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Hierarchical biomimetic porous tantalum fabricated by liquid metal dealloying for biomedical applications

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Robust biological activity and rapid osseointegration plays an important role in implant stability and fixation in order to deliver better surgical outcomes for patients. Hence, closely mimicking the topological features of natural human bone can lead to greater osseointegration at the bone-implant interface. Here, we have introduced a selective corrosion based method to synthesise a multi-scale open porous surface coatings via liquid metal dealloying and microstructure control. Liquid metal dealloying offers a versatile method to rapidly produce unique hierarchical surface coatings with tuneable porosity, ligament structure and layer thickness. This is demonstrated by creating a number of open porous Ta coatings with nano-to-micro scale microstructural characteristics by dealloying in liquid Bismuth melt. The effect of precursor microstructure, composition and processing conditions on the ligament structure and coating thickness were discussed in detail. The resultant porous structure due to the careful control of the precursor composition and microstructures presents a hierarchical morphology with bimodal pore distribution, which results in a higher porosity and surface-area-to-volume ratios. The porous coatings achieved in this work consists of bimodal porosity with interconnected nano-porosity within the range of 70-500 nm and micro-scale porosity, ranging from 1-10 □m, which is driven by precursor microstructure control. The effect of temperature, immersion time and grain-boundaries, and its effect on dissolution, ligament coarsening and stability of the coatings are also discussed in detail. Overall, the liquid metal dealloying process provides a rapid fabrication process for designing multi-scale hierarchical porous structures with tuneable functionality.

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