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Electron Microscopy in Biomineral Research. W. W. Schmahl[α], E. Griesshaber[a], K. Kelm[b], A. Götz[a], W. Mader[c]. *[a]Dept. of Earth- and Env. Sci., LMU München, Germany. [b]DLR, Köln, Germany. [c]Inst. f. Anorg. Chem., Mater. Res., Univ. Bonn, Germany.*
E-mail: wolfgang.schmahl@lrz.uni-muenchen.de

Electron backscatter diffraction (EBSD) applied in a scanning electron microscope (SEM) is an ideal microdiffraction tool to determine crystallographic phase and crystallite orientation in the micro- and nanostructure of a polycrystalline or polyphase material [1]. We investigate the high level of hierarchical structural organization in the shells of marine organisms to study bio-controlled crystallization [2]. For example, in calcitic brachiopod shells, three types of material microstructures exist [3]: (i) nanocrystalline layers (with Vickers hardness exceeding that of inorganic calcite by 100% [2, 4]) , (ii) fibre composites with calcite single crystal fibres with [uv0] morphological axes, and (iii) material formed by columnar crystals with [001] morphological axes selected by competitive growth. The presence of these types and their structural details vary from species to species. All materials represent hybrid composits of the “inorganic” mineral phase and the “organic” biopolymer. Biopolymer films form an intercrystalline matrix and Transmission Electron Microscopy reveals that biopolymers are incorporated into the “inorganic” crystals [2, 5]. A composite architecture is applied hierarchically from the molecular to the macroscopic scale. This leads to excellent hardness and fracture toughness of the biomaterial compared to the pure inorganic phase. The organic matrix controls the morphology and microstructure during growth by compartmentalization of space in combination with growth selection. With the exception of selection of the inorganic phase, there is only counterevidence to the concept of “inhibitor” or “promotor” molecules involved in morphogenesis of the “inorganic” material or any epitaxial mechanisms for the selection of crystallographic orientation.

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