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Addressing manufacturing challenges IN NbTi monofilament

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The successful production of NbTi multifilament superconducting wires requires overcoming several manufacturing challenges. The initial step is to produce monofilaments, which comprise of a NbTi solid solution, a Nb diffusion barrier, and a copper stabilizer. This study investigates the essential requirements, explores potential solutions, and addresses processing difficulties encountered during monofilament manufacturing. Cylindrical ingots with 10 mm diameter and 25 mm length of Nb-46.5%Ti alloy were produced using vacuum suction arc melting, followed by heat treatment at 1200°C for 1 hour. Subsequently, the ingots were encased in a Nb layer and assembled in a clean room within an oxygen-free copper (Cu-OFHC) container. The containers were vacuum sealed after capping to preserve the original assembly, reducing the oxidation of the components. Two different welding methods were investigated for securely joining the caps: brazing and tungsten inert gas (TIG) welding. Afterward, the sealed containers were subjected to plastic deformation using the rotary swaging process, resulting in the production of Cu/Nb/NbTi monofilaments. Chemical and microstructural analyses were conducted according to specified requirements. The produced ingots exhibited a uniform chemical composition, free from inclusions and with low contaminant content. After heat treatment, a homogeneous microstructure of equiaxed grains was achieved. The cap joining processes, including brazing and TIG welding, were examined to assess their effectiveness in creating an oxidation-free seal while maintaining the initial hardness of the copper container. Finally, the quality of the monofilaments were assessed focusing on surface integrity, the ratio of Cu/NbTi, uniformity of copper thickness surrounding NbTi, and the mechanical bonding among NbTi, the Nb layer, and the Cu container. This study evaluated the feasibility of manufacturing NbTi monofilaments using various approaches in line with specified requirements, providing significant contributions to the manufacturing process of NbTi superconducting monofilaments.