Proposal # 5: The Transport of Contaminants in Thin Film Deposition Processes

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Goals and Objectives

Study the transport and deposition of contaminant particle sources in low pressure processes such as CVD and PVD, ion implant, etc. and determine the effect of process conditions on wafer contamination during wafer processing and handling. We will study the fundamental relationships between the contaminant transport and deposition and the physical behavior of the flow, thermal and process conditions. Physical Models of the process gas, thermal field, particles, walls and other relevant phenomena that may affect particles such as electrostatics, thermophoresis, and turbulence will be evaluated. The elimination of particle contamination will be studied using control by means of flow, electrostatics or geometrical design changes, material selection and particle traps.

Project Description

MacGibbon and Busnaina investigated particle transport and deposition from nucleation sites, process gas, and from the wall in a tungsten CVD cold wall reactor at a pressure of 0.9 Torr. The study determined the particle deposition (for a size range of 10.0-0.05 micron particles) on the wafer and reactor wall, and the number of particles that exit the chamber with the gas. The model results were verified by experimental measurements. The study also determined the nucleation mechanism and the gas phase reaction that produces the tungsten silicide particles [1,2]. There is a definite need to evaluate transient conditions (including turbulence) significance to particulate and transport in thin film deposition processes (CVD, PVD, ion implant, etc.) and to determine the effect of diffusion, thermophoresis, thermal convection, electrostatics and non-ideal flow on particle deposition. Studies of thin film deposition low pressure processes to investigate particle generation, transport and deposition and its effect on film deposition will be undertaken. Physical Models of the process gas, thermal field, particles, walls and other relevant phenomena that may affect particles such as electrostatics, thermophoresis, and turbulence will be evaluated.

Modeling of the particle nucleation, transport and deposition processes provides an excellent tool for understanding how particulate contamination takes place. We propose to construct a robust complete model of the particle transport mechanisms and their interactions with the process conditions. The results will provide understanding for better process and equipment design such as guidelines for the process conditions and reactor geometry.

1. MacGibbon, B.S., Busnaina, A. A., and Fardi, B., "The Effect of Thermophoresis on Particle Deposition in a Low Pressure Chemical Vapor Deposition Reactor," *J. of the Electrochemical Society, Solid State Science and Technology,* Vol. 146, No. 8, 1999.
2. MacGibbon, B.S., Busnaina, A. A. and Rasmussen, D. H., "Particulate Contamination in Tungsten LPCVD: An Experimental Study," *Journal of American Vacuum Science and Technology B*, 17(2), Mar/Apr, 1999.