Sequential and In-Situ Atom Probe Tomography and Optical Spectroscopy on Single Luminescent Nanoscale Objects

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Correlating two or more microscopy and spectroscopy techniques on the same nanoscale object may yield an amount of information difficult to achieve by other means. In this contribution, we present selected studies of micro-photoluminescence (μ-PL), high-resolution scanning transmission electron microscopy (HR-STEM) and laser-assisted atom probe tomography (APT) performed *sequentially* on single nano-objects containing quantum confined systems based on III-V and II-IV materials. This approach can be applied to the study of heterostructure interface definition, presence of extended defects such as stacking faults or dislocations, carrier localization and optical emission in quantum confined systems [1-4]. Furthermore, the use of complementary techniques may be extremely helpful for a correct interpretation of atom probe results and for understanding its limitations [3,5]. Finally, we will show that the study of PL *in situ* in an atom probe opens up novel possibilities, such as the discrimination - with a spatial resolution beyond the diffraction limit - of the optical signal of two quantum wells (QWs) and the manipulation of the optical signal of color centers by the application of an electrostatically-induced stress [6].

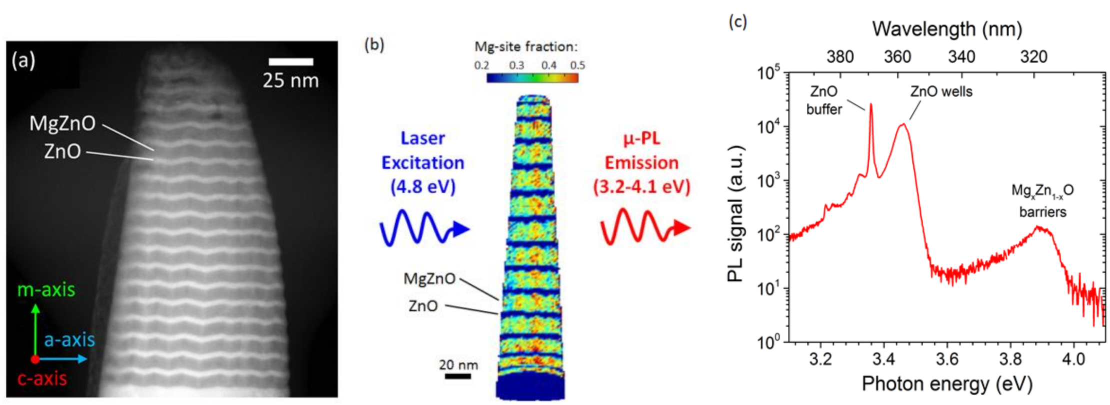

Figure: An example of *sequential* multi-microscopy analysis. **(a)** STEM image of ZnO/(Zn,Mg)O MQWs. The white layers are the ZnO QWs, the darker ones are the (Zn,Mg)O barriers. **(b)** Mg-site fraction map calculated from an atom probe tomographic 3D reconstruction. **(c)** μ-PL signal (T=20K) of a ZnO/(Zn,Mg)O MQWs system emitted by an atom probe tip (adapted from ref. [3]).

[1] L. Rigutti et al., Nano letters, 14, 107–114 (2014). [2] L. Mancini et al. Appl. Phys. Lett., 108, 042102 (2016) [3] E. di Russo et al. Appl. Phys. Lett. 111, 032108 (2017) [4] L. Mancini et al., Appl. Phys. Lett. 111, 243102 (2017) and Nano letters 17, 4621 (2017) [5] L. Mancini et al. J. Phys. Chem. C 118, 24136 (2014).
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