Nanofriction properties of graphite tribofilms: influence of the tip/sample interface

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Previous study has shown that friction properties of lamellar compounds are significantly improved in the presence of liquid [1]. In the present work, the nanofriction properties of the macrotribofilms formed from UF_4 powder in the presence of liquid, are investigated at the nanoscale. For this purpose the tribofilms are characterized using an atomic force microscope coupled with a friction force microscope. Three different AFM tips (Si, CrAu & Si_3N_4) are used in order to study the influence of the friction interfaces on the nanotribological properties. AFM images recorded on the tribofilms reveal a heterogeneous surface constituted of smooth platelets surrounded by granular areas as shown in Figure 1.

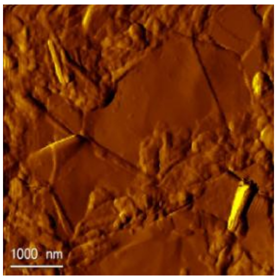

Figure 1: AFM deflection image recorded on UF4 tribofilm.

The friction forces as a function of the total normal load using the 3 AFM tips are reported in figure 2. Each data point of a curve is average lateral force obtained from 8 measurements on different areas and the error bars are the associated standard deviation.

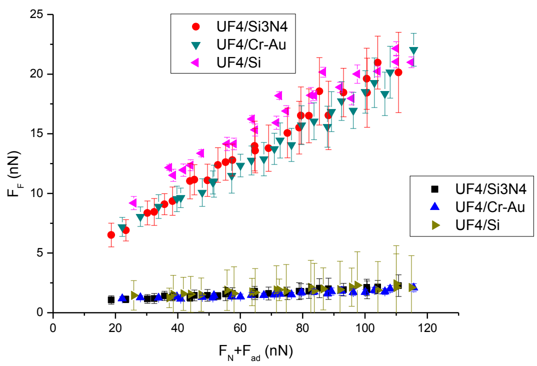

Figure 2: Friction force as a function of total normal load recorded on UF_4 tribofilms using the three types of AFM tips.

Classical contact mechanic theories have been used to fit the experimental curves reported in figure 2. Data recorded on granular areas are well fitted by DMT [2] theory whereas on platelet areas the curves are better fitted using the JKR one [3]. The shear stress values deduced from these procedures are reported in table 1.

	τ_{Si} (MPa)	τ_{CrAu} (MPa)	τ_{Si3N4} (MPa)
Platelet area	4.4±1.4	3.2±0.8	4.9.± 2
Granular area	62±9	58±5	69±10

Table 1: Shear stress values deduced from JKR (platelet zone) and DMT (granular area) contact theories.

The shear stress values calculated on the platelets are around 10 times lower than the ones measured on the granular area revealing their good friction properties. Note that the friction forces measured on the platelets are of the same order of magnitude than the ones measured on HOPG bulk indicating that the platelets are probably HOPG particles oriented with their c axis perpendicular to the surface.

The fact that the nature of the tip has no influence on the friction behavior, suggests that sliding occurs between two basal graphene planes. This conclusion is strongly supported by SEM post-analysis of the tips which show graphite flakes bonded to the tips by electrostatic force in the regions corresponding to the contact area.

1. References

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