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P4.107 Additive manufacturing for realising a tailored tungsten-copper composite plasma-facing component heat sink

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Tungsten (W) is a refractory metal foreseen as plasma-facing material in future magnetic confinement fusion devices. Furthermore, W containing metallic composite materials, such as W particle- or fibre-reinforced composites, are currently regarded as promising advanced materials to enhance the performance and integrity of highly heat loaded plasma-facing components (PFCs). In principle, W is an intrinsically hard and brittle metal which means that the processing of W is rather difficult. That is also the reason why only rather simple geometries, e.g. flat tiles or monoblocks, are typically used for W armour parts in PFCs. Against this background, additive manufacturing (AM) could be a highly versatile approach for the realisation of W parts for PFCs. The characteristic feature of AM processes is that three-dimensional objects are created by sequential layerwise deposition of material under computer control, which implies that such a technology is capable of producing objects with more or less arbitrary shape. Within previous work, it was found that bulk pure W can be consolidated directly by means of powder bed based selective laser beam melting (LBM) with a rather high relative mass density (> 98%). The present contribution will summarise recent progress regarding the AM of pure W by means of selective LBM for material fabricated with preheated W substrates (up to 1000℃) in order to minimise the formation of crack defects within the deposited material. Additionally, it will be shown how the possibilities of AM technologies can be exploited for realising tailored W structures that can further be processed to structures with potentially superior layout compared to classical reinforced composite materials. Finally, results regarding the manufacturing and high heat flux testing of a PFC mock-up that makes use of such a tailored tungsten-copper composite material heat sink will be presented.

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