

Fabrication and Characterization of Fixed-Nano-Abrasive Polishing Pads using Vertically Aligned Carbon Nanotubes

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Chemical mechanical polishing (CMP), the widely used planarization technique in semiconductor manufacturing, is a representative loose-abrasive polishing process in which abrasives are separately supplied between the pad and the substrate. Despite the many advantages, loose-abrasive approach has scratching defect issue due to the agglomeration of abrasives, and creates abrasive residues which require post-CMP cleaning. Massive disposal of industrial wastewater is another drawback of the loose-abrasive type polishing. In contrast, fixed-abrasive polishing approach can inherently eliminate the possibility of particle agglomeration or abrasive residue as the abrasives are fixed on the pad. However, this type of polishing has not been used in precision polishing due to the difficulty of fabrication and maintenance of small abrasives on the pad surface.

In this research, we introduce a novel fixed-abrasive pad comprising vertically aligned carbon nanotubes (VACNTs) embedded on the polyurethane pad surface. The VACNTs were synthesized using chemical vapor deposition (CVD) which allowed CNTs to grow vertically with high aspect ratios. The diameter and length of the VACNTs were 10 nm and 5 μm , respectively. We impregnate the VACNTs in polyurethane followed by an oxygen plasma etching to allow a slight protrusion of CNT tips, Fig 1a. Owing to the high aspect-ratio structure, VACNTs can be stably fixed in the polyurethane pad while the protruded VACNTs from the polyurethane can perform as fixed abrasives, Fig. 1b. Our pin-on-disk polishing experiment confirms the polishing traces performed by CNTs, resulting in surface roughness (S_q) decreased from 28.8 to 9.8 nm without supplying additional chemicals and abrasives, Fig. 1c. We also demonstrate generating a mirror-like surface by polishing using the developed fixed-nano-abrasive pad, Fig. 1d.

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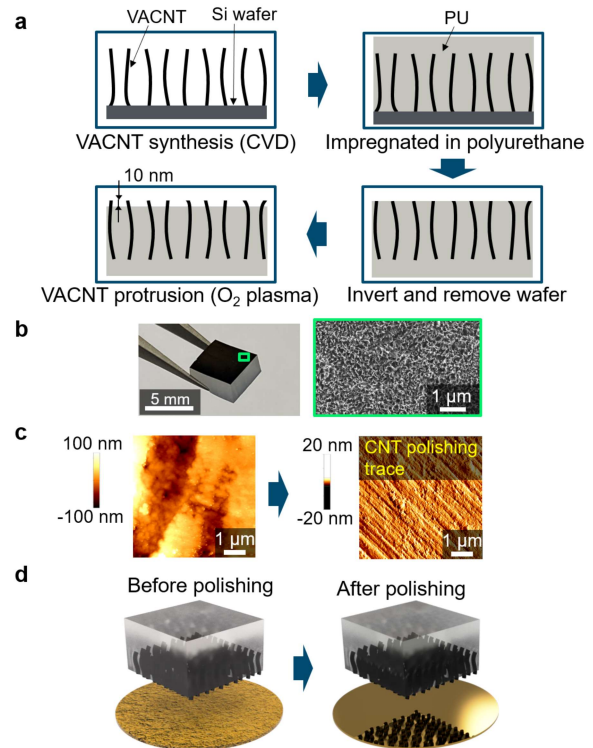


Fig. 1. Fixed-nano-abrasive pads using vertically aligned carbon nanotubes. (a) Schematics of fabrication procedure and (b) SEM images of the fabricated pad. (c) AFM images of Cu surface before and after pin-on-disk polishing experiment, and (d) schematic diagram of mirror-like surface polishing.

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