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Atomic resolution observation of inorganic or organic crystal in liquid by Freaquency-Modulation AFM

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To observe the liquid/solid interface with atomic resolution is very important for discussing about mechanism of crystal growth process. Atomic Force Microscopy (AFM) has been widely used for investigating a 3-dimensional nano-scale surface topograph. Especially, frequency modulation AFM (FM-AFM) is a powerful method for imaging surfaces on an atomic scale (Morita et al., 2009). However, high-resolution FM-AFM imaging had been limited in vacuum environments. Therefore, studies of solution growth have been carried out by using contact mode AFM or amplitude-modulation AFM (tapping mode, dynamic mode).
Recent progress in FM-AFM in liquids has opened a new way to direct visualization (Fukuma et al., 2005a; 2005b). We have developed a high-resolution FM-AFM working in liquids based on a commercially available AFM (Shimadzu: SPM-9600). The main modification was a low-noise optical deflection system. FM-AFM apparatuses of same model for liquid environment were already used by Rode (2008) and Hiasa (2009).
Recently, we have tried to observe soluble crystals in saturated solution. It is different case from insoluble crystals such as the muscovite mica (Fukuma et al., 2005b) and the calcite (Rode et al., 2009). We used an open fluid cell. The concentration gradually increased during the observation because of evaporation of water. We observed the soluble crystals in the saturated solution at 20 degC and room temperature was kept at higher temperature, 23-24 degC. In this condition, the crystals dissolve at first. And then the crystals grow through the equilibrium state. Therefore, various phenomena of crystals could be observed depending on time. By using evaporation method, we already succeeded to observe various soluble crystals with atomic or molecular resolution such as alkali halide crystals (NaCl, KCl, KBr), KDP (KH_2PO_4), amino acid crystal (glycine, H_2NCH_2COOH), and protein crystals (lysozyme).

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