Unveiling the light emission of InP-InGaP hetero-structured nanowires

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The luminescence emission in semiconductor nanowires (NWs) yields valuable information on doping and crystal inhomogeneities only accessible with nanometer spatially resolved techniques such as tip-enhanced photoluminescence (TEPL) and cathodoluminescence (CL). This type of information is necessary for the development of new quantum devices [1].

We report here an investigation of the luminescence emission of a single InP-InGaP hetero-structured NW [2] by micro-photoluminescence (μ-PL), CL, and TEPL.
We have obtained a first approximation of the composition of the sample using μ-PL, which presents in the beginning of the wire (lower part) the emission associated with the InP as reflected in the low energy tail of the broad band centered at 770 nm, which is contributed by a parasitic InGaP shell. The band is redshifted along the wire due to a compositional change of the InGaP shell (Fig. 1a). The PL signal of this part of the NW is 100 times stronger than the associated with the InGaP NW section in the upper part of the NW. The SEM images (Fig. 1b) show how the wire is slightly tapered. This is due to the deposition of an InGaP shell on the bottom of the wire during the synthesis process, as reflected by CL spectra taken at different points along the wire (Fig. 1c). The spectrum is broadened showing the emission from InP in the low energy side, and the InGaP shell. The CL spectra supports the presence of the InGaP shell already observed in the μ-PL spectra, but with enhanced spatial resolution.
Finally, TEPL (Fig. 1d) enables to get a high resolution view of the NW compositional structure. In particular the heterojunctions are resolved, and one can characterize with nanometric resolution the different sections of the heterostructured NW.

The three luminescence techniques reported herein appear as complementary for the characterization of nanostructured semiconductors suitable for quantum devices, as qubits, LEDs, and solar cells [3,4].

References

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Figures

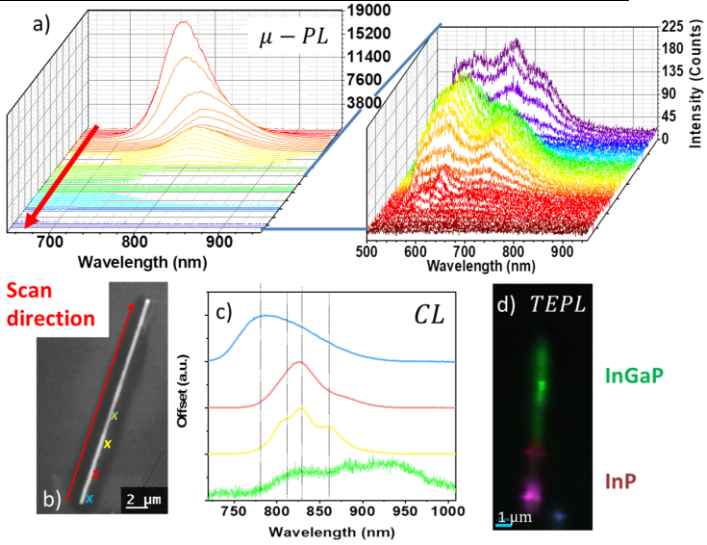

Figure 1a) μ-PL results, **1b)** SEM image (the colored dots indicate the measured points by CL), **1c)** CL spectra, **1d)** TEPL emission along the NW.