

Nanostructuring of Biomaterials - A Pathway to Optimizing Bone Grafting

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Many medical situations call for a bone graft. Among them are fusions of the spine, fractures, gaps in bones caused by trauma or infection, and oral surgery. In a typical bone graft, a biocompatible material is shaped to fit the affected area. It provides a framework supporting the new tissue, blood vessels and soft tissue as they grow to connect fractured bone segments. In the talk we will show the latest achievements in the development of NanoBone[®] biomaterial - a nanocomposite mixture of silica gel and hydroxyapatite, and how small and wide-angle x-ray scattering and TEM are used to characterize the material's structure and, hence, gain a control over material's biomedical properties.

Silica gel is an incomplete linkage of polysilicic acid. It is characterized by numerous open bonds which are always SiOH groups or SiO⁻ groups (depending on the pH value). Owing to these open bonds, the internal surface of the material is extremely large. This inner surface is 84 sq.m./g in size. The pores in the silica gel have a maximum in pore sizes ranging from 10 nm to 20 nm and are interconnecting.

The produced HA is identical to biological HA, which is characterised by 3 nm thick plates with a diameter of 40 nm. Powder diffraction documents that the temperature dependent crystal growth of the embedded HA is different from the pure powder.

SAXS and WAXS are used to characterize the structure of the gel matrix which determined the biological properties of the material.

Short time after implantation the silica gel was degraded and replaced by an organic matrix. Ultrastructurally, the matrix appeared amorphous with only single collagen fibrillae. Histological and immunohistological methods indicated the presence of carbohydrates and the bone proteins osteopontin, osteocalcin and BMP-2.