3D Analysis of II-VI nanostructures by atom probe

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Nanostructures based on II-VI semiconductors have several applications in microelectronics, en optoelectronics and photonics. For example, insertion of a single quantum dot (CdSe for example) in a ZnSe nanowire allows controlling the emission of a single photon under optical excitation[i]. Generally, the optical properties of the nanostructures depend mainly on their size, their composition and their stress state. Until recently, access to these information was essentially obtained by transmission electron microscopy but atom probe tomography (APT) allows now reaching locally the chemical composition of these nanostructures in 3D[ii]. Access to chemical information inside a nanowire (doping, contamination, precipitation, insertion, segregation ….) in the direct space is complex and APT should become a major tool for nanowire characterization[iii ,iv].

In this work, ZnTe nanowires containing CdTe quantum dot have been grown by MBE with Au as catalyzer[v] (figure 1). A methodology to analyze the nanowires by APT has been developed and APT was used to characterize different parts of the nanowire (catalyzer, QD, defects, core, internal shell…). For example, figure 2 shows a 2D map of the Cd composition in the zone of the QD together with a 1D profile measured along the growth direction. These measurements show that the QD contain a mixing of Cd and Zn and a gradient of Cd composition was found. Moreover, a strong accumulation of Cd was found on 2D defects (stacking faults). These results suggest that surface diffusion and segregation play an important role in the growth of a CdTe QD in a ZnTe nanowire.

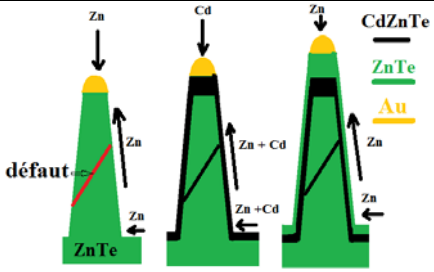

Figure 1 : Mechanisms of nanowire growth

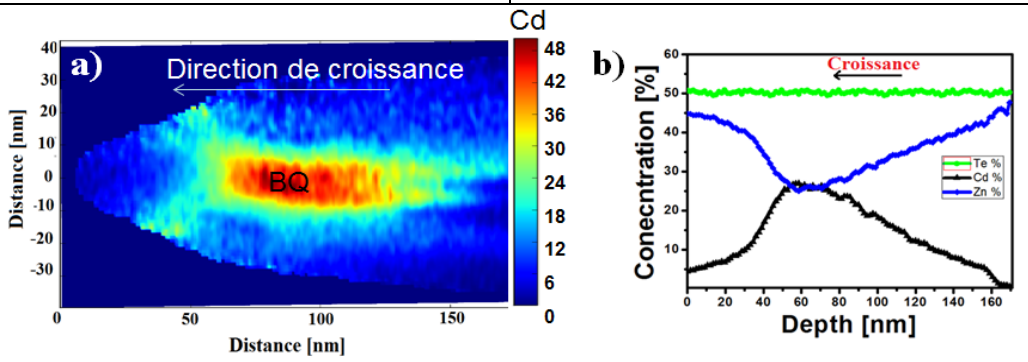

Figure 2 : (a) 2D map of Cd obtained by APT of a CdTe quantum dot inside a ZnTe nanowire (b) concentration profile of Cd along the growth direction measured in a 10 nm diameter cylinder

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[iv] O. Moutanabbir, D. Isheim, H. Blumtritt, et al, *Nature* **496**, (2013) 78-82.
[v] P. Rueda-Fonseca, E. Bellet-Amalric, R. Vigliaturo et al., Nano Lett. **14**,(2014)1877.