X-ray computed tomography

X-ray computed tomography (CT) is a nondestructive method for imaging of inner structure of materials. The sample is placed between the X-ray tube and the detector. A lot of projections from different angles of rotation of the sample are recorded. From these projections, slices through the sample are reconstructed to get 3D data. Grey values in slices correspond to linear attenuation coefficient of material.

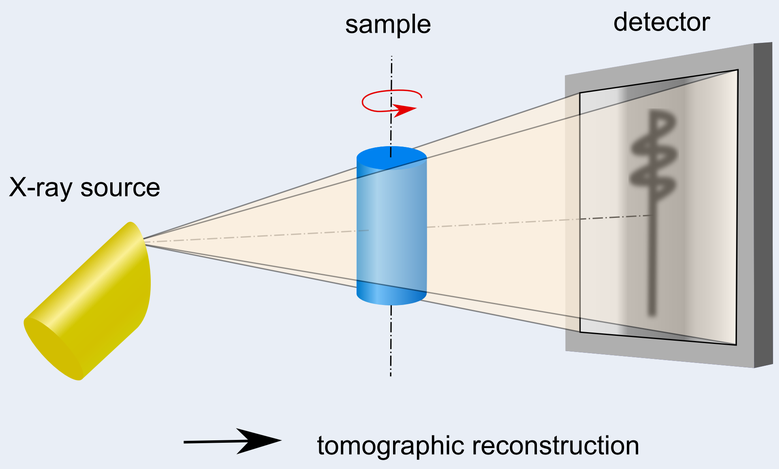

Figure 1: Scheme of X-ray computed tomography setup.

CT scan of an object visualizes its inner structure. It is possible to get a slice through an object in arbitrary direction. Based of different X-ray attenuation, and therefore different grey levels of various structures in CT data, it is possible to segment and further analyze these structures. Apart from visualization, analyses such as pore analysis, wall thickness analysis, and dimensional measurements can be carried out.

Figure 2: Meteorite found near Zdar nad Sazavou.

Geology

In the figures, there is a meteorite, classified as a chondrite, which fell near Zdar nad Sazavou, Czech Republic, on December 9, 2014 and was found on May 2, 2015 [1]. Tomographic scan of the meteorite shows different phases of material: matrix, troilite, metals. These information help with classification of the meteorite.
From knowledge of volumes and distrubution of air voids and air cracks we are able to deduce a degree of erosion and weathering.

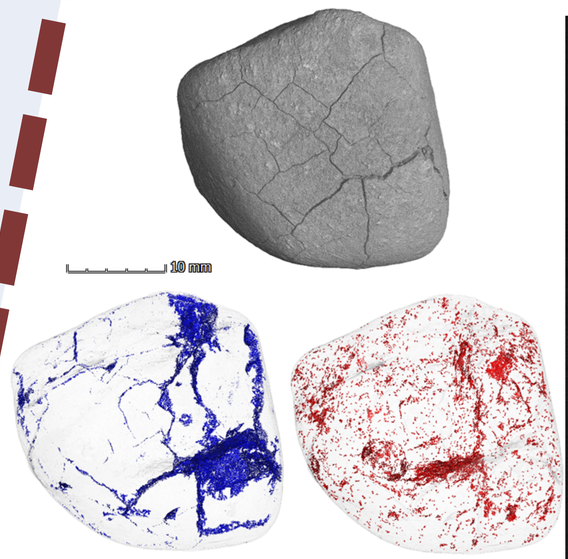

Figure 3: 3D render of CT scan of meteorite. Blue colour represents air cracks, red colour represents air voids.

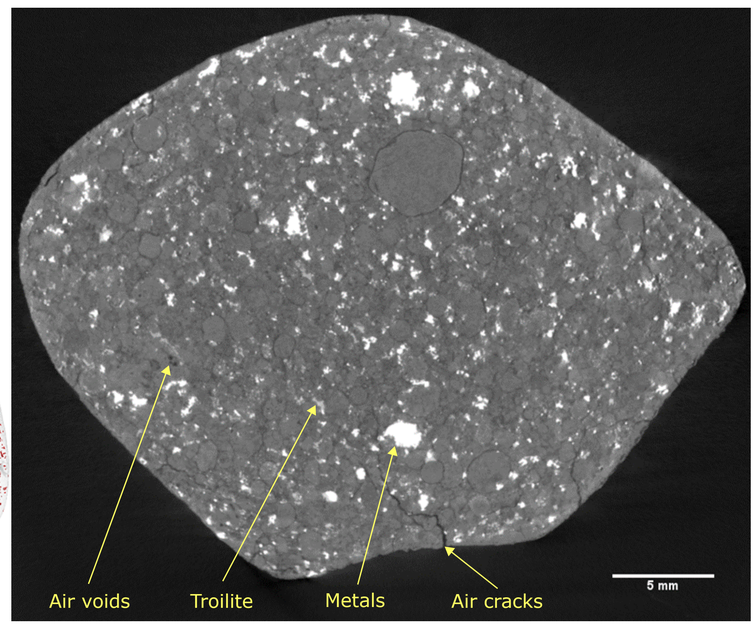

Figure 4: Tomographic slice of meteorite with description of different phases.

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X-ray computed tomography for inspection of inner structure of materials

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Tissue engineering

Scaffolds based on biopolymers are useful for tissue engineering application. They have complex porous structure employed for cell seeding and subsequently, for creating a tissue replacement for bones and tissues. Therefore, imaging of these scaffolds is neccessary for the study of their structure and morphology. Since biological tissues have usually low contrast in X-ray region, a staining with the contrast agent such as ceramic hydroxyapatite microparticles, silver ions or silver nanoparticles [2] is used.

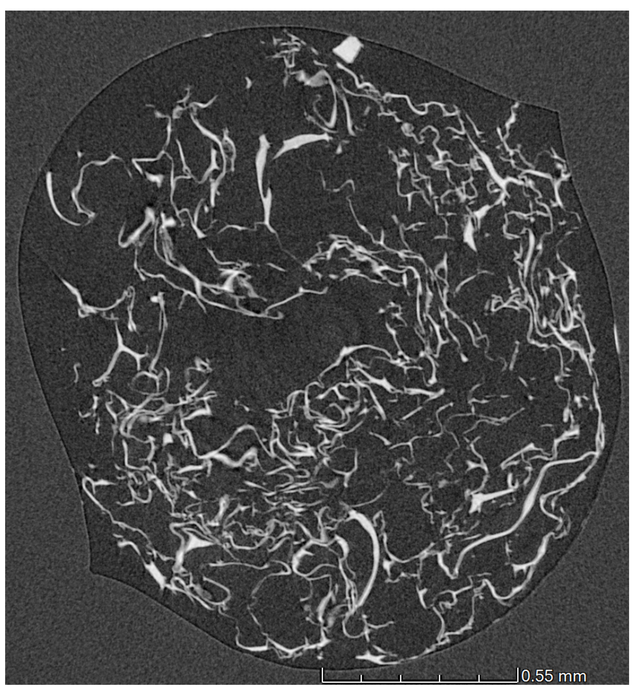

Figure 5: Tomographic slice of a collagen-based scaffold suitable for cell-seeding.

Figure 6: 3D render of collagen-based scaffold. CT allows visualization and inspection of such a complex, intricated structure.

Civil engineering

Composite reinforcement (FRP) intended for the concrete structures is a heterogenous material consisting of two basic components - a load-bearing component in the form of unindirectionally oriented fibres and a binder composed of a polymer matrix [3]. Main features and benefits of FRP cover its chemical and corrosion resistance, thermal and electrical non-conductivity and electromagnetic transparency.
CT can be used to control an outcome of manufacturing process. It shows fibre distribution and reveals air voids in the structure. The volumes of matrix, fibres and air can be quantified and compared to original manufacturing values.

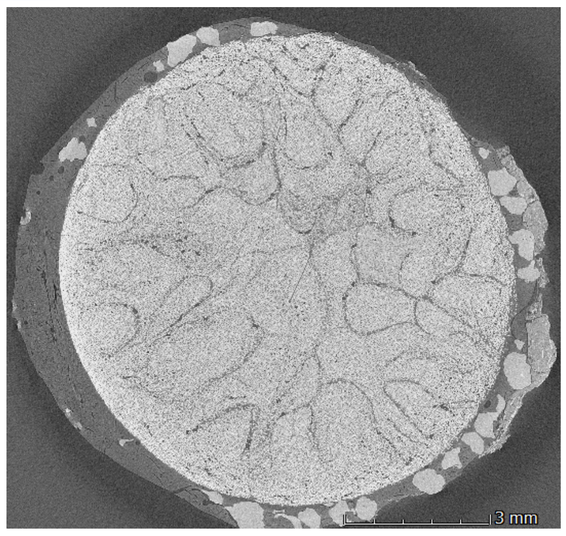

Figure 7: Transversal tomographic slice of FRP rod. Fibres are not distributed uniformly, but they form clusters.

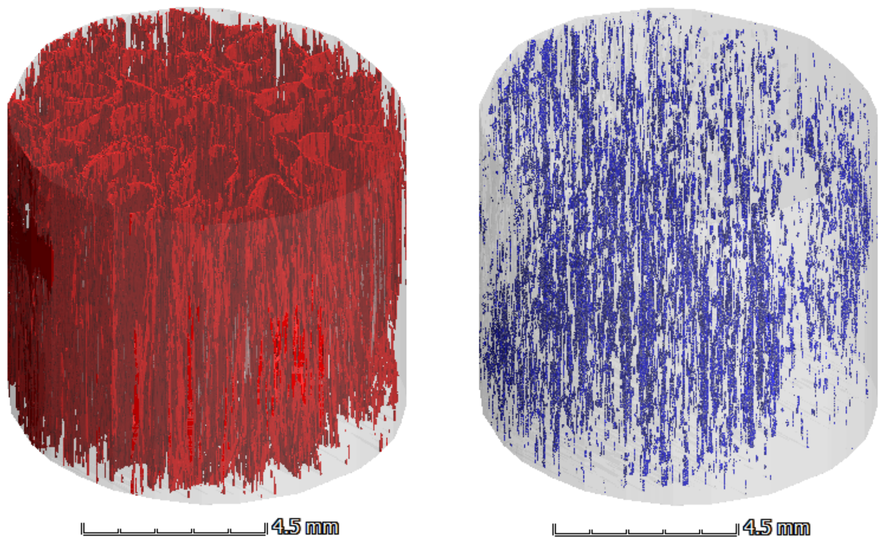

Figure 8: 3D transparent render of an FRP rod. Red colour represents space between fibre clusters, blue colour represents air voids within the rod.

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[2] Žídek, J., et. al., Accurate micro-computed tomography imaging of pore spaces in collagen-based scaffold, J MATER SCI-MATER J, 2016, 27(6), 1-18. ISSN: 0957-4530.
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