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FM-AFM study on hydrophilic and hydrophobic metal oxides

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Interfaces of metal oxide and aqueous solution receive increasing interest due to their important role in nature and in industries. The topography of oxide surfaces immersed in solutions has been observed since AFM was invented in 1985. Fukuma et al. [1] observed tip-surface force modulated as a function of tip-surface distance using an advanced FM-AFM. The modulated force was ascribed to the localy modulated occupation probability of water molecules. Kimura *et al.* [2] further determined two-dimensional frequency-shift maps over a solution-mica interface and compared with a theoretical simulation. In the present study, two-dimensional frequency-shift maps were observed over solution-Al_2O_3 and solution-TiO_2 interfaces, as an extension of our force-distance curve study over TiO_2 [3].

α-$Al_2O_3(01\bar{1}2)$ and $TiO_2(110)$ wafers were calcined at 1273 K in air, immersed in an aqueous KCl solution, and observed with an FM-AFM. Figure 1 presents the frequency shift-distance curves over mica, Al_2O_3, and TiO_2. Modulations are most apparent over mica and least apparent over TiO_2. This order of microscopic structuring reproduces as the order of macroscopic hydrophilic property: (hydrophilic) mica, Al_2O_3 and TiO_2 (hydrophobic). The reason of the positive relationship will be discussed. It is known that TiO_2 exhibits a superhydrophilic property when irradiated by ultraviolet light. Frequency-shift curves before and after light irradiation are compared to evaluate light-induced modification of the solution structure.

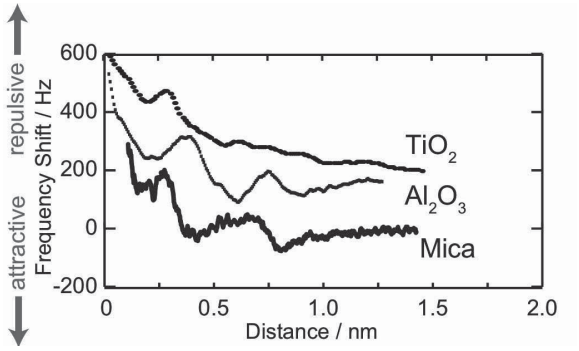

Fig. 1: Frequency shift-distance curves over mica, Al_2O_3 and TiO_2 wafers immersed in an aqueous KCl solution of 1 mol l^{-1}.

[1] T. Fukuma *et al.*, Appl. Phys. Lett. **87**, 034101 (2005).
[2] K. Kimura *et al.*, The 11th Int. Conf. on NC-AFM, 2008, Spain, Ext. Abstr. p.62.
[3] T. Hiasa *et al.*, Jpn. J. Appl. Phys. **48**, 08JB19 (2009).