Towards a SiGe-based laser

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The performance of electronic chips is to a large extent limited by the electrical resistance, which sets the maximum operation frequency and the minimum power consumption. It is expected that by replacing part of the electronic circuit by photonics, these limitations could be alleviated. For this goal, an integrated light source is required.

Silicon and germanium, unfortunately, cannot emit light efficiently due to their indirect bandgap, hampering the development of Si-based photonics. However, alloys of SiGe in the hexagonal phase are predicted to have a direct band gap [1]. In this work, we exploit the unique feature of the nanowire growth mechanism to control the crystal structure by tuning the contact angle of the catalyst particle and demonstrate the optical properties [2]. We show efficient light emission from hexagonal SiGe, up to room temperature, accompanied by a short radiative life time of around a nanosecond, the hallmarks of a direct band gap material. The band gap energy is tunable in the range of 0.35 till 0.7eV opening a plethora of new applications.

The next challenge is to demonstrate lasing from this new material. For this we have fabricated an external cavity. Above a certain excitation threshold, we observe a strong reduction of the radiative lifetime and a superlinear increase of the emission intensity, first indications of amplified spontaneous emission (ASE).

[1] Silvana Botti et al. , *Phys. Rev. Mat.* 3, 034602 (2019)
[2] E.M.T. Fadaly *et al.*, *Nature* 580, 205 (2020).