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Strength evaluation of large grain niobium sheets and derivation of allowable stress

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The high-purity niobium material used in the superconducting cavities is an ingot produced by electron beam melting, and is a polycrystalline with a grain size of 10 to 200 mm. Niobium sheets sliced from ingots contain large grains and called as large grain (LG). Superconducting cavities made from LG niobium have the advantages of a high maximum acceleration gradient, Q value, and low manufacturing cost. Large-numbered tensile testing at room temperature using two kinds of LG niobium sheets with RRR392 and RRR189 was performed. The tensile strengths are 79.2 MPa and 83.3 MPa, respectively, about half that of ordinary fine grain (FG) niobium. The variation of strength is significant due to crystal orientation. The minimum tensile strength was estimated based on material strength studies to apply the LG cavity to the High-Pressure Gas Safety Act, and the allowable stress for vessel design was derived. These are 12 MPa and 15 MPa, respectively, which are less than half that of FG niobium. The strength estimation method shown here can be applied with approximately 50 tensile testing results. It is also simple and versatile and does not require crystal orientation measurement.

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Footnotes

Funding Agency

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