Semiconductor Note No 3, posted April 23, 2003.

Mist Deposition

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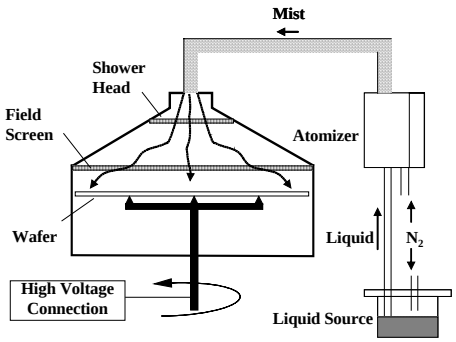
Liquid precursors are commonly used in semiconductor processing as source materials in the formation of thin film dielectrics, photoresist, organic semiconductors and others. The deposition method in these cases is typically a spin-on process in which well controlled amount of liquid is dispensed onto the substrate surface and distributed over it by centrifugal forces created by wafer rotation at thousands of revolutions per minute. Following deposition the wafer is subjected to low temperature anneal to drive solvents out and to solidify the film. Alternatively, methods such as microspray, immersion or ink jet printing can be considered.

The spin-on process is relatively simple to implement, works well in the variety of applications and as such is commonly used in semiconductor device manufacturing in photoresist and low-k dielectric deposition. However, it is inherently non-conformal and inherently incompatible with very large, often heavy, substrates such as those used in high-area electronics and photonics, large flexible substrates, as well as with roll-to-roll type of processes. The usefulness of other methods listed above would have to be considered in the context of a specific application. However, the issue of film thickness uniformity and controllability in the case of very thin films (<50 nm) could be a limiting factor for all of them.

An alternative to spin-on technique of covering solid surfaces with high viscosity liquids is a method of "mist deposition". As name indicates, the liquid in this case is slowly delivered to the substrate in the form of a very fine mist which then uniformly coalesces on its surface with very little waste. Just like in the case of spin-on process mist deposition is followed by thermal curing of the film. Mist deposition is independent of the shape of the substrate and does not have inherent limitations regarding either its size of minimum thickness of the film.



The method of mist deposition is commercially reduced to practice as a Liquid Source Misted Chemical Deposition (LSMCD) method. Figure shows schematic diagram of LSMCD module. A liquid precursor is confined in the stainless container from which it is pushed by nitrogen into an atomizer. In an atomizer liquid is converted into a very fine mist through interactions with a series of impactors. Then, mist is carried by nitrogen into the deposition chamber where it coalesces on the surface of a slowly (10 rpm) rotating wafer at room temperature and pressure very close to atmospheric. In order to control deposition rate beyond gravitational interactions, which in the case of sub-micron sized droplets are very weak, an electric field is created between the grounded field screen and a wafer. After deposition, film is solidified by subjecting wafer to low temperature (lower than 250 ^{o}C) curing in ambient air or in N_2 at the atmospheric pressure.

Mist deposition should provide an attractive alternative to spin-on processes in selected applications. It was successfully used to form thin layers of ferroelectrics, photoresist, high-k and low-k dielectrics, as well as organic semiconductors.