Light absorption in axially heterostructured semiconductor NWs

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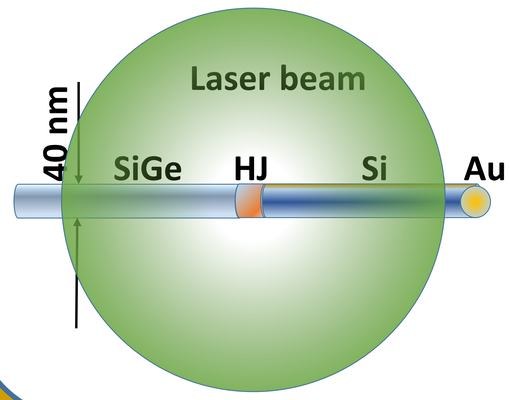
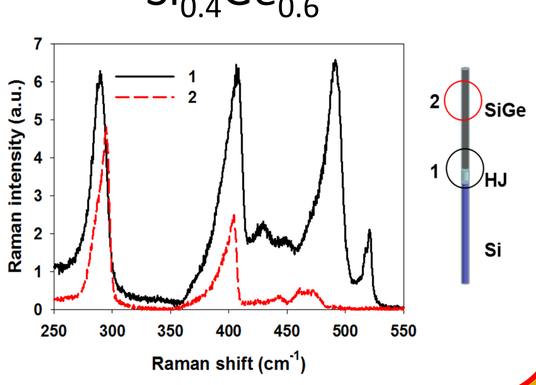
- **Semiconductor nanowires (NWs) → Behave as optical antennas**
- **The optical response depends on the NW diameter, NW composition, light wavelength, and the dielectric mismatch between the NW and the surrounding media**
- **Complex axially heterostructured NWs:**
  - **How these complex NWs interact with light?**
  - **Might one expect to engineer photon absorption/ scattering by using heterostructured NWs?**
- **Experimental approach: The light/NW interaction can be sensed by Raman spectroscopy, $I_R \approx |E|^2$, Si/SiGe heterostructured NWs**
- **Modelling the light/ NW interaction by solving the Maxwell equations by finite element methods (FEM)**

- **Axially heterostructured SiGe/Si nanowires are grown by the Vapour-Liquid-Solid (VLS) technique**
- **NWs deposited on Al substrates**
- **MicroRaman spectroscopy: 532nm, 100x, 0.95 NA**
  Laser beam size ≈ 1 µm

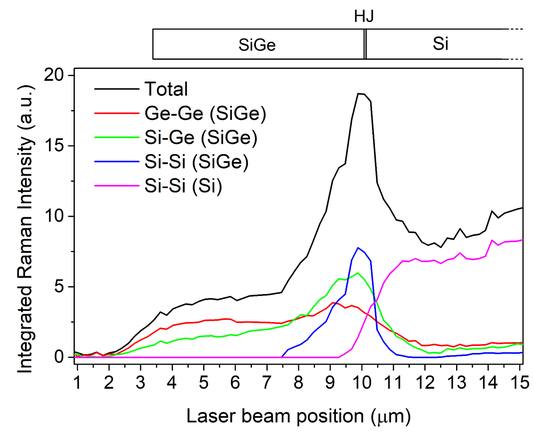


The laser beam sampling volume ratio for a NW (40 nm diamter) is ≈ 10:1:10 (SiGe:HJ:Si)

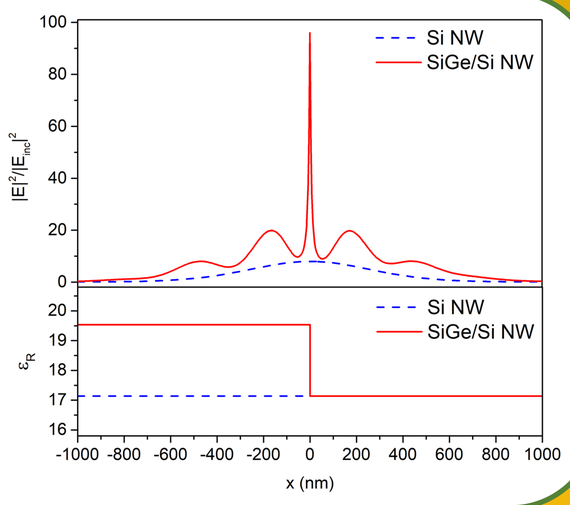
Non abrupt HJ, gradual composition between [Ge] = 0.6 and [Ge] = 0 over a few nm.
The Raman signature of the HJ is identified through the composition change
Enhanced Raman intensity arising from the HJ region



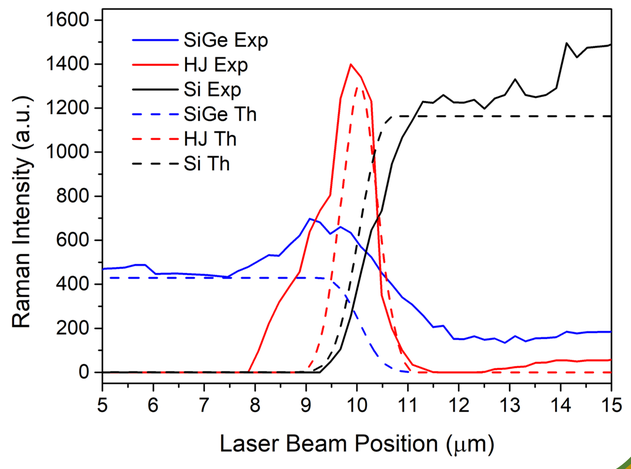
Experimental Raman intensity profiles along the NW showing the intensity enhancement at the HJ.
The enhancement factor of the HJ intensity per unit volume is 63



Calculated $|E|^2$ along an homogeneous Si NW and a heterostructured SiGe/Si NW, showing the enhancement of the electric field at the HJ. From this plot it is possible to calculate the Raman intensity profile by integrating $|E|^2$ for each position of the excitation laser beam



Calculated Raman intensity profiles along the heterostructured NW, compared to the experimental Raman intensity profiles. The agreement is very satisfactory. The Raman enhancement in this case is ≈ 60 very similar to the experimental value of 63



Axially heterostructured semiconductor NWs under visible light illumination present a strong confinement of the electromagnetic field at the heterojunction. This optical behaviour promises the use of axial heterostructured semiconductor NWs as photonic devices

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