Evaluation of Polishing Performance by CMP Pad with Bi-layered Asperities

Hyun Jun Ryu, Ji-hun Jeong, Dong Geun Kim, and Sanha Kim*
Department of Mechanical Engineering, KAIST, *sanhkim@kaist.ac.kr

Polymeric pads with different mechanical properties are used in CMP (Chemical Mechanical Polishing) according to their fabrication purpose. Hardness is one of the most important property which determine the key polishing performances such as the material removal rate or the number of scratching defects. In general, hard pads promote high material removal rate but provoke defects to the polished surface. On the other hand, soft pads can guarantee better surface quality, yet the material removal rate is low [1]. In our previous study, we explored a concept of 3D structured bi-layer pad at the single asperity contact scale, which consists of a soft base structure and a thin hard layer [2]. We showed that the new heterogeneous pad design can enhance both the material removal rate and surface quality compared to homogeneous pad.

In this study, we investigate the polishing performance of polyurethane pads with an array of hard/soft bi-layered asperities. We first micro-replicate the array of soft hemispherical structures in the size of tens of micrometers using a PDMS mold. Then, we spin-coat the hard layer with a thickness of 1-2 μm. After appropriate curing stages, the hardness of the soft polyurethane base and hard polyurethane layer are 2.41 MPa and 41.5 MPa, respectively. The polishing results compares the material removal behavior of bi-layered asperities compared to the pads with single material asperities. The soft pad shows low material removal rate but high quality of polishing, whereas the hard pad exhibits high material removal rate yet accompanies few severe scratches. While the single material pads have such general trade-off, the bi-layered pad can polish the surface at high rate and create less scratches as the thin hard layer can deliver high enough forces on small abrasives for polishing

Corresponding Author:
Sanha Kim
Tel: +82 42-350-3022
E-mail: sanhkim@kaist.ac.kr
Department of Mechanical Engineering, KAIST,
Daejeon 34141, Republic of Korea
https://amselab.kaist.ac.kr/

while cannot withstand the forces for large agglomerated particles for scratching. Our result elaborates that the multi-material pad design can be an effective route for high performance CMP.

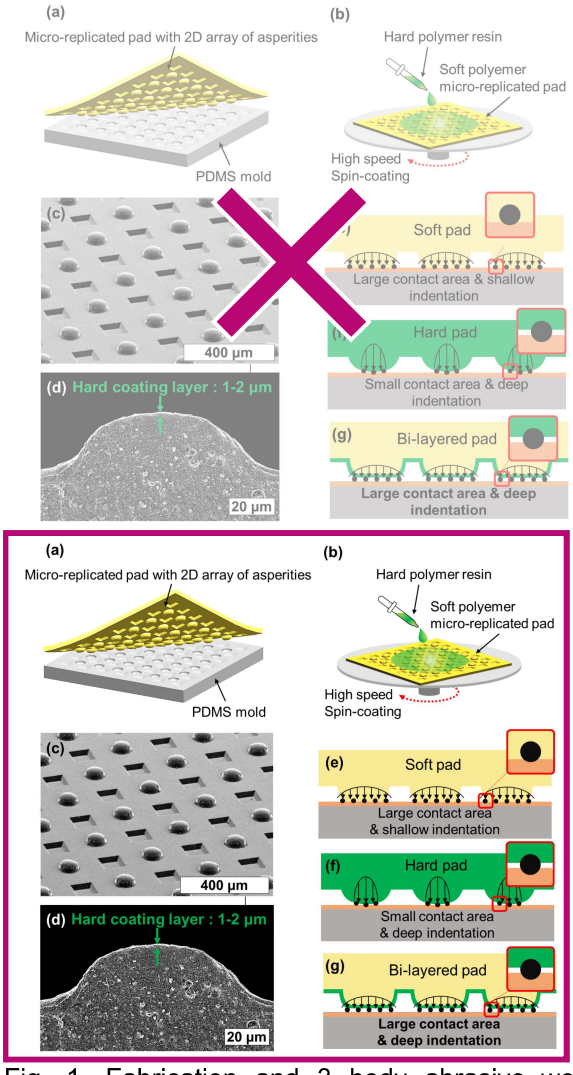

Fig. 1. Fabrication and 3 body abrasive wear mechanism of bi-layered structure. Schematics of (a) the micro-replication process for the soft base asperity structures and (b) spin-coating the hard thin layer. SEM images of (c) fabricated array and bi-layered asperities and (d) the cross-section. (e, f, g) Schematics of polishing behavior of soft, hard, bi-layered pads.

Preference: □Oral ■ Poster

Topic Area:
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Reference
[1] K. L. Johnson (1985), Contact Mechanics, Cambridge University Press
[2] H. J. Ryu, D. G. Kim, S. Kang, J. Jeong, S. Kim (2021), Mechanical Abrasion by Bi-Layered Pad Micro-Asperity in Chemical-Mechanical Polishing, CIRP Annals.

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