Elemental imaging on biodegradable orthopedic implants by μXRF

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The idea behind biodegradable orthopedic implants is to support the healing bone, enabling and promoting newly formed healthy tissue to steadily replace the implant. In this regard, studying the processes of implant degradation and the mechanisms of migration/incorporation of the implant' constituents into the bone tissue is of high priority. μXRF analysis perfectly serves the purpose, allowing determination of spatial distribution of elements in the sample on micrometer scale.

The low power μXRF setup at Atominstitut is tailored for detection of low-Z elements: Rh-low power tube (20W); 30mm^2 Si(Li) detector, LN_2 cooled, with ultrathin polymer window (UTW); operation under vacuum conditions - which is suited for analysis of magnesium, the main component of the implant alloy. To focus the primary beam on the sample a polycapillary optics (full lens) was used; another x-ray polycapillary optic (half lens) was inserted in front of the detector in confocal configuration allowing depth resolution. The beam size determined for Cu-Kα - 50x50μm^2, and 50x50x50μm^3 in confocal set-up.

The samples of rat bone tissue with implanted pins, made of biodegradable alloy, were collected at given time points between 1 and 18 months after implantation, and thin sections (range of 150-550μm) were then embedded into PMMA. The scans were performed in the areas, engaging the interface implant/bone and surrounding bone tissue.

The obtained elemental maps in non-confocal and confocal setups, as well as linescans of magnesium and yttrium (the constituents of the implants) and calcium (the primary mineral component of the bone), provide us with the relevant information on the degradation process.