# Atom Probe Tomography and Semiconductor Nanostructures: Principles, Applications, and Correlative Approaches.

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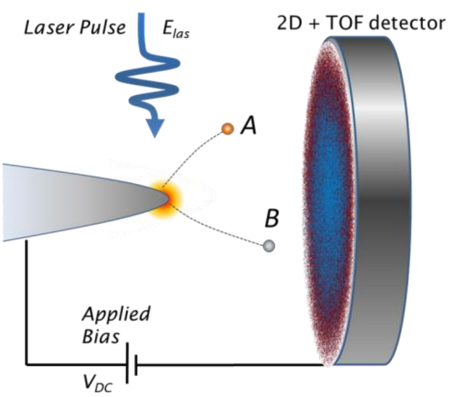
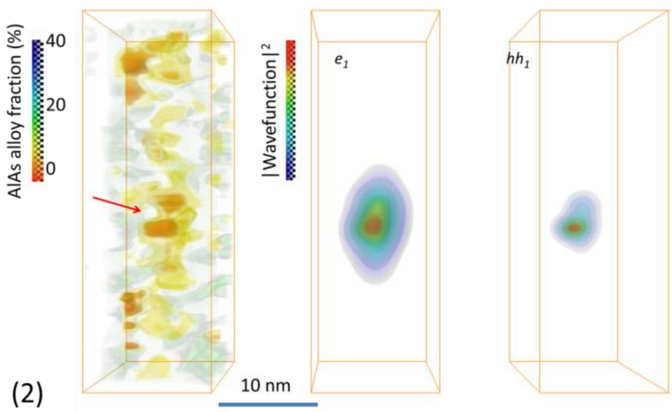
***I – Principles and Applications of Atom Probe Tomography.*** Laser-assisted Atom Probe Tomography (La-APT) is a technique based on the field-evaporation of ions from the surface of a sharp tip [1]. This process is triggered by a femtosecond laser pulse and the evaporated ion is detected by a time-of-flight and position sensitive detector (Fig. (1)). This allows for a controlled erosion of the specimen tip and for a 3D reconstruction of the elemental composition of the evaporated volume. In this part of the lecture, I will introduce the principles of the technique, the protocols of sample preparation, and some selected results of its application to semiconductor nanostructures. A part of the lecture will be dedicated to some limitations of the technique, such as possible reconstruction artefacts and compositional biases: while the atom prober must take them into account, they also may teach us a lot about surface physics in high electric field [2].

***II – Combining Atom Probe with other techniques.*** Atom Probe can be combined with other experimental techniques, such as Transmission Electron Microscopy (TEM) and Micro-Photoluminescence Spectroscopy (μPL) applied to semiconductor quantum wells, quantum dots and nanowires. This can be done with different degrees of accuracy: (i) comparative experiments, in which different parts of the same macroscopic samples are analyzed with different techniques [3] (Fig. (2)), (ii) correlative experiments, in which the same nanoscale object is analyzed by different techniques [4] and finally, a perspective on (iii) coupled, in-situ experiments, in which APT and μPL could be performed within a single experimental setup. For each of these approaches, I will explain through state of the art examples the information that could be retrieved from the system under study.




(1)




(2)

*Figure (1) Laser-assisted field ion evaporation and detection. Figure (2) (Left) density plot of AlGaAs alloy composition: the red arrow points to a quantum dot whose electronic states (right) can be calculated directly based on the atom probe measurement [3].*

[1] Blavette, D. et al., *Nature* (1993) 363, 432-435. Gault, B.; et al. *Rev. Sci. Inst.* (2006) 77, 043705.
[2] Mancini, L. et al. *J. Phys. Chem. C* (2014) 118, 24136. Silaeva, E. et al., *Nano Lett.* (2014).
[3] Mancini, L. et al. *Appl. Phys. Lett.* (2014), 10, 243106.
[4] Rigutti, L. et al. *Nano Lett.* (2014), 14, 107-114.