Proceedings of the 4th International Conference on Fluid Flow and Thermal Science (ICFFTS'23)
Dubai, United Arab Emirates- December 07 - 09, 2023
DOI: 10.11159/icffts23.006

Transport Processes in the Fabrication of Thin Films by Chemical Vapor Deposition

Yogesh Jaluria
The State University of New Jersey, USA

Abstract

Chemical vapor deposition (CVD), which involves deposition of solid materials on a heated surface due to the chemical reaction of gases, is used to fabricate thin films that are of interest in the semiconductor industry and to coat surfaces for enhanced wear and temperature resistance. The quality and uniformity of the thin films, along with the rate of deposition, are of particular interest in electronic and optical applications. The flow and heat and mass transfer, along with chemical reactions, determine the film quality as well as the deposition rate. This paper is focused on the basic transport processes and presents experimental and numerical results on chemical vapor deposition for the fabrication of thin films. The basic aspects of the process, particularly the flow and temperature distributions, for an impingement type reactor with a rotating base are first studied in a laboratory scale simplified system. The characteristics of the flow and its dependence on parameters like inlet velocity and diameter, and susceptor temperature and rotational speed are investigated. This study, therefore, indicates the expected physical trends and provides inputs for the validation of numerical models. However, these experimental results consider only the flow and thermal transport, without considering the deposition process. But the study can form the basis for the choice of operating conditions for obtaining good film uniformity and high rates of deposition. Deposition is then investigated on a small, industrial, CVD reactor for the fabrication of Gallium Nitride films. Thin film samples are obtained and examined for thickness uniformity and deposition rate for a variety of operating conditions. Results are presented for a few samples to indicate the basic trends that agree with the earlier findings from the lab study on the flow. Good agreement with numerical results on deposition are also obtained. It is found that increase in deposition rate often comes at the expense of film quality and, therefore, optimization must be undertaken to achieve high-quality films with acceptable deposition rates.