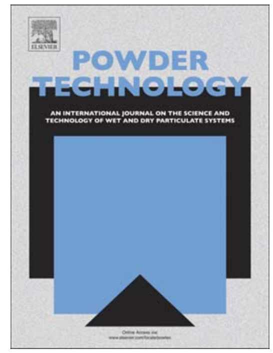

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Optimizing Particle Characteristics of Nanocrystalline Aluminum Nitride

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Abstract

Aluminum nitride (AlN) nanopowders are synthesized in a chemical vapor synthesis (CVS) process using triethylaluminum (TEAl) and ammonia as precursors. A simple reaction-coagulation-sintering model is used to investigate the influence of process parameters, such as hot-wall reactor temperature and system pressure, on particle characteristics: size and agglomeration for example. The results of the simulation show good agreement with the experimental data and enable a better understanding of the effects of temperature and pressure on the particle size and microstructure. Pure wurtzite phase AlN nanocrystals are obtained for all tested process parameters. The primary particle (crystallite) size ranges from 2.7 nm to 11.5 nm with (secondary) particle size in the range of 4.3 nm to 12.4 nm. As predicted by the simulations, the experiments show a low degree of (hard) agglomeration that even reaches the value of 1 for syntheses above 1400 °C and 100 mbar, implying the complete absence of hard agglomerates at those conditions.

Keywords: Aluminum Nitride, Nanoparticles, Gas phase synthesis, Agglomeration, Crystallinity

1. Introduction

Aluminum nitride (AlN) ceramics have attracted a lot of interest recently, particularly in the electronics industries, due to their high thermal conductivity and a thermal expansion coefficient closely matching that of silicon. In addition, its 6.2 eV wide direct band gap is the largest among the III-V semiconductors and enables its application in ultraviolet (UV) light-emitters. AlN films have been used for example for light emitting diodes (LED) [1], buffer layers [2], strain sensors [3], acousto-optical devices [4], passivation of thin films [5]. On the other hand, AlN powders are a promising route for the production of ceramic bodies for packaging applications [6, 7] phosphors for LEDs [8, 9] and refractory ceramics [10, 11, 12]. However, the good thermal stability of AlN limits the sinterability of the material, making processing of the powders into bulk forms more difficult. One of the ways to circumvent the problem is to start from nanoscaled powders which are widely known to have largely improved sinterability over the corresponding bulk materials [13].

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