

Custom-Designed Glassy Carbon Tips for Atomic Force Microscopy

1. Objective of work

This work developed a glassy carbon tip which are intended for AFM application because of the properties that the material offers (mechanical, electrical and surface).

2. Sample description

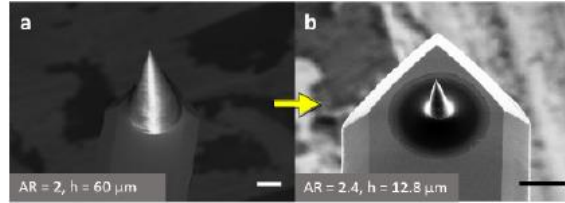
Various cone-shaped tips were patterned on silicon wafers using IP-Dip and IP-L photoresists with a Nanoscribe 2PP set-up equipped with galvo scanning mirrors (laser power of 30, 33.6 mW, 25 mm/s writing speed and sluicing distance of 200 nm). The tips were processed with UV (200 mJ/cm²) and post-exposure bake (75 °C for 15 min). Pyrolysis temperature of 900 °C.

3. Equipment and conditions for Atomic Force Microscopy

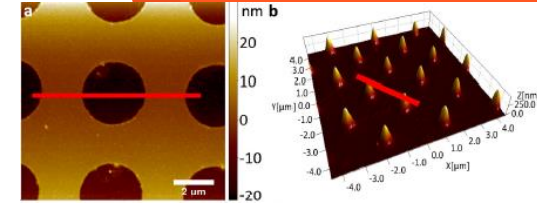
All AFM measurements were conducted with a Dimension Icon AFM in a cleanroom environment. Surface morphology tests were performed using: AFM calibration gratings CS-20NG and TGT1, multilayer carbon fiber mat and electroplated copper surface with tips of 5 μm and AR 2. TGT1 test were obtained in dynamic mode and electroplated copper surface in contact mode (10 μm/s and 100 μm/s). Single scan was 2 μm by 2 μm and tip-apex profile obtained by blind reconstruction.

4. Results

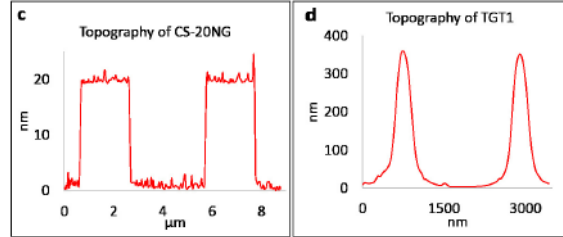
AFM images were obtained using glassy carbon tips. CS-20NG (circular patterns with 20 nm depth) and TGT1 (spikes of 300-500 nm height) details obtained with these tips were efficiently resolved. The average measured height of a TGT1 spike was 350 nm, corresponding to its vendor supplied values. The measured depth in carbon fiber mat was in line with the overall dimensions and sharpness of the tip. The AFM image of electroplated copper surface had a lateral resolution of 40 nm. The vertical and lateral resolution can be further improved by a taller or sharper carbon tip.



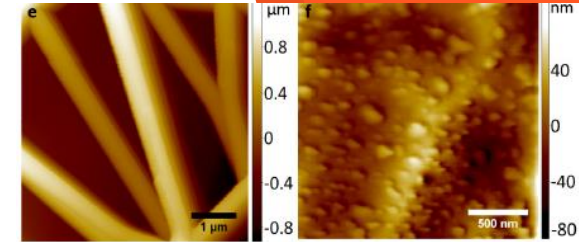
Glassy carbon tip before (a) and after (b) of pyrolysis, demonstrating the shrinking volume.



AFM images recorded using glassy carbon tips. (a) Calibration grating CS-20NG; (b) TGT1 calibration grating.



Cross-sections corresponding to the CS-20NG (c) and TGT1 (d) recording.



AFM images of carbon nanofiber mat (e) and electroplated copper (f)