Biomaterials

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Calcite mineralisation of bacterial surface-layer proteins

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Biomineralization of bacteria plays a decisive role in geological mineral formation, e.g. large parts of Poland are formed by sedimentation of calcium carbonate giving rise to agglutinated colonies of bacteria [1,2]. In this work we investigated the mechanism of calcium carbonate deposition at the nanoscale on the surface-layer of the heat resistant bacterium Geobacillus stearothermophilus. The structure of the surface layer is composed of rhombohedral motifs at the nanoscale of different sizes. The surface of the isolated surface layer and also the complete bacterium was mineralized stepwise by calcium carbonate.

In our biomineralization experiments the S-layer serves as biotemplate and induces crystalline calcite coverage as indicated by the FFT analysis of the high-resolution TEM micrographs (Figures 1 and 2). The nucleation takes place at the corners of the rhombohedral motifs (unit cells) and extends over the interconnecting bars till the whole S-layer sheet is mineralised. Assumably, firstly vaterite nanocrystals are formed which by time are successively transformed to the more stable calcite crystal phase. The vaterite crystals are observed at the thin areas around the corners of the rhombohedral S-layer unit cell. On the corners and on the bars the crystallisation is advanced and thus only calcite is detected. The calcite crystals are 3-5 nm in size and follow the topography of the S-layer showing the (1-10) plane towards the substrate. At the bars the crystals are lying flat on the smooth surface in the same direction (oriented attachment) and at the corners they are standing up 60° or 75° due to the pyramidal form of the corner. These observations are in accordance with results of the synthesis of silicate layers on S-layers but stand in contrast with results of *Schultze-Lam et al.*, where a mineralisation starting in the pores was observed [3,4].

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2. M. Obst, M. Dittrich, H. Kuehn, Geochem. Geophys. Geosyst. (2006). 7, Q06011.
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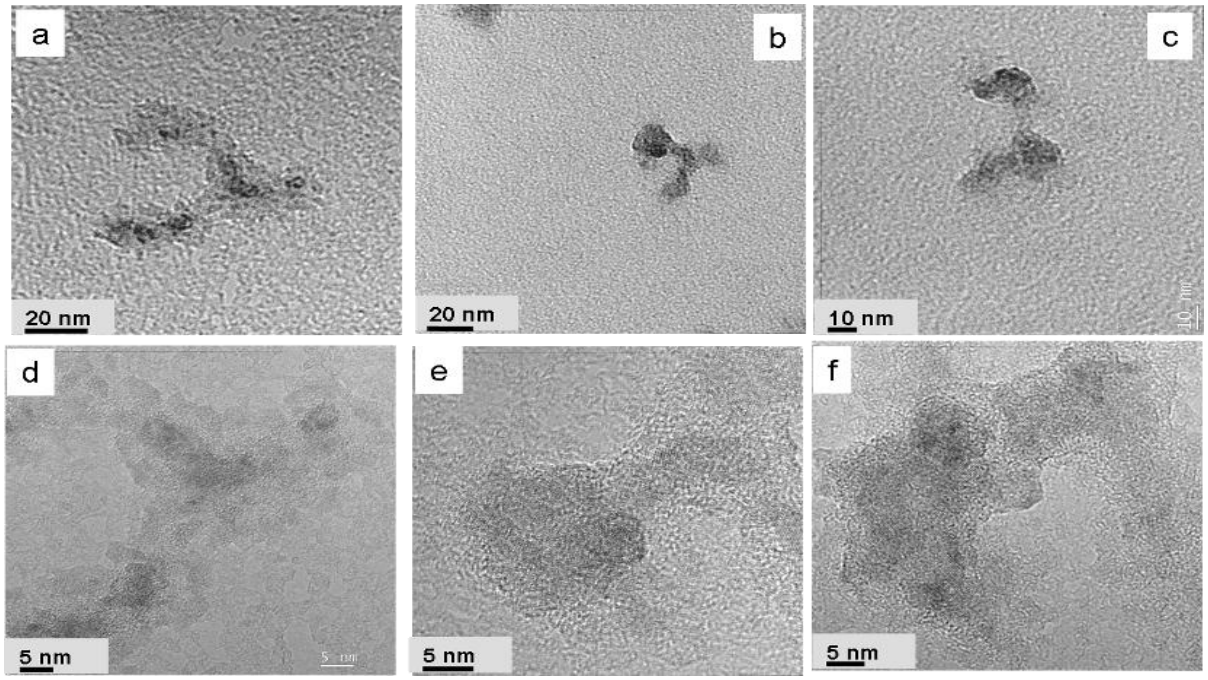

Figure 1.

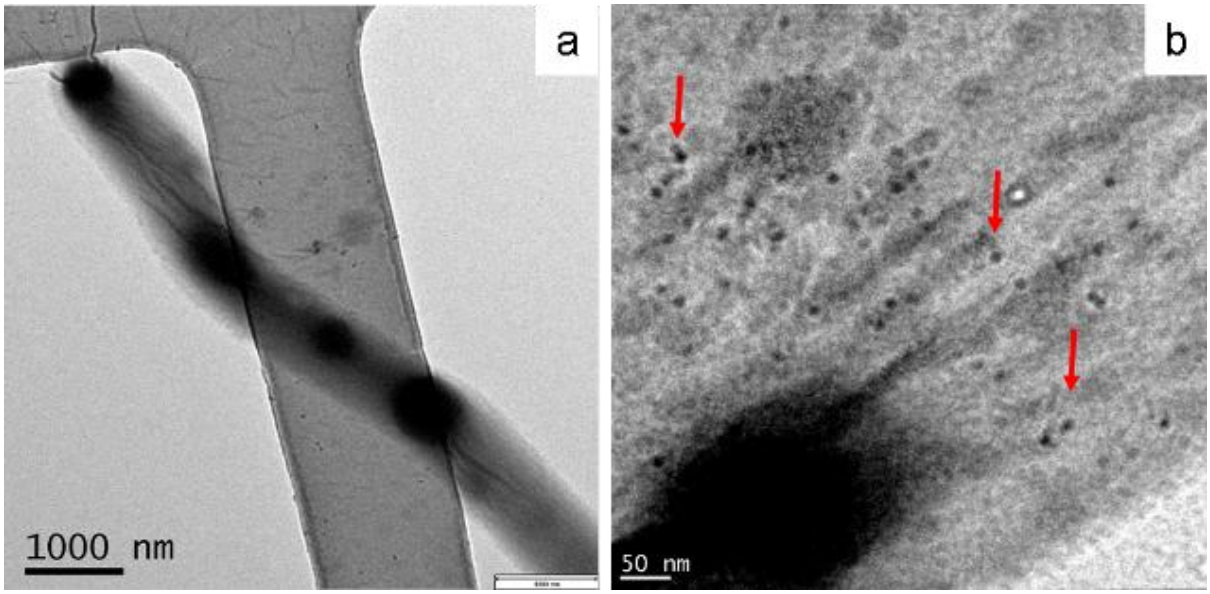

Figure 2.