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Additive Manufacturing of niobium for superconducting RF applications

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"Superconducting Radio Frequency (SRF) components made of bulk niobium could profit from the novel shapes, parts number reduction of assemblies, and cost and lead time decrease from Additive Manufacturing with Selective Laser Melting (SLM). However, pure niobium is not available on this technology thus far. In the framework of FCC Special Technologies, a project aims at developing pure niobium for SRF applications.
This study introduces the first parts manufactured in pure niobium and presents an extensive physical and mechanical characterisation of the material. The process chain is covered, starting from the characterisation of powder coming from different routes, then the development method for the process parameters, and finally a post-processing heat treatment with titanium gettering to improve the purity of the material.
The parameters developed enable the manufacturing of fully dense niobium components with densities over 99.9%. The heat treatment reduced Oxygen impurities from 600 ppm to just 17 ppm, leading to an increase by a factor of 10 the Residual Resistivity Ratio (RRR) to reach 75. The materials exhibit a supercritical transition temperature Tc of 9.2K. Finally complex parts were manufactured such as 6GHz half-cells and the HOM coupler for the crab cavity DQW.
These findings demonstrate the feasibility of niobium in SLM for the manufacturing of complex components. The preliminary purification heat treatment by titanium gettering shows very encouraging results."

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