609d Experimental Results from a Spatially Programmable Chemical Vapor Deposition System

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A CVD tool with promising combinatorial experiment capabilities by exploiting the programmability rendered by its recently developed tri-hexagonal-segmented showerhead design is discussed here along with pertinent experimental results. This novel CVD tool is used to intentionally induce non-uniform deposition patterns on a single wafer by exposing three regions under the showerhead (hexagonal segments) on the wafer to three different recipes (precursor concentrations) simultaneously during a single run thus resulting in different thickness profiles on the same wafer and a thickness gradient at the boundaries of the segments. The three recipes are cycled through each of the three segments by repeating the experiment on a different wafer so that each segment is exposed to every recipe by the time the experiment is repeated with three wafers. This methodology which can be extended to more segments, provides an exhaustive data set through a minimum set of relevant experiments in order to identify a model between wafer state properties (thickness, sheet resistance, grain size etc) and the recipe parameters (temperature, flow rates, partial pressures, concentrations of precursors etc). The gap between the segmented showerhead and the wafer is an additional parameter of this novel design that is used to vary the gradient on the wafer. Process repeatability, intra-segment uniformity, inter-segment uniformity for identical recipes in all three segments and the effect of inherent temperature non-uniformities due to a spiral heater are also discussed. An immediate application of such programmability would be in combinatorial materials research where a deliberately induced concentration gradient of one or more precursors over the wafer surface (that can be measured and quantified with the help of an in-situ metrology system like a mass spectrometer with spatial sensing capabilities) would translate into gradients in the film properties on the wafer after processing. The area on the wafer with the most desirable property (material/electrical) could then be chosen and the corresponding recipe used in future to generate a uniform film with this desirable property on the entire wafer surface.