A Study on the Measuring of RCA between Wafer and Pad in CMP

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Chemical mechanical polishing (CMP) is processing of relative motion between pad and wafer by supplying the slurry which abrasive particles are dispersed. This process consists of mechanical and chemical action such as contact with wafer and chemical composition of the slurry. In this paper, we investigated real contact area (RCA) between pad and wafer according to different surface of samples pad. We measured pad surface roughness parameter R_{ku} *and pad surface. The RCA measured by using actuator which applying constant air pressure. Then we used calculation program to know real contact properties. Finally, we considered correlation between real contact area and real pressure.*

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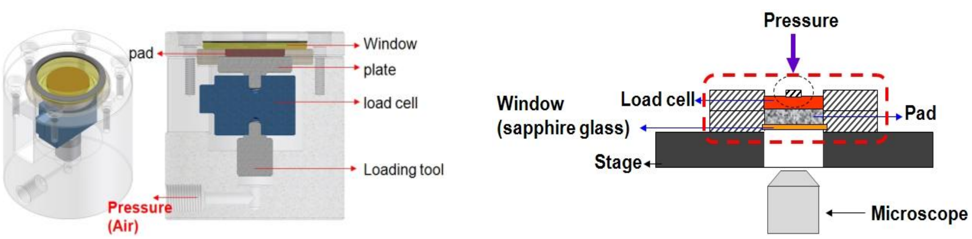
1. Introduction

There are many factors affecting on CMP process such as polishing pressure, temperature, relative velocity of between pad and wafer, slurry abrasive size, concentration of particles, hydrodynamic of the slurry film and types of the wafer films. Especially, an understanding of the pad surface state and its effect on the polishing process is essential to a more fundamental understanding of chemical mechanical polishing.[1] We investigated real contact area (RCA) between pad and wafer. Real contact area between pad and wafer is key factor in local contact pressure, friction and pad wear all of which impact material removal and defect formation.[2] In this paper, we studied real contact area according to different surface state of pad and measured pad roughness parameter, kurtosis (R_{ku}), pad surface images. Finally, we considered correlation between real contact area and real pressure according to shape of pad asperity.

2. Experiment

To change the asperity of pad surface used dummy wafer by different break-in times. The break-in times set 5, 10, 15, 30mimute and compared with conditioning pad. Pad samples diameter is 5mm for RCA between pad and wafer; it collected circle shape around pad center. We obtained kurtosis parameter that represents sharpness of pad asperity among the pad surface roughness used contact stylus profiler. The contact stylus profiler set 0.5mm/s contact tip speed and 12.5mm measured length. The kurtosis parameter measured 5 times and represented average value. The real contact area (RCA) measured by used actuator which applying air pressure and load cell. So, it has benefit of stable pressure, easy to control pressure and accurate measuring position.



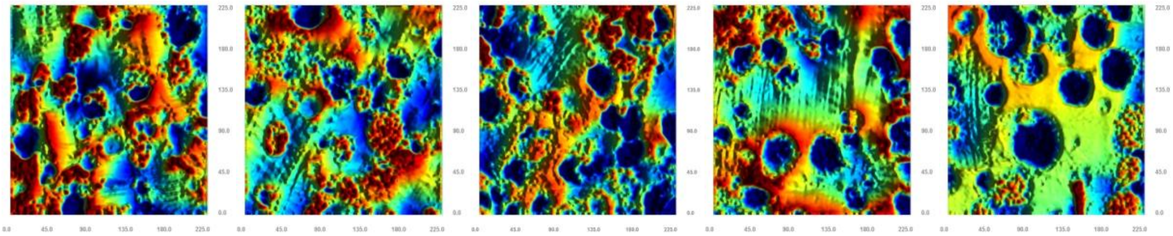
(a) Air pressure actuator (b) Real contact area measurement system

Fig. 1 Schematic of real contact area actuator and system

The schematic of RCA system such as (a) air pressure actuator and (b) real contact area system showed Fig. 1. The actuator made up part of a sapphire; replaces wafer, part of plate; put on the sample pad, part of sensor; apply constant air pressure and part of air entrance. The available of air pressure range is until 5,000g/cm^2 but in this experiment pressure applied 350g/cm^2 air pressure actually used in CMP. The actuator set up on the stage and captured the real contact image used optical microscope. We used magnification of x10 lens in the experiment. The RCA image adjusted contrast processing after captured of raw images that size are width 800um, height 600um. We calculated RCA, ratio and real contact point between pad and wafer.

3. Results

The pad roughness is important factor for describing shape of pad. We focus on kurtosis parameter that defined sharpness of pad asperity. After conditioning pad has the highest R_{ku}, 6.95 and 30minute break-in time pad has lowest R_{ku}, 3.11. Fig. 2 showed confocal microscope images according to different break-in times. The measurement set magnification of x50 lens and width and height both 225um sizes. The red area means asperity the formed on the pad surface while blue area means pad valley and flat surface. (a) After conditioning pad has large red area and red area tended to decreased during the longer pad break-in times.



(a) After conditioning (b) 5minute polishing (c) 10minute polishing (d) 15minute polishing (e) 30minute polishing

Fig. 2 Pad surface images

The real contact area about after conditioning pad, 15minute polishing pad and 30minute polishing pad showed Fig. 3. The black spots are RCA between pad and wafer. We obtained real contact area, ratio and mean area of each population used calculation program.

(a) After conditioning (b) 15minute polishing (c) 30minute polishing

Fig. 3 Real contact area between pad and wafer

After conditioning pad has highest population contact points (213) and real contact ratio (1.35%). The 15minute break-in time pad has follows as population contact points (45) and real contact ratio (0.76%). The 30minute break-in time pad has lowest population contact points (24) and real contact ratio (0.54%). The mean area of each population represented opposite tendency such as contact points and ratio, after conditioning pad, 15minute and 30minute break-in time pads has 304,037um^2, 819,777um^2 and 1,748,750um^2 respectively.

4. Conclusion

In this paper, we focus on investigation the between pad surface state and real contact area according to different break-in times. After conditioning pad has sharpness (high R_{ku}) asperity of pad and it has bluntness (low R_{ku}) during the longer break-in times. This results apply to real contact area is follows as; (1) the high R_{ku} pad takes the high real pressure for wafer and (2) the low R_{ku} pad takes the low real pressure for wafer according to mean area of each population.

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