

Surface characteristics of magnetite nanoparticles synthesized by metal-reducing bacteria

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Biologically induced mineralization occurs beginning with metal adsorption to extracellular polymers (EPS) dominated by proteins or cell wall materials, followed by the nucleation of small metal hydroxide grains, and with sufficient time, the complete mineral formation. The microbially formed minerals show that their surfaces are coated with thin organic membrane and its origin is supposed from EPS and cell wall materials in previous studies [1, 2]. These microbially formed minerals have benefits for biomedical applications because of reactive functional groups on the organic membrane. Therefore, the objective of this research was to examine the surface characteristics of magnetite nanoparticles synthesized by metal-reducing bacteria.

The metal-reducing bacteria were enriched from inter-tidal flat sediments. The mixed culture of bacteria synthesized magnetite (Fe_3O_4) nanoparticles using akaganeite ($\beta\text{-FeOOH}$) as a magnetite precursor and glucose as an electron donor. Mineralogical characterization was performed by XRD and TEM-EDX analyses. FT-IR and XPS were used for surface chemical analysis of the synthesized magnetite nanoparticles.

The magnetite nanoparticles formed by the bacteria had around 10 nm size and spherical shape. The microbially formed magnetite was coated with organics containing an abundance of reactive carboxyl groups without any chemical process for functionalizing them. The results of FT-IR and XPS analyses showed that the binding states of the organic materials were chemically stable. These microbial processes may lead to a simple preparation of functional organic-magnetite nanoparticle complexes, and they can be useful materials for medical applications such as contrast agents for magnetic resonance imaging (MRI), enzyme and protein immobilization and drug delivery systems (DDS).

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Infrared and Raman shifts of calcite in the Kasuga contact aureole, southwestern Japan: An application for solvus geothermometer

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The calcite-dolomite solvus geothermometer is one of the widely used methods for the estimation of metamorphic temperature. The equilibrium Mg / (Mg+Ca) ratio of calcite (CaCO_3) coexisting with dolomite ($\text{CaMg}(\text{CO}_3)_2$) increases with increasing temperature. Systematic analyses of infrared absorption (IR) and Raman bands for solid solutions between calcite and dolomite have been studied (e.g. [1, 2, 3, 4]); however, not much has been attempted for the solvus geothermometry. We applied these calibrations for well-studied metamorphic limestones (metamorphic temperature: 400–630°C [5]) in the Cretaceous Kasuga contact aureole, southwestern Japan with using micro FT-IR and micro laser Raman spectrometer. IR and Raman bands of the ν_1 and ν_4 in calcite shift to higher wavenumbers with increase of metamorphic temperature (Fig. 1). Micro FT-IR and micro laser Raman spectrometry of calcite may be a powerful geochemical tool for calcite-dolomite solvus geothermometry.

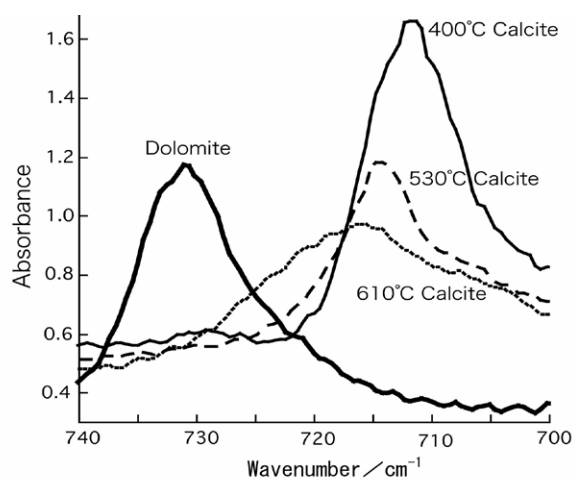


Figure 1: IR ν_4 spectra variations of calcite.

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