III-nitride nanostructures: Fundamentals and applications

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Selective area growth (SAG) by molecular beam epitaxy (MBE) is one of the best approaches to develop a variety of nanostructures on different substrates. Some basic aspects of SAG will be first addressed, referring to the initial stages of nano/microrod nucleation within the mask nano/microholes leading to a final stable hexagonal structure, shown in Fig. 1; the factors controlling the nano/microrod diameter in axial heterostructures; and the dislocation filtering efficiency as a function of the nano/microrod geometry.

Core-shell InGaN/GaN microstructures have been successfully grown by MBE following two approaches: i) from top–down (etched) GaN cores, and ii) from bottom-up (MOVPE) GaN cores. In both cases, a conformal growth of InGaN layers was achieved, see Fig. 2(left). Based on this approach, core-shell micro-LED arrays were successfully fabricated.

A relevant finding is the evidence that the In incorporation efficiency depends markedly on the crystal plane, being the highest on polar *c*-planes and minimum for non-polar ones. Thus, different types of In-related emission are observed in the microstructures. Taking advantage of this effect, dot-in-a-wire InGaN structures were grown, embedded in ordered GaN nanorods. The InGaN region grows along the polar, semi-polar and non-polar planes, thus incorporating different amounts of In, see Fig. 2(right).

Finally, SAG was also used to grow III-Nitride ordered nanostructures on semi-polar and non-polar oriented GaN/sapphire templates aiming at the fabrication of pseudo-substrates by nanocrystal coalescence with tailored lattice constant and high crystal quality.

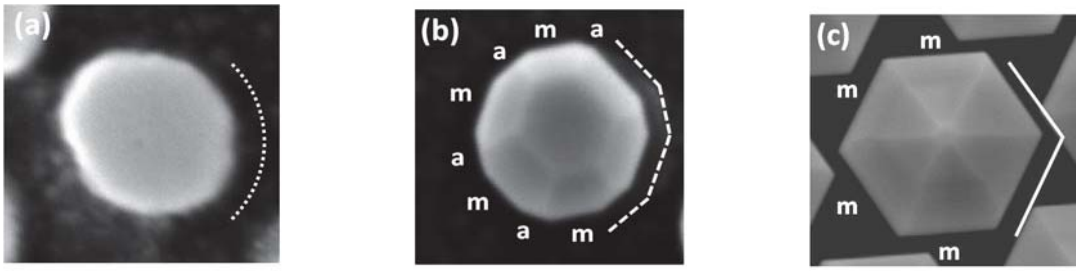

FIG. 1. Evolution of nanowire nucleation and growth.

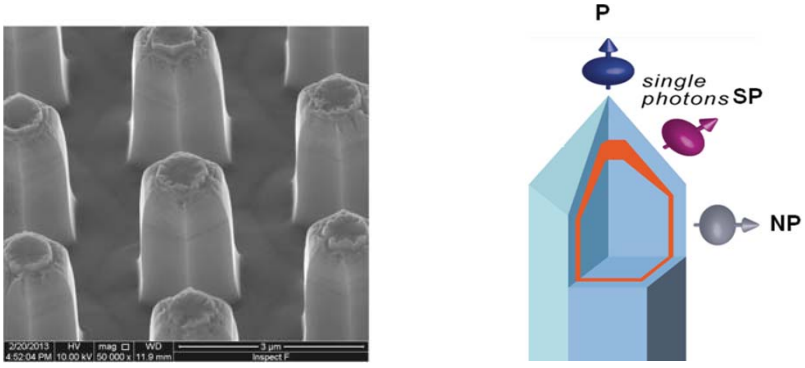

FIG. 2. Core-shell microstructures (left) and dot-in-a-wire structures (right).