Direct observation of host-guest complex formations by frequency-modulation atomic force microscopy in water

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Recent progress in instrumentation of atomic force microscopy (AFM) allows us to investigate surface structures with subnanometer resolution. In particular, frequency-modulation AFM (FM-AFM) has proven to be a powerful technique for investigating surfaces with true atomic resolution not only in vacuum but also in liquid. Previously, liquid-environment FM-AFM imaging of various samples, such as proteins[1], self-assembled monolayers[2], lipid bilayers[3] and minerals[4], have been reported. The previous reports demonstrated that the FM-AFM technique should contribute to understand various phenomena at solid/liquid interfaces.

In this study, we report a direct observation of host-gust complex formations at a solid/liquid interface using a home-built FM-AFM system. Pillar[n]arene is a new class of macrocyclic host structure with symmetrical pillar architecture. Pillar[5]arene (P[5]A) is known as a good host for n-alkane molecules by CH/π hydrogen bonds. Although such host structures are expected as molecular-recognition elements in many applications, direct observation of host-gust complex formations in real space is difficult due to the lack of analytical method. Therefore, we have investigated the host-guest complex formations at single molecular level using FM-AFM in water. The obtained FM-AFM images showed a highly ordered structures of P[5]A molecules with hexagonal packing on a mica substrate and their complexation with 1-octanesulfonate, which is used as a guest molecule. The results demonstrate that FM-AFM is capable of visualizing molecular-scale association/dissociation processes of host-guest complexes in water.

References

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