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X-ray scattering methods to image bone healing around bio-resorbable implants

In recent years, bio-resorbable magnesium implants have gained interest as treatment options for bone fractures. Their advantages include their mechanical properties, their excellent immunological response during healing, and the reduced need for a second intervention to remove the implant. In this study, we wanted to understand the behavior of bone around Mg biodegradable implants and the impact that physical training has on bone healing and mineralization.

X-ray scattering techniques are well suited for this application as they probe structural information on materials with features on the nanometer scale. Small-angle X-ray scattering (SAXS) can yield information about the changes in orientation of bone nanostructure. Small-angle scattering tensor tomography (SASTT) can provide spatially resolved 3D anisotropy information [1]. By combining both techniques, we can obtain 3D information and mitigate SASTT's significant sampling requirements, improving both statistics and spatial resolution.

With the use of these two techniques, we have been able to characterize the role training plays in healing and remodeling of bone around ultra-high purity (XHP) Mg implants. Our measurements suggest that physical training leads to a higher degree of orientation of hydroxyapatite (HA) in bone and found that training might lead to a quicker response of the bone metabolism. These results are highly relevant for understanding degradable implants' behavior and are expected to be of clinical significance in the treatment of bone fractures.

[1] M. Liebi, M. Georgiadis, A. Menzel, P. Schneider, J. Kohlbrecher, O. Bunk, M. Guizar-Sicairos (2015) Nanostructure surveys of macroscopic specimens by small-angle scattering tensor tomography. Nature 527(7578):349–352. Doi: 10.1038/nature16056

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