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Data Constrained Modelling with multi-energy X-ray computed microtomography to evaluate the porosity of plasma sprayed ceramic coatings

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Coatings of the materials zirconium boride (ZrB2) and hydroxyapatite (HAp) underwent X-ray micro-Computed Tomography (X-ray μ-CT) scanning at the Australian Synchrotron. The Data Constrained Modelling (DCM) approach was used to reconstruct 3D models and assess porosity and void distributions. The results from the 3D analysis were compared to a 2D porosity and void distribution assessment, determined from image analysis of the coatings. It was found that the 3D and 2D porosity quantifications were in moderate to good agreement. The 3D porosity determined from the ZrB2-1 model, 24.7%, was within the range determined from 2D analysis, 22.1 ± 2.6%. Alternatively, the 3D porosity determined from the HAp-1 model, 22.8%, was marginally greater than the determined 2D porosity, 19.8 ± 2.1%. However, a comparison of the 2D and 3D void distributions revealed that a 2D assessment poorly predicts the 3D microstructure of coatings and cannot be used to infer properties strongly dependent on the 3D void network. Furthermore, the 3D analysis demonstrated the deficiencies in typical CT segmentation methods applied to data with a moderate CT resolution size of 5.4 μm. The DCM methodology can quantify fine-structure details below the resolution of the performed CT and thus assess the multi-scale porosity and void networks within atmospheric plasma spray (APS) deposited coatings. The superior DCM approach enabled the quantification of pores below the CT resolution limit and revealed that approximately 91.5% and 81.0% of the ZrB2-1 model and the HAp-1 models, respectively, would not have been accurately modelled using typical CT segmentation methods.

Level of Expertise

Student

Presenter Gender

Man

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He/Him

Which facility did you use for your research

Australian Synchrotron

Students Only - Are you interested in AINSE student funding

Yes

Do you wish to take part in the Student Poster Slam

Yes

Condition of submission

Yes

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