Aerosol-assisted vapor phase synthesis of powder composites in the target system GaN/TiN for potential electronic applications

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Synthesis and investigations of nanocomposites in the system GaN/TiN may help in understanding complex phenomena observed at GaN/titanium metal interfaces as well as expand a potential area of modern electronic/ceramic applications for such composites. Herein, powder composites in the system GaN/TiN are synthesized by means of the aerosol-assisted vapor phase synthesis (AAVS) method that was already succesfully used to make nanopowders of BN and GaN as well as the magnetic semiconductor “GaMnN". Both aqueous and methanol solutions of the two metal precursors were employed. Mixtures of gallium nitrate with either in situ made titanium nitrate or titanium chloride were employed in aqueous solutions while gallium nitrate and titanium methoxide were used in the methanol medium. In all cases, the initial atomic ratio was Ga/Ti=5/1. After aerosol powder formation at 1000°C, all raw products were pyrolyzed at a selected temperature in the 950-1100°C range for several hours under an ammonia flow to complete nitridation reactions. The dark brown to black products were characterized by X-ray diffraction, scanning electron microscopy, X-ray photoelectron and infrared spectroscopy, oxygen analysis, helium density, and surface area determinations. The data indicated the formation of hexagonal GaN and a cubic phase linked to titanium species. The latter phase was determined to be cubic TiN evolving at increased temperatures via the crystallographically related and similar cubic TiO and “TiON" solid solution phases formed at lower temperatures. Also, severe depletion of gallium was observed in these systems due to GaN sublimation and decomposition under applied conditions. The composite powders GaN/TiN are planned to be processed into mechanically compact forms that could be considered for unique substrate applications.

Acknowledgements: JFJ, MD, and CC wish to acknowledge the support of AGH University of Science and Technology grant No.11.11.210.62. RTP acknowledges the support of National Science Foundation Grant No. CHE-9983205.

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