Direct Measurement of Solvophobic Attraction between Fluorinated Silica Surfaces by Atomic Force Microscopy

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The origin of the hydrophobic attraction between macroscopic hydrophobic surfaces[1] has been under debate for a long time. Almost 15 years ago, it was shown that the bridging of nanobubbles attached to hydrophobic surfaces is attributable to be the origin of long-range attractive forces.[2] However, this bubble-bridging force is occasionally regarded as not being a 'true' hydrophobic force because it is not produced by surface hydrophobicity itself but rather by the bubbles attached to hydrophobic surfaces.

Recently, we have successfully found that there also exists an additional attractive force larger than the van der Waals attraction between silanated silica surfaces on which there were neither nanobubbles nor a gas phase.[3] The range of the force is approximately 10–25 nm and the force is stronger than the van der Waals attraction. This force would be a true component of hydrophobic attraction because it is probably caused by the surface hydrophobicity itself.

In this study, the interaction forces between fluorinated silica surfaces were measured in organic solvents using atomic force microscopy (AFM) in order to examine whether such a force also exists in other solvents. We conducted the force measurements between the fluorinated silica surfaces in formamide, whose contact angle is 96°. In the approaching force curves (**Fig. 1**), the surfaces jump into contact at a distance of 10–20 nm that indicates the presence of an attractive force that is stronger than the van der Waals attraction. The range of the attraction is comparative to that of the hydrophobic attraction in water without nanobubbles. This result confirms that the 'solvophobic attraction', which is very similar to the hydrophobic attraction, exists in some organic solvents.

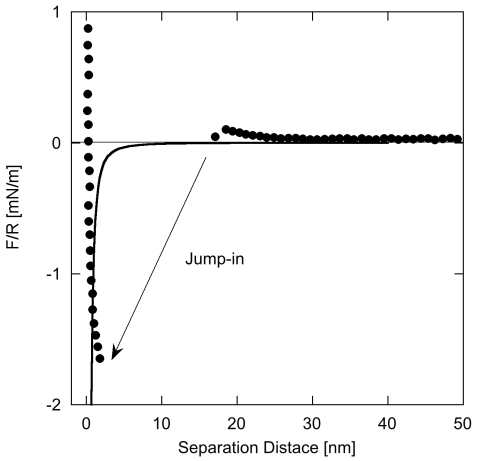

Fig. 1 Approaching force curve between fluorinated silica surfaces in formamide. The solid line shows van der Waals attraction.

References:
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3. Ishida, N., Kusaka, Y., Ushijima, H. Langmuir, 28, 13952 (2012).

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