Modeling and System Design for Atmospheric Pressure CVD of YSZ

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Stagnation flow reactors have found increasing application in the electronics CVD industry.[1] Under the proper conditions this configuration offers several advantages including uniform deposition rate over a wide area and short residence time at high temperature for the reactant species. Both of these characteristics are desirable for large-scale manufacture of YSZ films and coatings for fuel cell, battery and sensor applications.

This paper describes fluid dynamics and deposition modeling to support design of a laboratory-scale CVD reactor. This laboratory reactor will be used both to conduct research on the mechanism and kinetics of the deposition process and to identify critical process parameters for design of a larger, production-scale reactor.

Fluid dynamics model for a cylindrical reactors is well established and predicts flow characteristics that yield uniform temperature and concentration boundary layers over the substrate surface.[2] Kinetics model for YSZ deposition is not as well established and extraction of critical reaction steps and rate constants is difficult. The final reactor design provides the ability to explore a wide range of process parameters within the stagnation flow regime.

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References:

1.) P. N. Gadgil, “Single Wafer Processing in Stagnation Point Flow CVD Reactor: Prospects, Constraints and Reactor Design,” J. Electron. Matls. **22** (2), 1992, 171.
2.) C. R. Kleijn, K. J. Kuijlaars, and H. E. A. van den Akker, “Design and Scale-Up of Chemical Vapour Deposition Reactors for Semiconductor Processing,” Chem. Eng. Sci. **51** (10), 1996, 2119.