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Investigation of Particle Characteristics Using Array Faraday Cup Installed PCDS

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Extended Abstract

As semiconductor device is developed with its degree of integration near 10 nm, sufficiently small particles within several nanometer which brought into the semiconductor fabrication process were affected on process yield drop. Current methods to measure particles in vacuum condition semiconductor fabrication process chambers are needed to prepare samples by collect particles in the way of deposition or settling on sample wafers. Sampled particles are then analyzed using ex-situ methods such as scanning electron microscope (SEM) to investigate its shape or energy dispersive spectroscopy (EDS) to investigate its composition. These methods are widely using in process diagnosis because, the gained information of particles involve significantly on process yield. However they have problems on additional costs on sample wafers to measure, and these methods neither can measure the particle size distribution well, thus it is hard to treat immediately in contaminants occurring, or unexpected process changes.

By the problems occurred when using ex-situ methods, in-situ measurement devices using diversity of fundamentals were developed. A device called in-situ particle monitor (ISPM) is using light as the source to measure the size of particles in vacuum condition, but most of commercialized ISPMs are using the laser which emits the light around 780 nm, it only can detect particles over 200 nm (Takahashi and Daugherty., 1996). Another device called particle beam mass spectrometer (PBMS) was developed to overcome the problems of ISPM. This apparatus can measure the size distribution of nano-scale particles inside vacuum condition in real time by measuring the charged particle current at faraday cup (Ziemann et al., 1995). Regardless of the advantages on real time measurements, these in-situ methods can only measure the particle size distribution, information of particle shape or composition cannot be gained.

Hence, the device that can measure particle characteristics complexly was needed, and the device combined with PBMS, SEM, and EDS which called particle characteristics diagnosis system (PCDS) to

measure the particle shape, composition, and size distribution was developed. The stage of SEM inside PCDS works as faraday cup of PBMS, and the size distribution measurement, SEM imaging and EDS measurement are also available by this stage. However, this PCDS includes the same apparatus of PBMS, particles smaller than the certain size corresponds to the critical voltage are also deflected to faraday cup, and each different sized particles arrive at different positions on a faraday cup, and because of this result, current measurements using faraday cup should be performed at several positions where the particles are estimated to reach. Therefore, array structured faraday cup was designed and then the current values were measured simultaneously with each array to classify the particle size more accurately.

In this research, sodium chloride or polystyrene latex (PSL) particles were classified by its size using scanning mobility particle sizer (SMPS). Size classified particles were then sampled and measured by array faraday cup installed PCDS to investigate the size classification changes when using array faraday cup. Results were also compared to the measurement data gained by SEM, and EDS.

References

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