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APPLICATION NOTE
NANOINDENTATION TESTING OF DLC film

Diamond-like carbon thin films are important hard-wearing films that are required to have a high hardness and adhesion. In this application note, two DLC films on silicion were prepared under different conditions and the elastic modulus, hardness, and scratch resistance was measured.

1. Elastic modulus and hardness

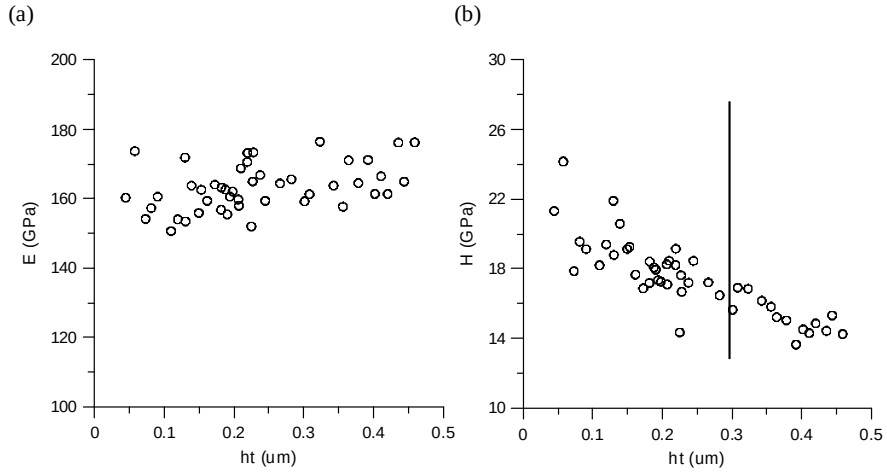


Fig. 1. Elastic modulus and hardness as a function of penetration depth for Sample A5 (500W 300 nm DLC on Silicon). Decrease in H above 250 nm is due to substrate effect.

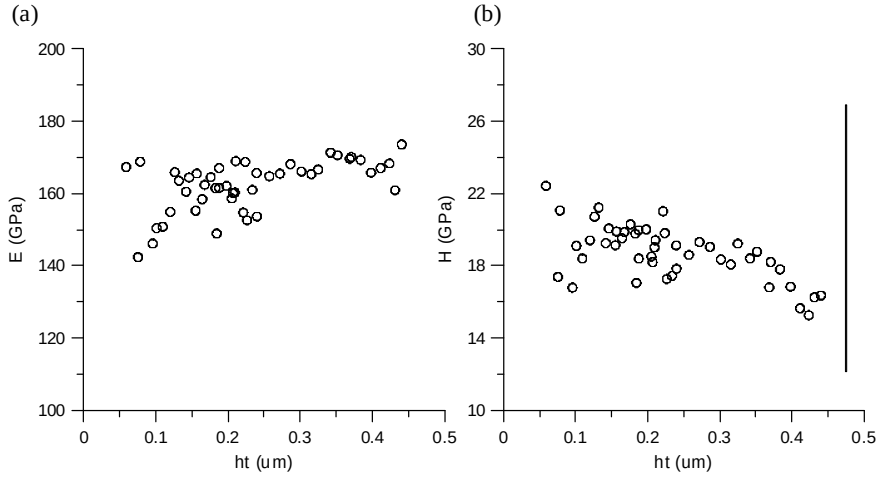
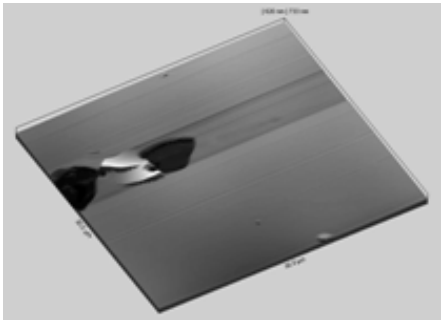


Fig. 2. Elastic modulus and hardness as a function of penetration depth for Sample A3 (300W 500 nm DLC on Silicon). Decrease in H above 400 nm is due to substrate effect.

2. Scratch

Optical image x40 lens



AFM image

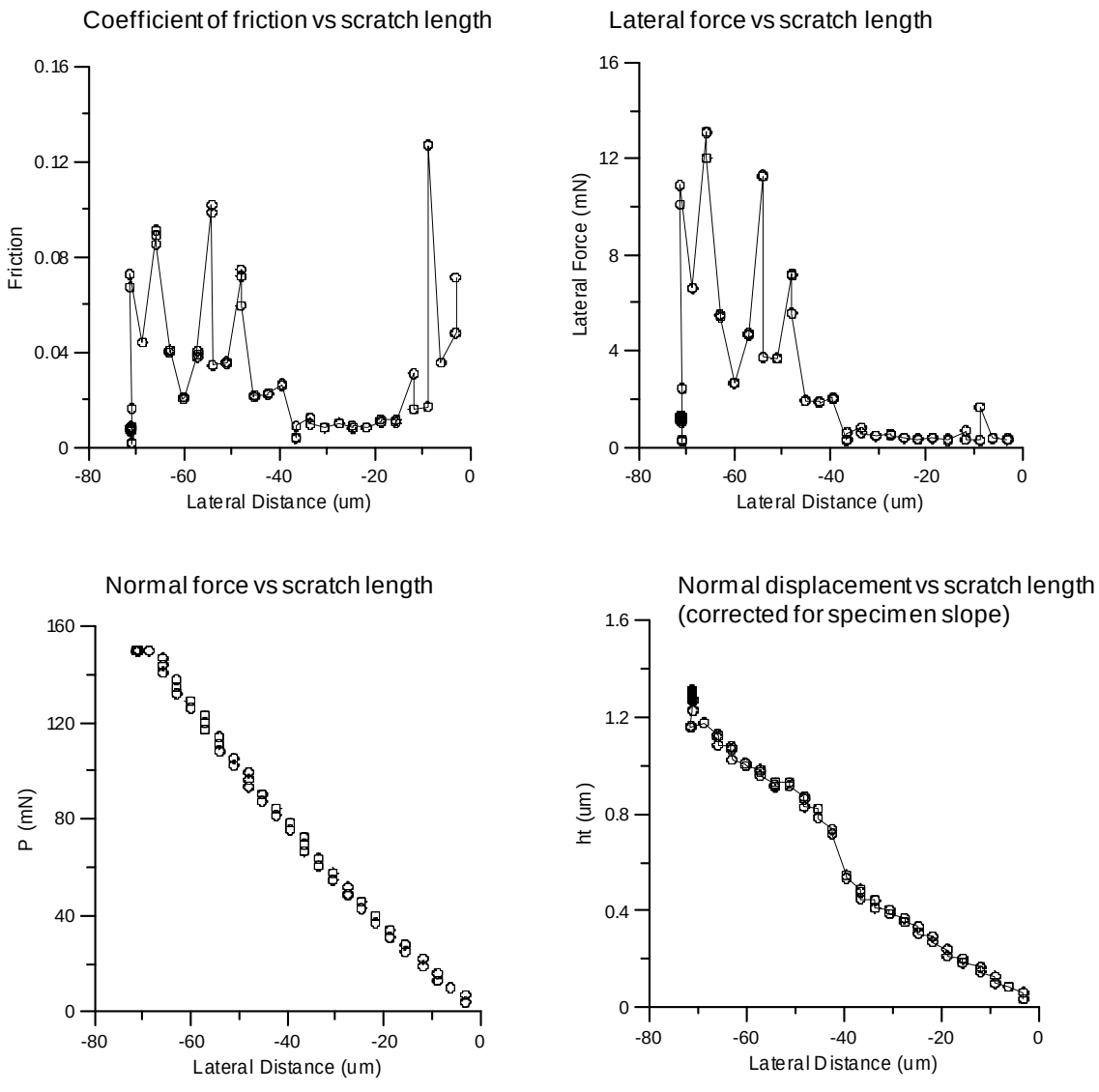


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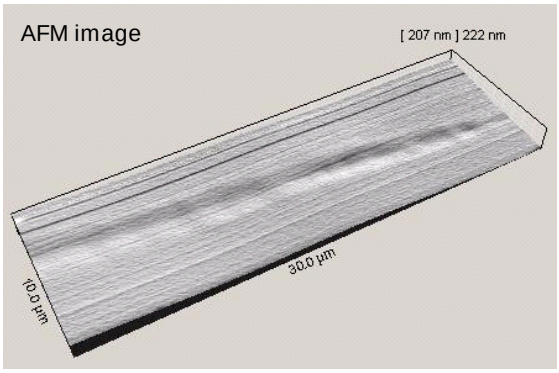
Fig. 2. 70 um scratch, ramped load from 1 to 150 mN. Scratch goes from right to left in figures.
5 um radius, 60 degree sphero-conical indenter Sample A5 (500W 300 nm DLC on Silicon)

Optical image x40 lens



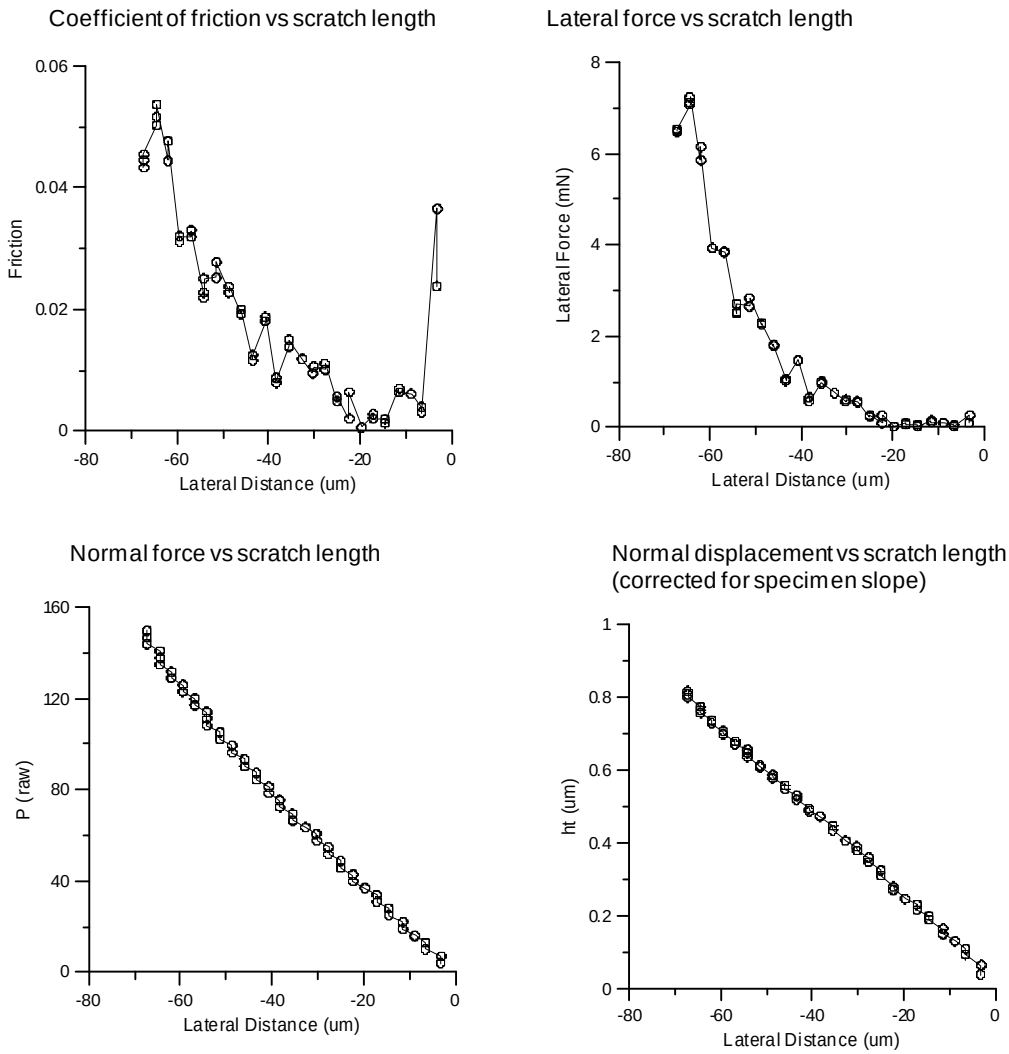


Fig. 3. 70 um scratch, ramped load from 1 to 150 mN. Scratch goes from right to left in figures. 5 um radius, 60 degree sphero-conical indenter. Sample A3 (300W 500 nm DLC on Silicon).

Observations:

The results show that Sample A5, 500 W 300 nm fails in scratch at about 80 mN load with the 5um radius indenter used whereas the other sample, 300W at 500 nm, does not show any failure. Values of E and H appear to be very similar for both samples over the range of penetration depths. Note the fall off in values of H as the indenter starts to probe the properties of the underlying substrate (H silicon about 12.5 GPa). No fall off in E is observed since the elastic modulus for the substrate (approx 172 GPa) is similar to that of the films.