International Copper Association
Copper Alliance

High-Tech Conductors Far from Competitive with Copper

Study Name: Competing High Technology Conductors
Study Author: IDTechEx
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A new study from market research firm IDTechEx shows that despite significant progress, emerging conductive materials are still a long way from being competitive with copper. The work focuses on pure nanocarbon materials, copper nanocomposites and high temperature super conductors

Overview

New research—commissioned by The International Copper Association (ICA)—explored pure nanocarbon materials, copper nanocomposites and high temperature super conductors, showing that these materials do not have the requisite properties or costs to threaten the current copper market.

Improved conductors would theoretically have lower resistance, high ampacity, lighter weight, smaller size and insensitivity to room temperature. However, according to the research, none of the materials deliver these benefits.

Copper Nanocomposites

Copper nanocomposites refer to the inclusion of conductive material—such as carbon nanotubes (CNTs) or graphene—in a copper matrix. Their low levels of electrical resistance mean they could see use in a range of electrical applications such as data cable, circuit boards or bonding wire. However, the research highlights reproducibility, poor metal wettability, scale, cost-effectiveness, upstream supply-chain and the ability to make usable wire as common challenges.

Pure Nanocarbon Materials

In their nanoscale form, CNTs offer flexural strength, low temperature coefficient of resistance and low coefficient thermal expansion, giving them theoretically significant advantages over copper. In practice, successfully translating these benefits to the macroscale is proving difficult.

Progress is being made to macroscale CNT wires, yarns and tapes, with potential applications in electric motors and low power electronic applications, but CNT yarn will not be used for these applications for at least another 10–15 years.

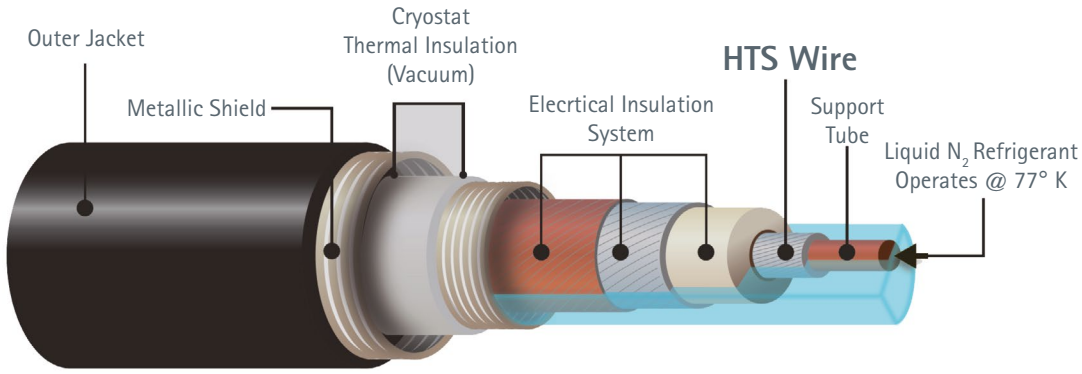
High Temperature Superconductors (HTS)

HTS partly-based on copper conductors are the most promising of the emerging materials. With cable that transmits three to five times the power of copper cable, HTS have already been used in a number of projects.

According to the research, processing costs are the greatest challenge for HTS. With current costs at $100 per kiloamp meter, displacing just 1% of copper cables is a realistic outlook for HTS over the next 10 years.

Key Findings

- Continued research has displayed that emerging conductive materials are far from competitive with copper (or aluminum) in terms of properties and cost.
- High Temperature Superconductors continue to improve, with most efforts going into reducing the processing costs.
- CNT yarns have had resistivity improvements, but are limited by dependency on raw material production and improved post-yarn processes.
- Copper composites show mixed results with CNTs and graphene.



Typical HTS cable structure