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Numerical analysis for robust design of filament assisted chemical vapor deposition chamber

Hyo Seong Lee
Chosun University, South Korea

The conventional polymer thin film deposition CVD (Chemical Vapor Deposition) system has a limitation in deposition of various substrates as a deposition system in a high temperature environment (especially high temperature and high pressure environment). FACVD (Filament Assisted Chemical Vapor Deposition) is a method of causing a radical reaction of an initiator by a filament and reacting with a monomer and being deposited on a surface at room temperature. It is possible to form an organic thin film under low temperature and low vacuum process conditions. Therefore, it is an advanced thin film deposition system capable of depositing on a substrate sensitive to temperature, such as cotton, paper, etc. This study aims to derive optimal chamber design by numerically analyzing the behavior of monomer in gas phase during FACVD process. Through the visualization of the gas flow in the chamber and the thin film deposition, the analysis was carried out using the Commercial FEA tool (COMSOL®) for the process conditions and optimum design of the chamber. For the analysis, the heat transfer module, convection diffusion module and the chemical reaction module were sequentially used to visualize entire process which are flow of the initiator and the monomer gas, thermally decomposed by the filament and the deposition reaction respectively. A parametric study has been performed to design an optimal chamber structure that achieves uniform thin film thickness distribution. As a result of analysis, it is confirmed that the optimized chamber produces uniform thin film area of 300×300 mm. The numerical approach to chamber design was well validated by compare the thickness of thin film between FEA and experimental result. Thin film thickness difference between analyzed and actual deposited was found less than 5%.

leegytjd822@chosun.kr

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