Nodule contact trajectory analysis of PVA roller brushes on a rotating plate

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ABSTRACT

We observed PVA brush contact trajectory with different brush-wafer relative velocities. Based on this observation, we reproduce a brush contact map on a 300 mm wafer. As a result, we found an emerging stamp type of contact in the region of not only near-zero and negative relative velocities. Furthermore, we estimated the area of these trajectories from relative velocities and found that the area shows significantly less than the value from the geometric calculation.

INTRODUCTION

PVA brushes are widely used for post-CMP cleaning. The Roller-type brushes, which rotate horizontally on a rotating wafer on a vertical axis, have different contacts depending on their nodule positions and rotation conditions. Therefore, proper nodule positioning and rotation conditions are important for more efficient cleaning. In this study, we observed the contact trajectory of the nodule using evanescent fields and investigated the difference in the area depending on its position on the rotating disk under each rotational condition.

METHODOLOGY

Figure 1 shows a schematic of the experimental setup. We used the evanescent field on a prism to distinguish between contacting solids and gases/liquids. A collimated LED parallel light enables the generation of several hundred-nanometer thicknesses of the evanescent fields [1]. The relative motion of the roller brush and wafer in the actual cleaning was reproduced by rotating the brush ω_w on the vertical axis while rotating the brush on ω_b the horizontal axis. This apparatus can reproduce the nodule contact during brush scrubbing. We observe the nodule contact path with a high-speed video camera. And then, we use MATLAB® software for image processing to calculate the series of contact trajectories. We used two types of prisms, PMMA and BK7. We also estimated a theoretical geometric nodule path calculated from relative velocities and nodule shape.

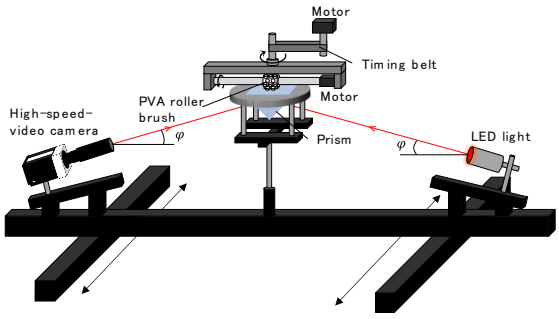

Fig.1 Schematic of the experimental setup

RESULTS AND DISCUSSION

Figure 2 shows a typical example of a contact trajectory map of a nodule for brush rotation ω_b = 150 rpm and wafer rotation ω_w = 100 rpm. A stamp-type of contact [2] emerged at the near-zero relative velocity region. In addition, a stamp-type contact also emerged negative velocity region. We believe that this relates to cross-contamination [3].

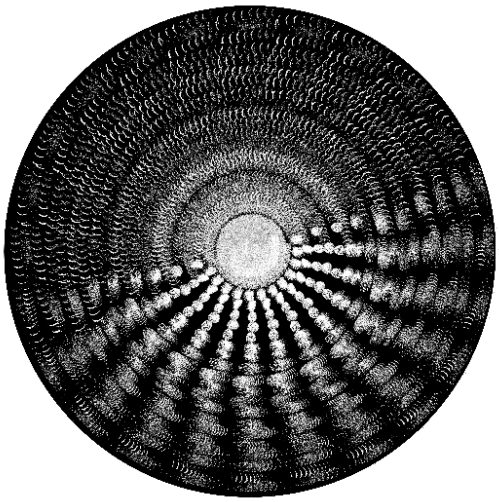

Fig.2 Nodule contact trajectory map on a 300 mm plate, ω_b = 150 rpm, ω_w = 100 rpm.

Figure 3 shows the estimated and measured area of nodule trajectories. The stamp type contact area, i.e., the nodule bottom area, is also shown. The figure shows a simple geometric estimation calculated from nodule size and contact time, and relative velocity overestimates the area. This result indicates that care is needed to estimate the contact area from relative velocities.

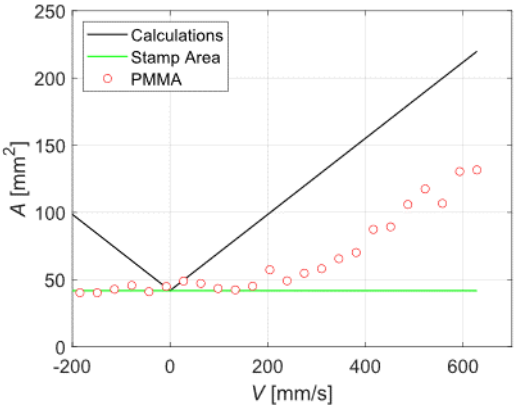

Fig.3 Estimated and measured trajectory area as a function of the relative velocity.

CONCLUSIONS

We observed PVA brush contact trajectories during brush scrubbing and reproduced a brush contact map for a 300 mm wafer. We also estimated the trajectories area from the geometric calculation. The results showed that the stamp-type contact emerges in both near-zero and negative relative velocities

regions. Furthermore, the measured area was much smaller than the estimated value obtained by the relative velocities.

References
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