Liquid AFM for Batteries and Electronic Devices

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Atomic Force Microscopy (AFM) in liquid environments has been significantly improved in recent years. A key technology of our liquid AFM is using a quartz tuning fork sensor instead of Si cantilevers as its force sensor. It shows much higher quality factor compared to Si cantilevers and we have achieved atomic/molecular-resolution in ionic liquids (ILs), which have typically 100 times higher viscosity than water [1,2]. In addition, since its deflection can electrically be detected, it can be applicable for non-transparent liquid. In this presentation, we will show our recent results on liquid AFM, which are focused on applying for batteries and electronic devices.

The first topic is a lithium-ion battery (LIB). In-situ observation of electrode/electrolyte interfaces of LIB materials will be presented. A spinel-type lithium titanium oxide ($Li_4Ti_5O_{12}$, LTO) (111) substrate and IL containing Li ions were used as the electrode and electrolyte, respectively. LTO is known as a LIB negative electrode material. The surface structure of the LTO substrate before and after Li-ion insertion (charging) will be shown.

The second topic is AFM in liquid metal. Although electrode/semiconductor and electrode/insulator interfaces play crucial roles in electronic devices, there are few techniques for direct investigations on them. By using liquid metal as the electrodes, they would be investigated by liquid AFM. Since liquid metal is optically non-transparent, Si cantilevers cannot be applicable. We will talk recent development of our liquid-metal AFM system utilizing a quartz tuning fork sensor.

References

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