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Abstract title	**Characterisations of microstructure and residual stress in a customised cranial implant produced by Additive Manufacturing from commercially pure (CP) titanium**
Theme	Advanced characterisation
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Session	Poster (A1 Size)

Abstract *(max 400 words)*

Additive manufacturing (AM) is a promising alternative technique to traditional forging and forming processes. Owing to its versatility in making complex parts, AM is an attractive technique for medical applications and hence of a great interest for both engineers and physicians. This is primarily because a 3D model of a part with required dimensions and geometry can be made considering fine details of a patient's anatomy and specifics of surgery. Given the level of maturity of the traditional manufacturing processes, there are still areas to be improved to make the manufacturing more efficient and cost effective, for example by using AM instead. Characterisation of the final material is very important to understand the gain.

The objective of this work is to obtain detailed knowledge of microstructure, mechanical properties, and residual stress (RS) distribution in custom made craniofacial implant produced by AM (Fig.1). For these analyses, electron backscattered diffraction (EBSD), optical microscopy, XRD, hole-drilling based on electronic speckle pattern interferometry (ESPI), micro-hardness tester as well as GOM ATOS were used.

The microstructure of the AM material was found to be drastically different from that observed for sheets produced by traditional industrial technique (i.e. rolling). It was presented by α colonies and α laths, as expected result of complete β→α transformation. Homogeneous microstructure consisted of coarse mm-scale grains along with relatively smaller grains of 1 – 100 μm**Error! Reference source not found.**. The grain size exceeded the average size of a deposited layer of material (~ 50 μm) significantly, suggesting the presence of epitaxial grain growth, well known characteristic of AM process [1].

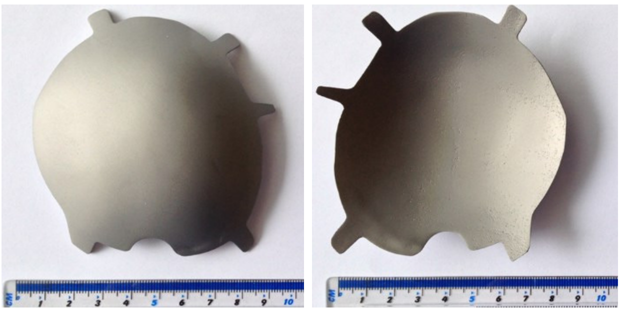
Stages of microstructure transformation during the manufacturing process were specified. The crystallisation of β phase was strictly oriented and resulted in texture, which led to variant selection during phase transformation [2]. Despite some grain boundaries exhibited local bulges indicating the progress of

recrystallization, the number of fully recrystallized grains was negligible, as ~ 95% of the analysed areas were substructures. The microhardness distributions and compressive RS were found to be homogeneous throughout the sample (Fig. 2).

The obtained results improved the existing knowledge of microstructure and properties in cranial implants made by AM, and will be useful for further application.

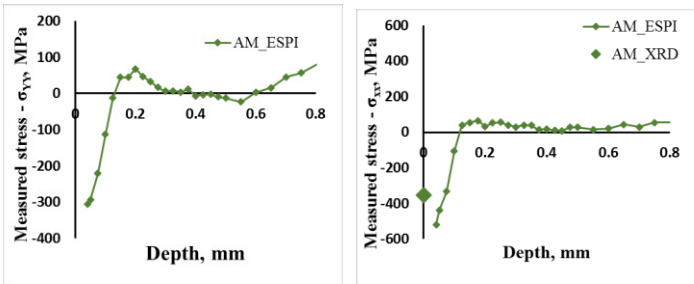
[1] Al-Bermani S.S, Blackmore M.L, Zhang W, Todd I. Metall Mater Trans A, 2010, 41A(13) 3422–34.

[2] Burgers W.G. Physica, 1934, 1 (7-12) 561-586.



front *back*

Fig. 1. Cranial implant.



parallel to build direction *perpendicular to build direction*

Fig. 2. RS measurements.