The Measurement & Characterisation of Porous Coatings Through XCT And the Influence of Voxel Size Choice.

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Abstract

The aim of this study was to investigate the effects a change in voxel size has on the functional characteristics of a porous surface. Porous coatings have been utilised across numerous fields, including the biomedical field where they have been exploited for their osseointegration potential. In order to analyse and characterise this surface type, where re-entrant features are present, the use X-ray Computed Tomography (XCT) is dictated thusly. Traditional amplitude parameters, often used to solely characterise a surface rely on the surface exhibiting line-of-sight features. This renders the use of amplitude parameters unsuitable for porous coatings and those produced through additive means, due to the decision of where to place a mean plane. The application of metrological filters also imparts negative effects on the re-entrant features, effectively removing them. To negate these negative complications, functional volume parameters and topographical surface areas have been used for the comparative study of the sample at differing voxel sizes.

For the study, Titanium alloy (Ti6Al4V) coupon samples (12.7mm diameter, 3 mm average thickness) were used. These incorporate a porous plasma sprayed top coating with turned machining marks on the underside. A unique identifier marking is present. These elements were utilised to ascertain the effects at different scales the effect of voxel size choice. Scans were completed on the Nikon XTH 225 industrial and Nikon MCT 225 metrology machines. With surfaces extracted and analysed. The results of this study showed significant differences in the obtained topographical surface area and values for the amplitude parameters of the machining artefacts. The surface decreased from 883 mm^2 to 471 mm^2 for voxel sizes 8 µm and 76 µm, respectively. The measured average surface roughness (Sa) decreased for the same voxel size choice. Visible differences are apparent on the extracted surfaces with the form of the coupons exhibiting noticeable changes with the unique identifier being only visible at a resolution below 25 µm s.

Although these findings may seem intuitive, it highlights the importance of selecting an appropriate voxel size without the compromises that come along with this. The functionality of the surface and scale of interest should be the deciding factor in selecting appropriate parameters for XCT, where a lower resolution may be more appropriate if larger scale analysis is required.

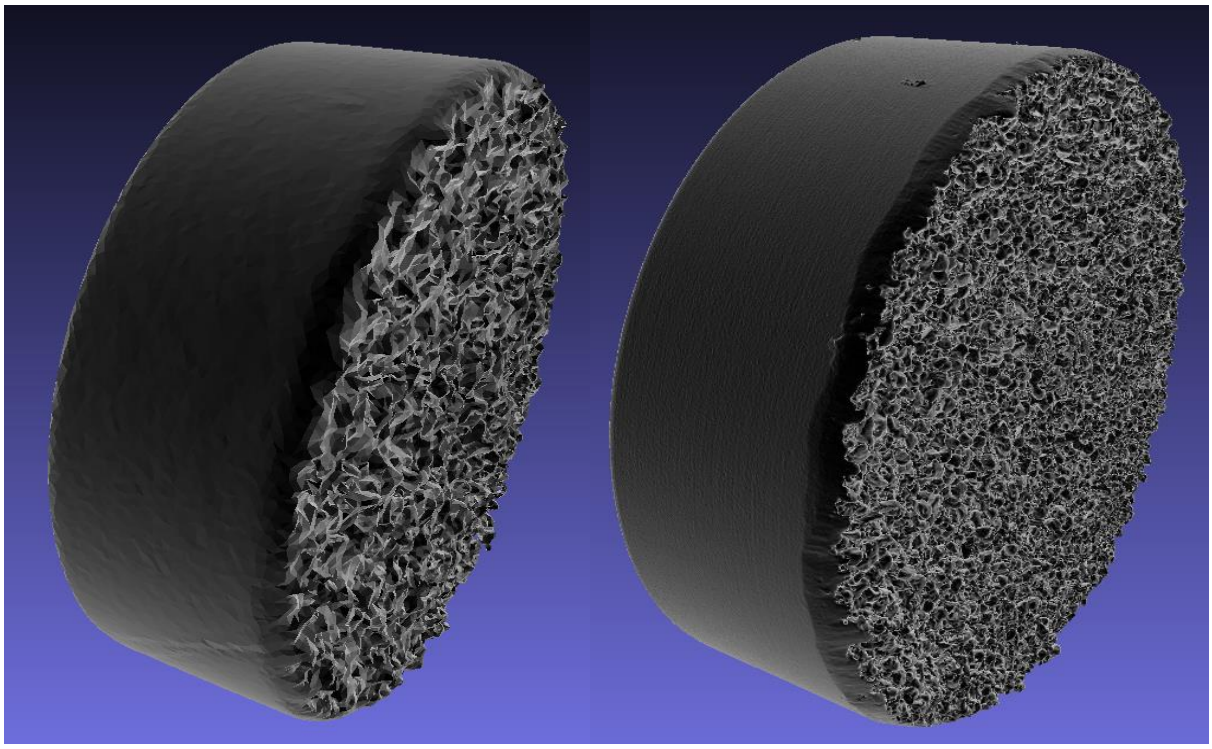

Figure 1 – Porous titanium Sample, captured at 76 µm (left) and 8 µm (right) voxel size on Nikon MCT 225.