

Development of three-dimensional architecture of bone at the nanometer scale using X-ray diffraction microscopy

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We have studied the 3D spatial relationships of mineral crystals to the collagen matrix of Alewife herring bone by using X-ray diffraction microscopy for the first time. We performed nanoscale and stereo imaging of the mineral crystals inside collagen fibrils at different stages of mineralization. The origin and distribution of mineral crystals inside the collagen matrix has been identified. Based on the mechanism of biomineralization and our experimental results, we have developed a dynamic 3D structural model of bone to account for the nucleation and growth of mineral crystals in the collagen matrix with maturation of bone. The results obtained from this study will not only contribute to understand the complex 3D microstructures of bone, but also provide a basic principle with which to design and fabricate highly ordered organic-inorganic hybrid biomaterials.