NANO-STRUCTURES OF GROUP-III NITRIDES BY MOCVD USING MOLECULAR PRECURSORS

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Abstract:
Performance advantages and cost benefits are the driving forces behind the adoption of any newly maturing technology. GaN, in this respect, has come a long way in establishing itself as commercially viable technology with promising applications in UV and visible opto-electronics (1-2). The recent research trend for miniaturisation by developing one-dimensional structures such as nanowires, nanorods and nanopillars, of semiconducting materials is on the frontiers. GaN nanostructures are the building blocks for nano-devices (3) which are synthesised by different methods such as laser assisted catalytic growth, template assisted synthesis (4), sublimation (5), direct reaction of Ga and NH_3 (6) and MOCVD (2).

We demonstrate the morphology-controlled growth of GaN nanostructures (nanorods and nanowires) by MOCVD taking advantage of hetero-epitaxy on sapphire substrate. Molecular compounds of gallium and nitrogen of the type [bis azido (diethyl amino propyl) gallium] with intra molecular donor stabilisation has successfully yielded nano-structures of GaN employing specific CVD process parameters.

The experiments were conducted in a vertical flow reactor with precursor delivery near to the surface. The substrate (single crystal 0001 sapphire) is directly placed on a resistively heated ceramic heater. The nanostructures were grown at 950°C with different process parameters.

The nanostructures classified as nanorods, which are preferentially oriented and nanowires, which are randomly distributed with respect to the substrate, were grown in the presence of hydrogen. The morphological variation and density distribution of these structures is brought about by the pressure and carrier gas variation.

It is seen that the as the pressure is lowered and hydrogen is used as carrier gas the preferentially oriented nanorods become smaller in dimension and get densely packed and are classified as nanowires. The dimensions of the nanorods were of the order of 30-50 nm and that of nanowires 15-20 nm.

References

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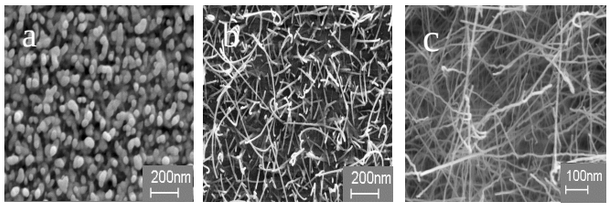

Fig. 1: SEM images of nanostructure a) preferentially oriented nanorods b) and c) disordered and randomly distributed wires and

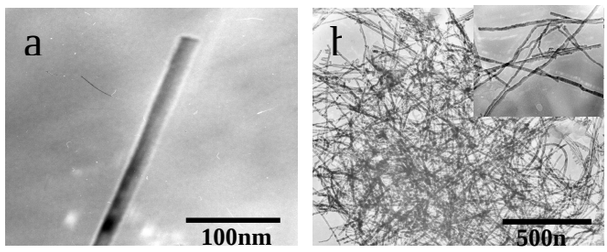

Fig. 2: a) TEM image of a single nanorod b) TEM image of random or disoriented nanowire (inset few individual wires)