Synthesis of nanopowders of magnetic semiconductor Mn-doped GaN utilizing the transamination/deamination scheme of gallium imide formation under anaerobic conditions

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In search for an efficient way of incorporating ferromagnetic manganese centers into the semiconducting lattice of gallium nitride, we employed an anaerobic synthesis. In the case of the system GaN/Mn, solid mixtures of the appropriate metal-bearing compounds, i.e., tris(dimethylamino)gallium and manganese(III) acetylacetonate, were allowed to react with liquid ammonia to afford manganese-containing gallium imide-based precursors. The precursors were pyrolyzed at 800°C for 4 hours under an ammonia flow to yield yellow-brown to black powders. In a parallel series of experiments, nanopowders of pre-formed pure GaN made at 800°C were soaked in an ether solution of the manganese compound, evacuated, and repeatedly pyrolyzed at 800°C under comparable conditions as above. Such a procedure was intended to explore an alternative route to GaN-particle surface modification with manganese. The product powders were examined with X-ray diffraction (XRD), scanning electron microscopy (SEM), and Fourier transform infrared (FT-IR) spectroscopy. Helium densities and oxygen contents were also determined for several samples. The paramount observation derived from the study is that the only crystalline phase detected in all of these materials, with particle sizes ranging from several to twenty nanometers, is the hexagonal GaN-based lattice. However, thorough magnetization experiments, that are the subject of a separate report, indicate significant manganese incorporation in the materials.

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