Fracture Strength Distribution of Individual Nb3Sn Filaments

Maxwell T. Dylla, Samuel E. Schultz, and Matthew C. Jewell, Senior Member, IEEE

Abstract—Brittle fracture of Nb3Sn filaments is one mechanism by which the current-carrying capacity of composite Nb3Sn wires is degraded. However, there is relatively little data in the literature on the intrinsic material fracture properties of Nb3Sn filaments, because the complex composite structure of magnetic wires makes obtaining reliable data difficult. Understanding the intrinsic fracture properties of Nb3Sn filaments is important for predicting the performance, mechanical integrity, and lifetime ofNb3Sn wires. In this study, we extracted individual Nb3Sn filaments from a Nb3Sn composite wire and conducted bend testing to determine the fracture strength distribution of the isolated filaments. The distribution is modeled using a Weibull function. The relative fracture properties of Nb3Sn filaments vary across a large range. We discuss the implications of this variability on the performance and reliability of Nb3Sn wires.

IEEE Transactions on Applied Superconductivity

Matthew Jewell
Assistant Professor
Materials Science

Fracture Strength Distribution of Individual Nb3Sn Filaments

IEEE Transactions on Applied Superconductivity

Nb3Sn is an advanced superconductor capable of carrying large electric currents, which makes it ideal for creating powerful electromagnets. However, the brittle Nb3Sn filaments within the composite wire sometimes break under magnetic forces, which degrades the performance of the magnet. In this study, we have calculated the intrinsic fracture strength distribution of individual Nb3Sn filaments and also examined how small unreacted niobium cores in the filaments impact the strength distribution. This will allow designers to build sophisticated magnet systems with greater confidence, and will give wire manufacturers guidance as they seek to optimize their wire geometries for maximum robustness. The experimental work described in this paper was conducted by UWEC Materials Science students Max Dylla and Sam Schultz.