

Bone Formation on Permanent and Transient Implants

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INTRODUCTION: The surface state of an implant has substantial influence on the bone apposition and, therefore, on the functionality and stability of the implant. Calcium phosphate surface coatings (BONIT[®]) give rise to bioactivity of metallic implants by stimulating a rapid contact osteogenesis and thus supporting the healing process. In case of bone defects the efforts are focussed on filling the gap with a synthetic bone graft substitute the structure of which is highly similar to natural bone. The bone graft substitute BONITmatrix[®] mainly composed of a highly porous calcium phosphate network not only fulfils this requirement but also completely degrades during reossification until the new bone has replaced the graft. Both biomaterials stimulate the body to form new bone and are fully resorbed during healing. The structural properties and the resorption behavior of these osteoinductive biomaterials are discussed as well as their mode of action in vivo.

METHODS: Structural characterization was performed by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) of surfaces and microtome slices, respectively. The composition was analyzed by energy dispersive X-ray spectroscopy (EDX) and atomic emission spectroscopy (AES). The solubility of the BONIT[®] coating was studied at 37 °C in 0.05M Tris-HCl-buffer (pH=7.3) [1], the cumulative release of calcium from BONITmatrix[®] was investigated in the same buffer.

RESULTS & DISCUSSION: Fig. 1 shows a SEM micrograph of the BONIT[®] coating on the surface of an implant (left). The alignment of the BONIT[®] crystal platelets nearly perpendicular to the surface enhances ingrowth of new bone into the porous implant surface and provides excellent capillarity, i.e. high capability for the immobilization of growth factors from the blood. The coating is mainly composed of brushite with small additions of hydroxyapatite. Chemically BONIT[®] represents a compound that is very similar to pre-stages of bony calcium phosphates during mineralization. The BONIT[®] coating increases the bone to implant contact area

(Fig. 1, right) and is completely resorbed by the body within 6 - 8 weeks.

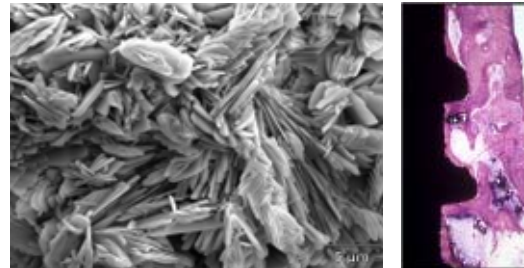


Fig. 1: BONIT[®] morphology (left) and new bone apposition on a BONIT[®] coated dental implant (pink stained, right).

In Fig. 2, the blue colored regions indicate a rapid multicentric formation of new bone within the interconnecting pores of the degradable bone graft substitute BONITmatrix[®].

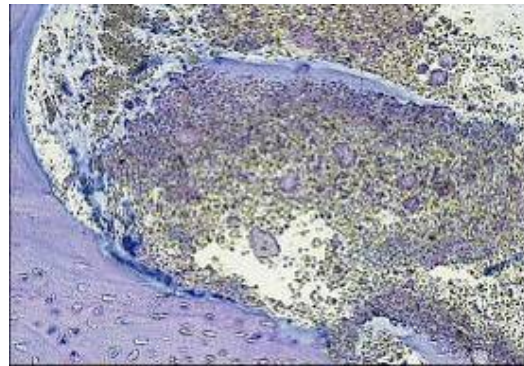


Fig. 2: Bone formation (blue) in BONITmatrix[®] (after 4 months)

BONITmatrix[®] consists of a porous network of hydroxyapatite and tricalcium phosphate (weight ratio: 60/40) glued with a silica xerogel. The biomaterial has a high porosity of 60% ± 5% due to interconnecting nano- and micro-pores which produce an internal surface of 100 m²/g [2]. It induces a rapid reossification of the defect whereas simultaneously the material gradually degrades. After 8 months the biomaterial is completely replaced by new autologous bone.

REFERENCES: ¹ P. Ducheyne (1990) *Biomaterials* **11(8)**: 540. ² R. Böttcher, P. Becker, V. Bienengraber, H.-G. Neumann (2004) *Biomaterialien* **5-S1**: 14.