Structural Characterization and Manipulation of Porous PVA Brush for High-Efficient Wafer Surface Cleaning

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Brush scrubbing processes are widely used to clean the surface contaminants on a wafer by rolling a soft brush made of PVA material. The process has the advantage of high cleaning efficiency owing to the direct removal of particles via making a physical contact with the wafers. However, as the miniaturization continues in semiconductor manufacturing, the reduction of nodes causes the generation of finer particles and the surface adhesion energy increases in reduction of the particle size. To effectively remove small sized contaminants, therefore, the structural design of the PVA brush should also be adjusted for efficient cleaning of fine particles.

This study discusses the necessity of advance in the structural design of PVA brushes used in post-CMP for confrontation of miniaturization of contaminants from scaling in chip fabrication. We analyze the structural characteristics of few commercialized PVA brushes in various perspectives. Structural variables such as the average pore size, porosity of inner structures and surface roughness of the brush are quantitative analyzed, and the particle removal force is calculated depending on different structural design using a finite element method as shown in Fig.1. We further identify the main influencing structural factors of the brush cleaning process based on contact mechanics theory and validate their effect on cleaning performance by wafer cleaning experiments. For example, differences in particle removal efficiency according to the pore sizes of the brush with open porous structure are confirmed as Fig. 2. We further experimentally verify the effect of the pore size on the cleaning efficiency, by manipulating the pore size of the brush using a NaCl template.

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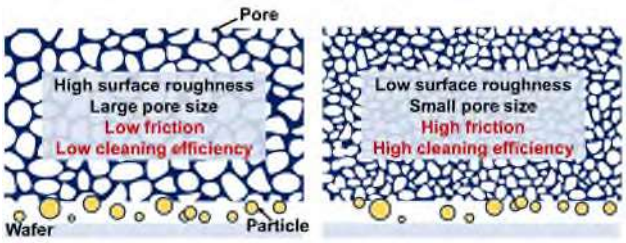

Fig.1 Particle removal efficiency according to the structural properties of PVA brush

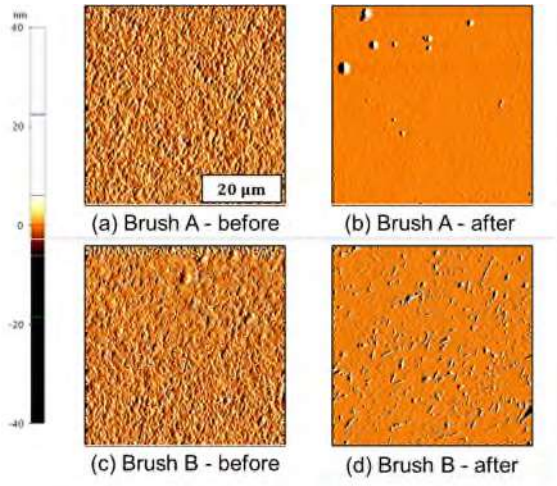

Fig.2 Cleaning Results using PVA brushes having different structural properties.

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