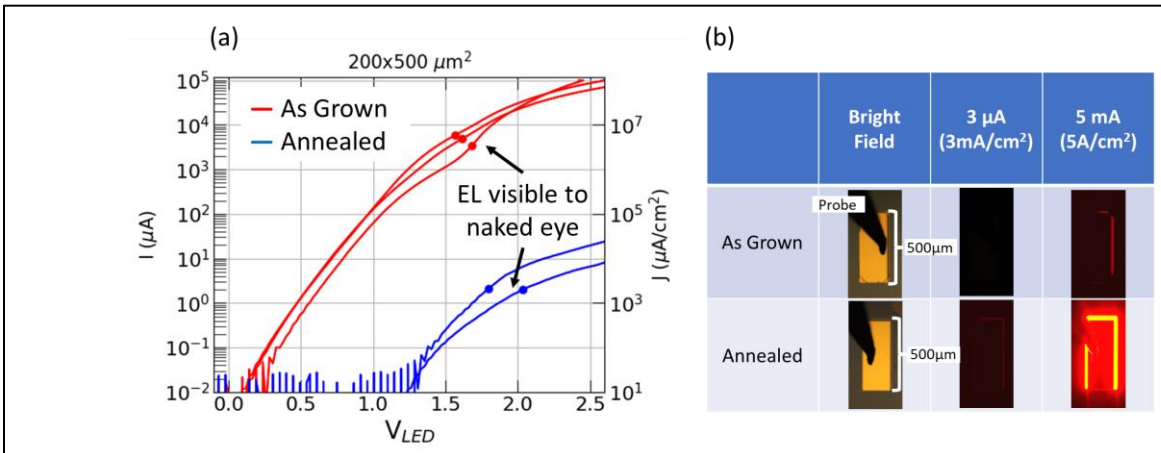

Figure 5: (a) IV characteristics of the LED comparing the device with and without annealing; the RTA'd LED shows high series resistance, which will be addressed in future work. Points indicate where the LED starts to emit light visible to the dark-adapted naked-eye. (b) Images of the devices under a microscope under different operating currents.

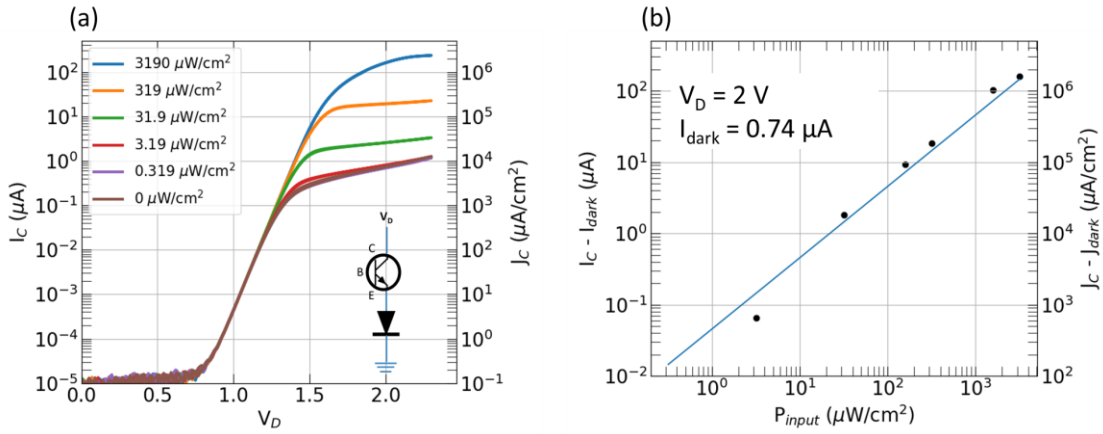

Figure 6: (a) IV characteristics of an HPT and LED in series [as in Fig. 1(b)] under different input powers (λ=1.55 μm). Amplified photocurrent from the HPT turns on the visible LED, clearly demonstrating up-conversion. (b) Current above dark current vs input power (V_D = 2 V). The curve deviates from linearity for input power < 32 μW/cm², but 3.2μW/cm² is still distinguishable from dark current.

Bibliography

1. Spitzer, Cary R., and Cary Spitzer, eds. *Digital Avionics Handbook*. CRC press, (2000): 126-135.