Selection and Properties of Structural Materials for Cryogenic Applications

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Abstract - Structural materials play a crucial role in large cryogenic systems such as particle accelerators and experiments, fusion reactors and their superconducting magnet systems. Adequate mechanical (strength, ductility, toughness), physical, magnetic and vacuum properties over the whole operating temperature range are important factors, either separately or in combination. Machinability, weldability or brazeability are also key parameters. The successful selection of a structural material for a cryogenic application is therefore closely related to obtaining a controlled microstructure and stable properties in service through the specification of a suitable manufacturing process.

A large experience in definition, specification and procurement of cryogenic structural materials has been gained during the construction of the Large Hadron Collider (LHC) at CERN. Examples of material developments will be provided, including innovative material solutions such as the one adopted for the 2500 end covers of the LHC superconducting dipole magnets, near net shaped starting from HIPed 316 LN powder. Special production techniques developed for different components of the CMS (Compact Muon Solenoid) detector, built around a 4 T superconducting solenoid, will be presented. These include the aluminum alloy end flanges of the 6.8 m diameter external cylinder of the magnet coil, the largest seamless rolled rings produced to date in the selected alloy and temper, and the reinforcement of the CMS Al-stabilized conductor, produced in continuous 2.5 km lengths with uniform mechanical properties.

This experience is the basis of ongoing developments for future particle experiments and fusion magnets that will also be extensively illustrated.

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