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The role of proteins and peptides in shaping the structure and microstructure of biogenic and biomimetic crystals

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In the course of biomineralization organisms form crystals which demonstrate superior characteristics as compared to their non-biogenic counterparts. One of the main reasons for this is that these crystals are actually hybrid nano-composites. In fact, each biogenic single crystal is not only encapsulated by an intercrystalline organic phase but in addition there are intracrystalline proteins within each individual single crystal. These proteins are the key players in the formation of biominerals and are vital in the precursor phase of their formation. I will show that both in biogenic and biomimetic crystals, these proteins have a major effect on their atomic structure and microstructure. This effect is in the form of lattice distortions which relax upon mild annealing. The distortions can be detected by means of high-resolution synchrotron diffraction. The activation energy of the relaxation of the lattice distortions is rather low and is comparable to the energy needed for protein unfolding. Furthermore, it will be shown that these intracrystalline proteins can stabilize metastable phases of calcium carbonate and even stabilize a previously unidentified twin law in calcite.