Morphologies of calcite induced by bio-films secreted by *Bacillus cereus*

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Microbially induced carbonate mineralization is a research subject widely studied in the past decades. In this process, microorganisms secrete extracellular polymeric substances(EPS) to form bio-films, which carry negative charge and have the capacity to bind metal ions, so bio-films may provide effective sites for carbonate nucleation. Some studies have been discovered that bio-films secreted by microorganisms can induce carbonate precipitation. However, the mechanism of bio-films induced carbonate nucleation and growth are not well understood. Preliminary studies by our group, we found that *Bacillus cereus* secreted massive bio-films, and induced the formation of platform and sunflower-shaped minerals. We postulated that the formation of these mineral morphologies were close to bio-films. In order to better investigate the formation mechanism of crystalline morphologies with bio-films secreted by *Bacillus cereus*, crystal growth experiments of bio-films secreted by *Bacillus cereus* were conducted with using an ammonium carbonate free-drift method. Morphology and phase of the precipitates were determined by scanning electron microscope (SEM) and X-ray diffraction (XRD). The results revealed that calcite peaks were observed from 6 hours after experimental treatment to the end of experiments (72 hours). SEM images showed that the morphologies of calcite were mainly strawhat and disc-shaped at 36 hours. These crystals were mainly hemispherical and spherical at 48 hours, in addition to micron-size needle-like overall appearance of the crystal surfaces. The sunflower-shaped minerals were formed via aggregation and fusion of micron-size layered particles at 72 hours. These results showed that bio-films secreted by *Bacillus cereus* played important roles in calcite precipitation with complicated and unusual morphologies. Morphologies of the precipitates ranged from disc-shaped to hemispherical and sunflower. These findings may provide reference for better understanding the principles governing biomineral formation and the mechanism of biomineralization.