609b Development of Generalized Design Criteria for Vertical Chemical Vapor Deposition Reactors

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A very common reactor configuration in the microelectronics industry employs a vertical geometry in which a stream of gas carrying the film precursors flows downwards to a heated rotating susceptor where the substrates to be coated are placed. Typical design criteria for such reactors include the elimination of buoyancy- and inertia-driven flow recirculations, uniformity of thickness and composition in the deposited films over large-area substrates, and ability to grow abrupt heterojunctions. The detailed analysis of such reactors using fundamental models of the transport phenomena and chemical kinetics poses a variety of challenges [1], but also offers the possibility for developing generalized maps of their parameter space identifying regions in which specific design criteria are met [2].

This presentation will focus on a parametric study of vertical reactors addressing the following issues: (1) The development of generalized design criteria for elimination of recirculations based on the Reynolds number, rotational Reynolds number, aspect ratio (inlet to susceptor distance divided by susceptor diameter) and Grashof number. (2) The development of generalized criteria for thickness and compositional uniformity of deposited films based on Peclet and Damkoehler numbers for designs that meet the criteria of the first part. Applications of this approach to the design of reactors used for growing multilayer structures of compound semiconductors such as GaAs, (Al,Ga)As, GaN and (Al,Ga)N will be discussed and compared to available experimental data.

References

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2. R.P. Pawlowski, C. Theodoropoulos, A.G. Salinger, T.J. Mountziaris, H.K. Moffat, J.N. Shadid and E.J. Thrush, "Fundamental Models of the Metalorganic Vapor Phase Epitaxy of Gallium Nitride and Their Use in Reactor Design", Journal of Crystal Growth, 221, 622-628 (2000).