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Haaland

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[54] HYBRID PULSED VALVE FOR THIN FILM COATING AND METHOD

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[58] Field of Search ..... 427/421, 180; 118/300, 118/323; 239/8, 11, 99, 101, 102.2

[56] References Cited

U.S. PATENT DOCUMENTS

3,739,393	6/1973	Lyon et al. ....	346/1
3,840,391	10/1974	Spitz et al. ....	427/565
3,868,698	2/1975	Dressler ....	346/75
4,019,188	4/1977	Hochberg et al. ....	346/75
4,290,384	9/1981	Ausschnitt et al. ....	427/600
4,407,450	10/1983	Chegolya et al. ....	239/8
4,462,760	7/1984	Sarich et al. ....	417/54
4,659,013	4/1987	Ledebuhr et al. ....	239/8
4,765,540	8/1988	Yie ....	239/8
4,970,985	11/1990	Slautterback ....	239/8
4,996,080	2/1991	Daraktchiev ....	427/57
5,114,748	5/1992	Tada et al. ....	427/421
5,150,836	9/1992	McKay et al. ....	239/5
5,166,000	11/1992	Singh et al. ....	427/421

OTHER PUBLICATIONS

G. Switzer, "A Versatile system for Stable Generation

of Uniform Droplets", Reviews of Scientific Instruments (1991).

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[57] ABSTRACT

An apparatus for coating a substrate with a relatively thin, uniform film of a liquid on a substrate with a minimum of waste. The apparatus includes a droplet generator capable of generating droplets of the liquid at a predetermined rate and of a predetermined size, a pulsed gas jet and a computer control which sequentially triggers the droplet generator and gas jet such that droplets are generated, then contacted by the gas jet, which accelerates the droplets and propels the droplets to impact and coat the substrate. In a preferred embodiment of the invention, the droplet size and velocity are selected such that the droplets break up upon impact with the substrate without splashing or rippling. The apparatus and method are ideal for coating semiconductor wafers with a photoresist solution. Droplets with uniform size and controlled trajectories are generated, in one embodiment, with a piezoelectric droplet generator, and then accelerated to precisely defined velocities by the pulsed gas jet toward the surface to be coated. The kinetic energy of the droplets is adjusted to overcome the free energy associated with surface tension on impact. The collision of the droplet thus results in a uniform, thin coating of photoresist or other coating solution which may then be further processed by conventional techniques.

12 Claims, 1 Drawing Sheet

