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Investigation of Additively Manufactured Copper Synchrotron Radiation Absorber for the Future Circular Collider

Future Circular Collider (FCC-ee) is a proposal for 92 km circumference double ring which would generate 50 MW/beam of synchrotron radiation (SR) power. Design studies call for the SR fan to be intercepted every ˜5 m with localised absorbers. Compared to the continuous design (in which the synchrotron radiation absorber (SRA) channel is located all around the beam pipe), this layout is advantageous due to faster conditioning of the vacuum chambers, lower material and manufacturing costs. The proposed SRA design uses turbulent water flow to remove generated heat. The use of additive manufacturing (AM) was chosen due to the ability to achieve complex structures in shorter time and with lower material consumption, compared to traditional manufacturing techniques (such as extrusion or casting) making it ideal for SRA production. The 95 mm SRA prototype and specially made samples were produced and examined computed tomography (CT), 3D scans, roughness, tensile, density, hardness tests, scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX). The AM process produced a part, which, according to 3D scan inspection, reflects geometry within approximately 0.3 mm deviation from model, shrinkage was observed, this should be accounted for during blueprints preparation. CT scan verified the inner channel vein is approximately 0.5 mm in width. Copper tensile samples have yield strength of 100 MPa, which is below that required of initial design, and similar to 1/8 hardened copper, this is consistent with other mechanical characteristics and to the measured hardness of approximately 72 HV0.1 kgf. The piece exhibits high density >95%, which decreases the risks of mechanical failures during exploitation. Further tests, such as He leak testing and thermal transfer efficiency calculation, are necessary to validate the part and manufacturing method for use in accelerator.

Type of contribution

Poster

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