Sub 100nm Particle Removal with Deionized Water and A Megasonic Frequency of ~835kHz

Jeff Lauerhaas[1], Kaidong Xu[2], Guy Vereecke[2], Rita Vos[2], Karine Kenis[2], Paul W. Mertens[2], Yi Wu[3], Tom Nicolosi[3], and Marc Heyns[2]

[1] IMEC vzw Industrial Resident from Verteq, Inc., Kapeldreef 75, B-3001 Leuven, Belgium
[2] IMEC vzw, Kapeldreef 75, B-3001 Leuven, Belgium
[3] Verteq, Inc., 1241 E. Dyer Road, Suite 100, Santa Ana, CA 92705

OBJECTIVE

It is a well known fact that as device dimensions shrink, so does the size of the defects that need to be removed from the wafer surface to prevent device failure. A common cleaning technique to remove particles involves Megasonic agitation during the cleaning cycle [1]. Particle sizes down to 100nm have commonly been removed by megasonics even though theoretical papers on megasonics (frequency = 1MHz) indicate removal of particles this small should not be possible [2]. It is believed that the dominant mechanisms of particle removal in megasonic cleaning include cavitation, microstreaming, and Schlicting streaming. By controlling the combination of these factors, finer particle removal could be realized in megasonic cleaning. Theoretical models and calculations which consider these mechanisms have been developed to predict removal rates of particles from Si wafers, even below 100nm in particle size [3]. The purpose of this paper is to provide direct experimental evidence that megasonics is indeed capable of removing particles below 100nm.

APPROACH

The megasonic system used in this study is a single wafer system operating at ~835kHz [4]. Room temperature deionized water was used during the megasonic cleaning cycle to remove the particles from the wafer surface. Light Scattering measurements (KLA Tencor SP1-TBI), enable LPD sizes to be measured down to 60nm and particles below this LPD size range can be detected with the average haze on the wafer surface.

RESULTS AND CONCLUSIONS

A typical cleaning result is shown in figure one. A monodispersed silica slurry a particles size distribution of 35.6 ± 9.9nm was efficiently cleaned off of the wafer surface with deionized water and megasonic agitation. Further data will be provided with LPD sizes in the range between 60 and 100nm.

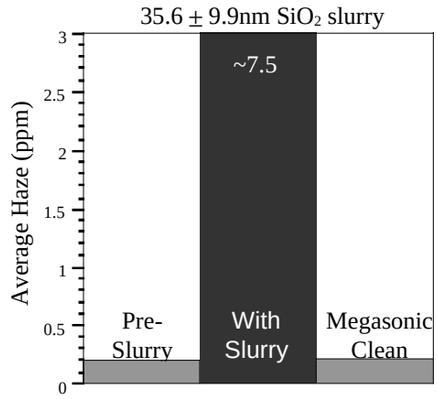

Figure One: SiO_2 slurry cleaned off of a Si_3N_4 wafer surface with deionized water and megasonic energy below 900kHz. The average haze was measured in the wide channel with oblique illumination.

REFERENCES

[1] G. W. Gale and A. A. Busnaina, "Removal of Particle Contaminations Using Ultrasonics and Megasonics: a Review", *Particulate Science and Technology*, 13: 197-211 (1995).

[2] M. Olim, , " A Theoretical Evaluation of Megasonic Cleaning for Submicron Particles", *J. Electrochem. Soc.*, Vol. 144 (10), 3657-3659 (1997).

[3] D. Zhang, "Fundamental Study of Megasonic Cleaning", Ph.D. Dissertation, University of Minnesota, St. Paul, MN (1993).

[4] M. Bran, *Wafer Cleaning System*, Verteq, Inc., U. S. Patent 6,039,059, Mar.21, 2000.