X-Ray Diffraction Analysis of Magnetosomes from Magnetotactic Bacteria

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Magnetosomes are uniform, nanosized and membrane-enclosed magnetic crystals that have been used in many biomedical applications such as magnetic separation of biomolecules, drug delivery, early diagnosis and detection of pathogens, hyperthermia treatment of cancer cells and magnetic resonance imaging[1]. However, magnetosomes are impossible to be created by artificial magnetic particles[2]. Moreover, large amounts of high-quality magnetosomes are difficult to be produced, as magnetotactic bacteria only synthesize magnetosomes under microaerobic conditions with sufficient iron[3].

The *fur* gene plays an essential role in the formation of magnetosomes. Previously, we solved six high-resolution crystal structures of Fur protein complexes from magnetotactic bacteria in four different states[4]. Recently, we constructed many complementary strains of *fur* mutants. Transmission electron microscopy (TEM) results confirmed that all *fur* mutated strains except a modified F4M strain substantially reduced the size of formed magnetosomes with dispersed arrangement in irregular chains. Moreover, the modified F4M strain was more resistant to oxidative stress (H_2O_2 and streptonigrin), and was easily to culture at normal conditions. We also investigated the crystalline quality of magnetosomes produced by wild type and *fur* mutated strains using X-Ray diffraction. Several diffraction patterns corresponding to ordered and disordered states were observed. Inspection of structural characteristics revealed disordered layers of magnetosomes, i.e. stacking faults characteristics. All *fur* mutants except F4M caused random disorders between layers stacked along the *c*-axis. This gives more evidences that F4M strain seems to have a stronger ability to synthesize high-quality magnetosomes under normal condition, and X-ray analysis can be used to reveal the composition and three-dimensional arrangement of magnetosomes. Taken together, our results provide insights for engineering magnetotactic bacteria by structural approaches with potential applications.

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