Atomic Structure and Electronic Trap States in Individual CdSe Colloidal Nanoplatelets by Low-Temperature Scanning Tunneling Microscopy

Louis Biadala[1]
Huu Thoai Ngo[1,2], Nemanja Peric[1], Iwan Morrels[2], Bruno Grandidier[1]
1. Université de Lille, CNRS, Centrale Lille, Université Polytechnique Hauts-de-France, Junia-ISEN, Centrale Lille, UMR 8520-IEMN, F-59000 Lille, France.
2. Physics and Chemistry of Nanostructures, Ghent University, 9000 Ghent, Belgium.
Louis.biadala@iemn.fr

Among the colloidal nanostructures available, nanoplatelets (NPL) are the most impressive material since they offer a compelling combination of the flatness 2D semiconductors to the richness of the versatile world of colloidal nanostructures [1]. The growth along the confinement dimension, ie the thickness, of all the NPLs in the solution can be controlled at the atomic layer scale. This tour de force in the chemical growth is evidenced by a nearly kT-limited emission linewidth in ensemble measurements at room temperature. By contrast with standard 2D semiconductor materials (MoS_2,WTe_2,..), the properties of NPLs can be further tailored by selectively changing their thickness or the in-plane dimensions. In addition, NPL are also used as seed material to form heteronanostructures that have striking optical properties.
To date CdSe NPLs have been the workhorse of the field and have been used as a playground to investigate the changes of charge carrier's dimensionality in nanostructures [2] or surface-related interactions [3]. While advanced properties of CdSe NPLs are constantly discovered, basics information on their structural properties (shape, trap states) are still missing, which hampers establishing direct correlations between structural and electronic/optical properties.
By studying individual CdSe NPL with a scanning tunnelling microscope (STM) we unveil for the first time their real morphology, their edge shape, as well as the spatial and energetic position of electronic trap state at their surface. These results are of tremendous importance to understand the growth mechanism, the nature of the interface for NPL-based HNS or the origin of trap states in NPLs.

References

[1] B. T. Diroll, B. Guzelturk, H. Po, C. Dabard, N. Fu, L. Makke, E. Lhuillier, and S. Ithurria, Chem. Rev. (2022).
[2] N. Peric, Y. Lambert, S. Singh, A. H. Khan, N. A. F. Vergel, D. Deresmes, M. Berthe, Z. Hens, I. Moreels, C. Delerue, B. Grandidier, and L. Biadala, Nano Lett. **21**, 1702 (2021).
[3] E. V. Shornikova, A. A. Golovatenko, D. R. Yakovlev, A. V. Rodina, L. Biadala, G. Qiang, A. Kuntzmann, M. Nasilowski, B. Dubertret, A. Polovitsyn, I. Moreels, and M. Bayer, Nat. Nanotechnol. **15**, (2020).

Figures

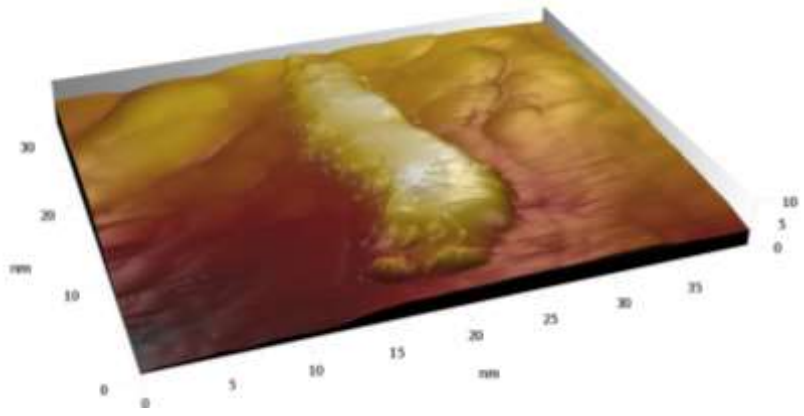

Figure 1: 3D STM image of an individual CdSe nanoplatelets on gold substrate