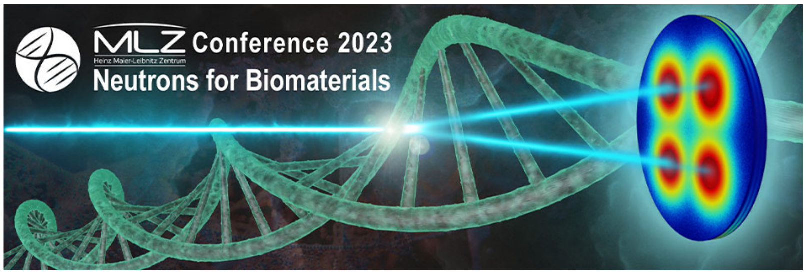

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Studying the bone-implant interface in 3D using X-ray scattering and imaging

Magnesium (Mg)-based implants are in the focus for orthopedic applications, due to their biocompatibility and biodegradability. Depending on the alloy, the degradation behavior and integration into the bone will differ. To elucidate this complex interplay which affects all hierarchical levels of bone, synchrotron radiation-based scattering and imaging techniques are used. Specifically, we have studied implants made of pure Mg, a rare-earth containing Mg-alloy (WE43) and titanium (Ti) implanted in rat bone using 3D X-ray diffraction tomography (XRD-CT) and high-resolution X-ray absorption tomography (μCT). Thus, we were able to observe differences in the volume loss and degradation rate of the implant, as well as the bone growth and its crystalline ultrastructure. The crystallite size and crystal lattice spacing of the bone surrounding pure Mg are lower than surrounding WE43, which is inversely related to their degradation rates. The information resulting from the X-ray scattering and imaging experiments is pivotal to establish and calibrate computational models of implant degradation and bone growth, in order to predict the behavior of implants that will be developed. In the future, complementary neutron-based characterization techniques could be used to enable in situ mechanical testing without impacting its mechanical properties due to radiation damage.

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