Abstract

Atomic force microscopy (AFM) and magnetic force microscopy (MFM) were employed to study the properties of individual biogenic magnetite nanoparticles (MNP). These MNP were extracted from bacteria. MNP in diluted aqueous suspensions were deposited onto atomic-level smooth substrates like mica. The substrates have been functionalized chemically in order to avoid MFM tip contamination by attaching particles during the measurements. AFM imaging shows that the size of single MNP ranges from 40 to 100 nm, while MFM imaging, combined with the result of modelling, indicates a smaller size of the magnetic core. The results are consistent with the existence of a membrane enclosing the MNP.

The magnetic properties of MNP have been studied in external magnetic fields and they are like those of single-domain nanomagnets. Moreover, we studied the capability of MFM to detect MNP fully or partly imbedded in a matrix. This is directly relevant to the task to find MNP in real biological tissue by MFM. A layer of spin-coated polymethylmetacrylate (PMMA) served as a matrix for MNP, which were previously deposited on the substrate surface. The imbedding depth can be precisely controlled by adjusting the PMMA concentration and other parameters. In this study, we observed the change of magnetic signals with imbedding depth and the maximum biological tissue thickness suitable for MFM investigation was determined.