New Research Shows Graphene Layers Significantly Improve the Conductivity of Copper

The International Copper Association (ICA) announced today that research on combining copper with graphene has led to the discovery of ultra-conductive copper (UCC) with electrical resistance much lower than pure copper.

According to ICA-funded and directed research at Shanghai Jiao Tong University (SJTU), the use of alternating layers of graphene and copper has achieved a verified breakthrough, providing conductivity 16% higher than that of copper at room temperature.

In 1913, the International Annealed Copper Standard (IACS) was established as a method of defining the conductivity of copper wires. Copper at 20°C was set at 100% IACS. Today, copper at 99.99999 purity only reaches 103% IACS.

The newly-recorded 116% IACS conductivity at room temperature represents the most conductive bulk material ever produced. Identifying copper-based materials with a higher percent IACS at room temperature has the potential to be a game-changing technology, since 60% of total copper usage is in wire and cable electrical conductivity applications.

“This research demonstrates an exciting development for copper in a market that has the potential to make significant positive impacts on society,” said Colin Bennett, Market Analysis and Outreach, ICA. “Graphene has been talked about as a super material, and it looks like its relationship with copper has the potential to make transformative advancements that haven’t been witnessed in years.”

Improved conductors would have lower resistance, high ampacity, lighter weight, smaller size and insensitivity to temperature.

UCC technology could see use in all electrical applications, including data cable; magnet wires in motor stators; copper foil in batteries; circuit boards; bonding wire for lead frame to chip; chip-level connections; power transmission cable; and power cable.

How It Works

Graphene is applied to a copper foil and then another layer of copper sandwiches the graphene. A stack of copper and graphene layers are pressed together, creating electron-path channels, and experimental results show a dramatic increase in bulk electrical conductivity with six layers. The conductivity of the channels has been measured at 100 times the conductivity of copper.

The Quest for High Conductivity

We live in an electrified world. Scientific discoveries starting in the 1820s set the stage for new applications of electricity and copper. Today, our world is electrifying further, as evidenced by the expansion of renewable energy, power grids, electro-mobility, communications, computing, and energy storage.

It is expected that the first applications for UCC will be in motor windings and offshore power transmission. UCC enables lighter weight, more compact, more efficient aerospace and vehicle motors. UCC cables could deliver megawatts of power with smaller diameters and lower losses
In the past 200 years, the quest to improve electrical conductivity has been influenced by three major scientific discoveries: 1) superconductivity, discovered in 1911; 2) carbon nanotubes, discovered around 1991; and 3) Graphene, discovered in 2004.

For more information on ultra-conductive copper, visit the Trends and Innovations section of copperalliance.org, or contact ICA.

About the International Copper Association (ICA)

ICA brings together the global copper industry to develop and defend markets for copper and to make a positive contribution to society's sustainable development goals. Headquartered in New York, ICA has offices in four primary regions: Asia, Europe and Africa, Latin America and North America. Copper Alliance® programs and initiatives are executed in nearly 60 countries through its regional offices. For additional information please visit copperalliance.org.

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