NANOSCALE INTEGRATION OF COLLOIDAL NANOCRYSTALS ON OPTICALLY ACTIVE LOW DIMENSIONAL EPITAXIAL HETEROESTRUCTURES

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The different methods used to fabricate quantum nanostructures usually emerge from distinct scientific backgrounds; physicists mainly favour "*top down*" approaches while chemists prefer "*bottom up*" methods. This dichotomy of approaches results in a technology gap between the two strategies used to produce nanoparticles, namely physical deposition, such as molecular beam epitaxy (MBE), and wet chemical synthesis. By way of example, tuneable photonic structures may be produced by using *either* nanofabrication *or* wet chemistry. However combinations of such approaches, as complementary realms of activity, offer the possibility to achieve novel functional nanomaterials and also give new scientific insights of a more fundamental kind; bridging the technology gap will open the way to the engineering of material systems that can offer *radically new properties*, with an unrivalled flexibility.

Here we report a dual approach that combines flexible wet chemistry with traditional semiconductor processing, with the aim to develop the fundamental knowledge to pursue alternative ways to create novel heterostructures that incorporate colloidal nanocrystals. Specifically, we combine InGaN-based multiple quantum wells (MQWs) and various colloidal nanocrystals and/or quantum dots (QDs). The laboratory and stage for our strategy is provided by the spontaneous formation of intrinsic nanoscale defects (Inverted Hexagonal Pits) in indium-containing III-nitride heterostructures.

Our results show that it possible to spatially confine nanoparticles prepared by wet chemical synthesis, or sets of distinct nanoparticles within those IHPs, at engineered depths and spacings, in order to create frameworks of spatially localized functional nano-objects. The proof-of-concept experiments were performed using the interfacial capillarity force present during the evaporation of the nanocrystals suspension. Control of the number of nanoparticles in each IHP and of the lateral inter-particle separation provides an experimental platform for multiple interaction studies and the investigation of the intrinsic properties of individual nanocrystals.

Figures:

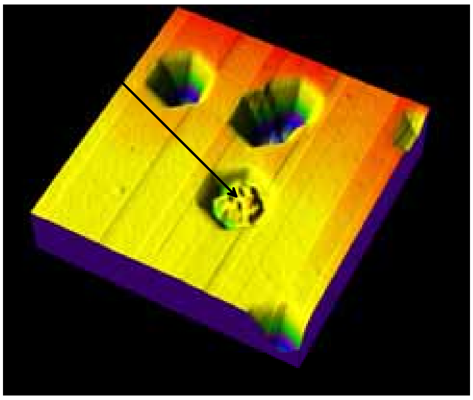

Figure 1. AFM image of gold nanoparticles confined on a nanoscale inverted hexagonal pit.