from different complex materials with scanning microbeam SAXS/WAXS. Results from the imaging of nanostructural parameters such as shape, size and orientation of nanoscale inhomogeneities in bone and other hierarchical biocomposites are presented. Moreover, a unique combination of *in-situ* bending deformation with X-ray nanobeam scanning is demonstrated for single carbon fibres.

Keywords: bone, carbon materials, small-angle scattering

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Engineered Bone from Bone Marrow Stromal Cells: a Structural Study by an Advanced X-ray Microdiffraction Technique

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One of the most recent therapeutic strategies for the reconstruction of damaged large bony segments includes the tissue engineering approach. It takes advantage of the patient's own cells, which are isolated, expanded in vitro, loaded onto a bioceramic scaffold and reimplanted into the lesion site. Bone marrow stromal cells (BMSC) are the most commonly used cell type.

A structural characterization of the engineered bone is largely desirable. An important point is to evaluate if the BMSC extracellular matrix deposition on a bioceramic scaffold recapitulates the ontogeny of the natural bone development. Moreover the investigation of the interaction between the newly deposited bone and the scaffold results particularly interesting. Indeed the chemistry and the geometry of the scaffold used to deliver BMSC in the lesion site determine spatial organization of the new bone and the bone-biomaterial integration.

We investigated for the first time the local interaction between the newly formed mineral crystals in the engineered bone and the biomaterial by means of microdiffraction, using a set-up based on an X-ray waveguide. We demonstrated that the newly formed bone is well organized inside the scaffold pore, following the growth model of natural bone, and that there is a good adhesion with the scaffold. Combining Wide Angle (WAXS) and Small Angle (SAXS) X-ray Scattering with high spatial resolution, we were able to determine the orientation of the crystallographic c-axis inside the bone grains, and the orientation of the mineral crystals and collagen micro-fibrils with respect to the scaffold. Moreover from a quantitative analysis of both the SAXS and WAXS patterns the grain size appears to be compatible with the model for early stage mineralization.

Keywords: SAXS, WAXS, bone mineralization

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Polychromatic Microdiffracion Measurements of Mesoscale Structure and Dynamics

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Polychromatic x-ray microdiffraction combined with differential aperture microscopy is a powerful new method for studying the local crystallographic structure of materials. This approach extends single-crystal methods to virtually all materials including materials characterized by heterogeneity at the atomic *and* mesoscopic length scales. Defects such as grain boundaries, surfaces, precipitates, second phases, strain, dislocations, vacancies, interstitials, site substitutions and other disruptions of perfect periodicity all have signatures best studied using single crystal methods. Here we describe emerging x-ray microbeam techniques that exploit "single-crystal like" x-ray diffraction measurements on subgrains in typical polycrystalline materials. We show how polychromatic and tunable monochromatic measurements on small sample volumes can bring single-crystal techniques to real materials and reveal their atomic and mesoscopic defect structures. This emerging revolution in materials science is certain to address long-standing issues of materials behavior.

Keywords: phase, texture, strain

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SR X-ray Microdiffraction Systems at SPring-8: Present Status and Applications

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In Hyogo beamline of SPring-8, we are developing research programs using an x-ray microbeam for applications to the wide range of science. Two types of the x-ray microbeam system have been developed; one is for a high spatial resolution and the other is for a high angular resolution. The former uses a Fresnel zone plate (FZP) for the x-ray focusing element, and the sub-micrometer beam is available [1]. By adopting a narrow slit in front of the FZP, a microbeam with a relatively small angular divergence can be also available [2]. The system is used, for example, for measurements of strain distribution in laser diodes with a è-2è diffractometer and structural analysis of polymers with a diffractometer using imaging plate detectors. The smallest beam size ever achieved is 70 nm in FWHM at 10 keV. The latter system uses a total reflection focusing mirror with a bent-cylindrical shape and the microbeam possesses very a small angular divergence of several arcsec with the beam size of a few micrometers [3]. The system is used for the estimation of local crystallinity of various semiconductor crystals for electronic devices. The both systems are opened for many kinds of users.

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Keywords: synchrotron radiation instrumentation, synchrotron X-ray diffraction, X-ray microanalysis

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Hard X-ray Nanoprobe with Refractive X-ray Lenses

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A hard x-ray nanoprobe based on refractive x-ray lenses allows one to apply hard x-ray analytical techniques, such as diffraction or fluorescence analysis, with high spatial resolution. This is particularly useful to investigate heterogeneous samples in materials, environmental and life science.

Using nanofocusing lenses (NFLs) [1-2], a nanobeam with a lateral extension down to 50 x 50 nm^2 is currently feasible at third generation synchrotron radiation sources in the hard x-ray range. The beam divergence of about 1 mrad is sufficient for many diffraction experiments. The beam size can be expected to be reduced to below 10 nm in the future [3].

We report on nanodiffraction experiments in materials science performed at beamline ID-13 of the ESRF. The coherence properties of the nanobeam are discussed in view of diffraction from small objects with coherent radiation.

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