Measurement of the lateral force and surface observation of a super water repellent film by using an Atomic Force Microscopy

Atomic force microscopy (AFM) is a type of SPM capable of high-magnification surface observation of both conductors and non-conductors under a variety of conditions including in vacuum, air, or liquid, by detecting the deflection of an extremely small cantilever probe as it approaches the sample surface. Furthermore, the lateral force microscopy function (LFM mode) can measure the horizontal force (frictional force) acting between the probe and the sample by detecting the twisting deformation of the probe. Frictional forces under extremely small loads on the nN order can be measured using this function. This study presents a series of friction experiments using the LFM mode.

■ Measurement of the frictional force of a super water repellent film by using the glass sphere probe

In micro and nano-scale friction, the surface adhesion force (attractive force) that acts between solid surfaces in contact behaves like a normal load and has a large effect on the friction. Possible causes of this adhesion force are thought to include meniscus force due to surface moisture, electrostatic force, and van der Waals force. Among these, the effect of the meniscus force is thought to be extremely strong.

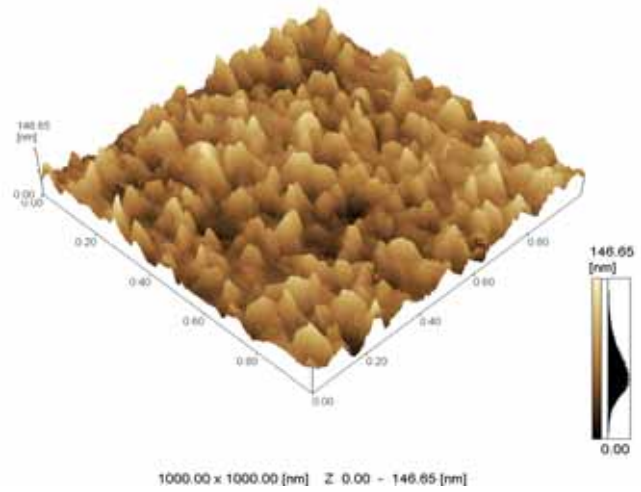

Fig.1 AFM image of a flower-like Al_2O_3 super water repellent film

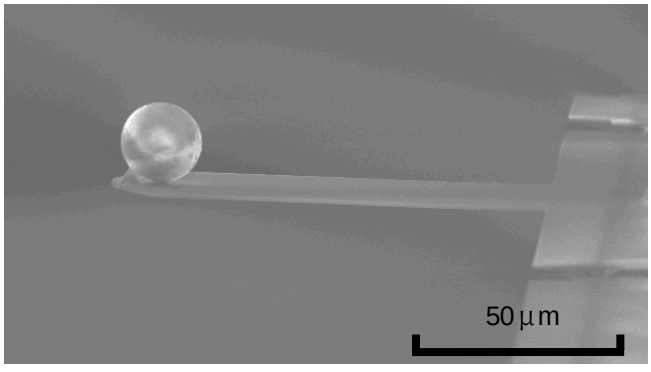

Fig.2 SEM photograph of the glass sphere probe

Therefore, the lateral force of super water repellent films that are expected to have a small meniscus force effect was investigated by varying relative humidity.

Figure 1 shows an AFM image of the super water repellent film surface, which was formed on a smooth glass plate by the sol–gel method, and have a large contact angle that is virtually non-wetted by water. Figure 2 shows an electron micrograph of the glass sphere probe used in this research. Experiments were performed using a probe with a glass sphere attached to a regular cantilever tip and changing the normal load and relative humidity. Figure 3 shows the experimental results. It is clear that the effect of relative humidity on the lateral force was extremely small for the super water repellent film surface.

The friction and adhesion forces under very small normal loads that could not be measured previously can be measured by AFM. Furthermore, it is possible to conduct a variety of friction experiments based on ideas such as using glass sphere probes presented here.

(Provided by Dr. Tomomi Honda, University of Fukui)

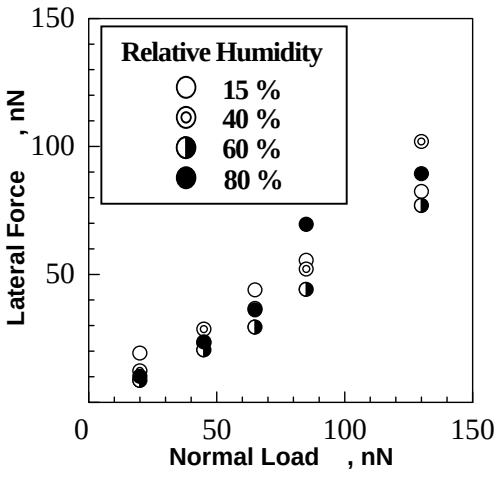

Fig.3 Normal load vs. lateral force