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Atomic Force Microscopy of Glass Surface Modified with Silane Coupling Agent Containing Fluorocarbon Chain

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Atomic force microscopic (AFM) data of glass surface modified with silane coupling agent containing fluorocarbon chain, (1H,1H,2H,2H-henicosafluorododecyl)-trimethoxysilane, were obtained. Fluorocarbon chains on the modified glass surface were found to stand close together. Double- or triple-layer of the silane on the modified surface was observed mainly near the border between modified- and unmodified-area.

Recently, we reported the syntheses of silane coupling agents containing fluorocarbon chain as well as the surface modification of plate glass using these coupling agents.[1-4] High modification ability of the silane coupling agents and high oxidation resistance ability of the modified glass surface against nitric acid were observed. These results were confirmed by measuring the contact angles on the modified glass surface and the oxidized glass surface with water and oleic acid. In regard to water and oil repellency on the modified glass surface, (1H,1H,2H,2H-henicosafluorododecyl)trimethoxysilane displayed the highest ability, and the largest contact angles of water on the modified glass surface exhibited 118°. Moreover, we applied the silane coupling agent for the surface modification of a denture to provide stain-protecting ability.[5] The layer thickness of the silane moiety on the modified glass surface seemed to have very thin film by ESCA measurement.[2] But, a clear explanation with respect to the thickness has not been made.

The half of a plate glass was modified in the same manner as in literature[2] using (1H,1H,2H,2H-henicosafluorododecyl)trimethoxysilane and the sample was analyzed by AFM (Seiko Instrument Inc. SPI-3700/ SPA-350). Figure 1 shows the modified area, in which the fluorocarbon chains were standing closely. Figure 2 shows a border between modified- and unmodified-area, in which an edge of the silane moiety appears as a sheer cliff, and the modified area away from an edge appears a relatively flat field. Figure 3 shows the depth of the modified/unmodified area, which was measured by AFM along the white line (1822 nm) in Fig. 2. The thickness of the silane moiety was 5.9 nm (double layer, 42%) and 8.9 nm (triple layer, 27%) in the region of modified moiety in 1822 nm length. The layer of the silane coupling agent on the modified glass surface should be composed of double- or triple-layer.

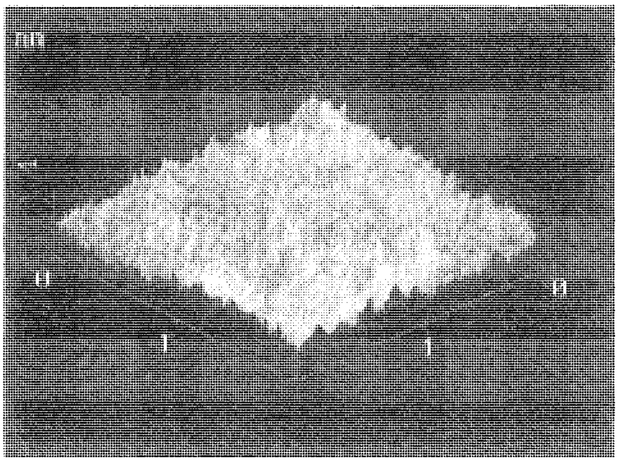

Fig. 1. AFM data of the glass surface modified with (1H,1H,2H,2H-henicosafluorododecyl)-trimethoxysilane. (ordinate: nm, abscissas: μm)

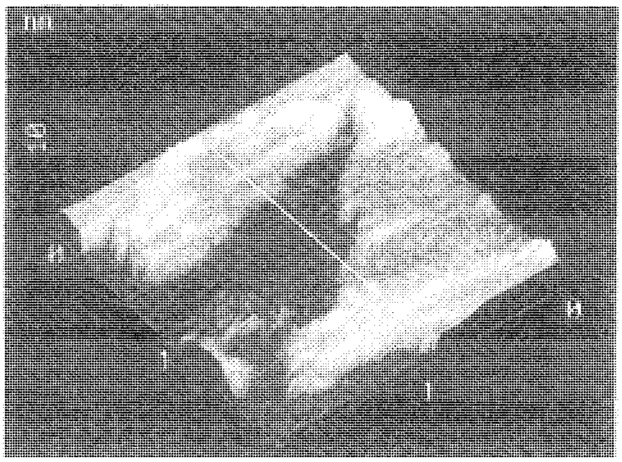

Fig. 2. AFM data of the border between modified- and unmodified-area on the glass surface. (ordinate: nm, abscissas: μm)

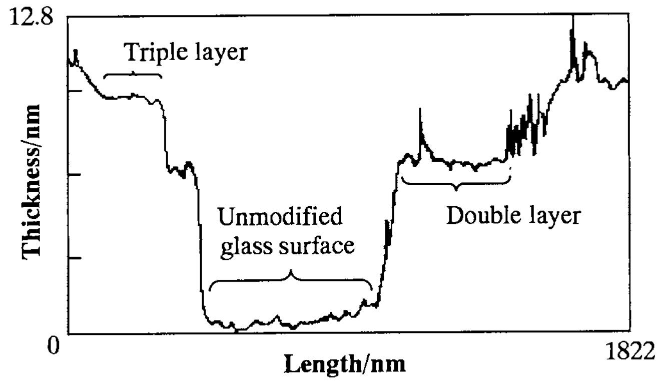

Fig. 3. AFM data in regard to silane thickness on the glass surface modified with (1H,1H,2H,2H-henicosafluorododecyl)trimethoxysilane.

References

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