Direct Bandgap Silicon Germanium

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I will present hexagonal crystal structure (lonsdaleite) Silicon Germanium (hex-SiGe), featuring direct bandgap emission [1] in the wavelength range 1.5 - 3.4 µm, as shown in Fig. 1. These alloys are currently prepared as nanowire shells, grown around a wurtzite GaAs nanowire core. Although the transition matrix elements of bulk hex-Ge has been predicted to be very small, we observe a radiative lifetime of 0.7 ns for hex-$Si_{0.2}Ge_{0.8}$ and 1.7 ns for hex-Ge. Moreover, hex-$Si_{0.2}Ge_{0.8}$ nanowires clearly show stimulated emission and optical gain [2], as shown in Fig. 2. We finally prepared [3] coaxial hex-Ge/$Si_{1-x}Ge_x$ and hex-$Si_{1-x}Ge_x$/ $Si_{1-y}Ge_y$ quantum wells showing quantum confinement with type I band alignment. Our results indicate that this new group IV semiconductor is promising for hex-SiGe light emitting devices, including quantum well lasers and quantum dot single photon emitters.

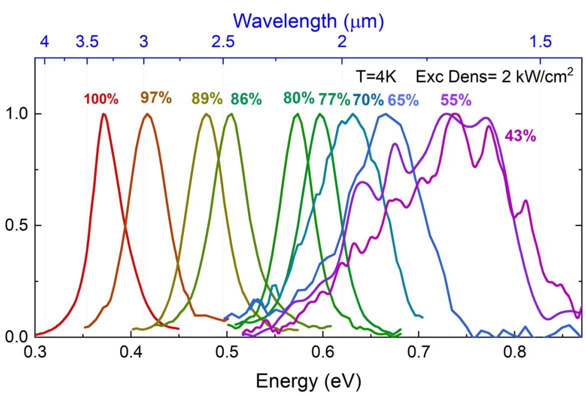

Fig.1. Tunability of hexagonal SiGe alloys

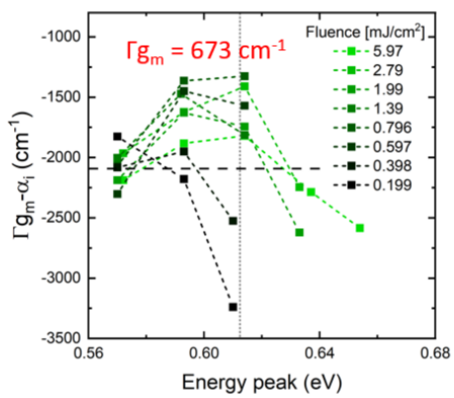

Fig.2. Observation of positive material gain in hex-SiGe

References

[1] E. Fadaly et al., Nature 580, 205–209, 2020

[2] M. van Tilburg et al., https://www.researchsquare.com/article/rs-4024141/v1

[3] W. Peeters et al., https://www.researchsquare.com/article/rs-3875137/v1