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The effects of flow multiplicity on GaN deposition in a rotating disk CVD reactor

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Abstract

The effect of gas flow multiplicity, i.e. the possibility of two very different flow regimes prevailing at random in a rotating disk metalorganic chemical vapor deposition (MOCVD) reactor, on the deposited GaN film is investigated. A transport model coupled with a system of chemical reactions in the gas phase and on the solid surface is implemented in the parameter regions where multiple flows are possible. In the region where either plug flow, imposed by forced convection, or buoyancy-dominated flow is possible, the results in the latter case indicate high deposition rate and decreased uniformity. In the former case, increasing the pressure and the rotation rate has a favorable effect on the deposition rate without sacrificing uniformity. In the parameter window where either rotation or combined rotation/buoyancy may prevail, the effects of buoyancy lead to higher deposition rate at the center of the wafer and reduced uniformity. The Arrhenius plots in the regions of multiplicity for exactly the same operating conditions reveal that the system operates in a diffusion-limited regime in the plug flow and in the rotation-dominated flow, in the first and second region of multiplicity respectively. In contrast, in the buoyancy-dominated flow and the combined rotation/buoyancy flow (first and second region of multiplicity respectively) the process shifts into the kinetics-limited regime.

Keywords: A1. Mass transfer, A1. Nonlinearity, A1. Arrhenius plot, A3. Metalorganic chemical vapor deposition, A3. Film uniformity, B1. Gallium Nitride

1. Introduction

Gallium Nitride (GaN) is a high-value product popular in the optoelectronics industry for use in Light Emitting Diodes (LEDs). Metal-Organic Chemical Vapor deposition (MOCVD) is the method of choice for the industrial production of high quality GaN films. Specifically, rotating disk Chemical Vapor Deposition (CVD) reactors are

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