In situ observation of aggregation and dissolution of hematite nanoparticles using liquid cell transmission electron microscopy

JUAN LIU[1], ANXU SHENG [1], FENG LIU[1], ZHIWEI WANG[2], ZHONGLIN WANG[3]

[1]School of Environmental Sciences and Engineering, Peking University, Beijing, China, 100871

[2]Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences, Beijing, China, 100083

[3]School of Materials Science and Engineering, Georgia Institute of Technology, Atlanta, Georgia 30332-0245, United States

Hematite is one of the most widespread and stable iron oxide minerals in natural environment. The aggregation and dissolution of hematite nanoparticles are related to a variety of biotic and abiotic geochemical processes. A burgeoning technique, in situ liquid-cell TEM (LCTEM), makes it possible to visualize the dynamic process of nanoparticles in fluid, such as aggregation and dissolution, with sufficiently high spatial and temporal resolution. This study presents an in situ observation of aggregation and dissolution of 9 nm, 30nm, and 173 nm hematite particles in aqueous solution by using LCTEM. The results reveal the size, morphology, and motion of hematite aggregates. When mass concentrations were same, the aggregates of smaller nanoparticles were statistically more compact and slightly larger than those of the larger nanoparticles. Aggregates in all samples were typically nonspherical. The movement of clusters and the way for clusters to attach with other clusters are related to ionic strength and the size of clusters. The dissolution of hematite particles in different particle sizes under electron-beam irradiation is also reported. The dissolution process of hematite particles depends on particle size, the synthetic method, and crystal defects. This study not only presents the influences of particle size on aggregation state and dissolution, but also demonstrats that LCTEM is a promising method to link aggregation state to dynamic processes of nanoparticles. As a former Ph.D student of Dr. Mike Hochella., Jr., I have benefited from Dr. Brown's excellent studies, especially in nanogeosciences and environmental geochemistry, for many years. It will be my honor to participate in this symposium.