Superconductor from solvent created: Study opens up new understanding of phenomenon

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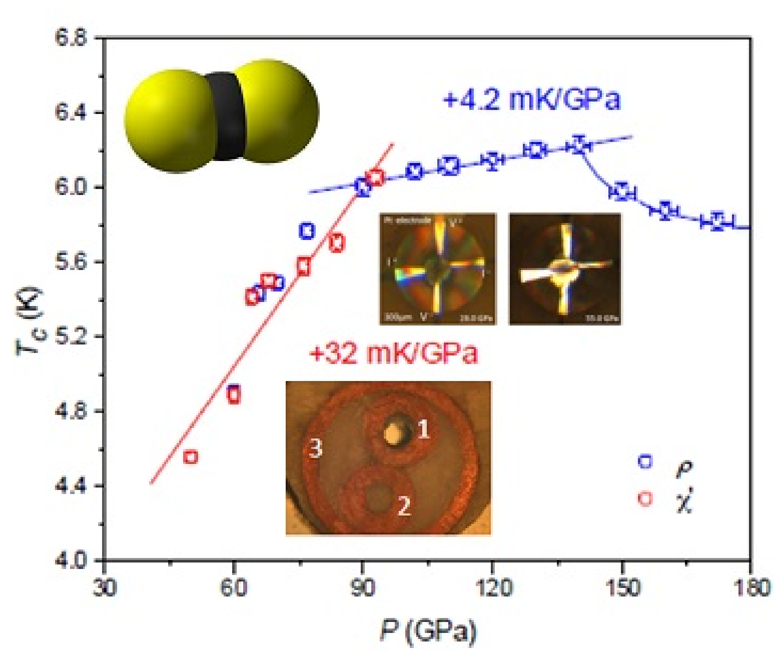

Pressure dependence of the critical superconducting temperature of a metal created by the team from CS2 molecule (top left) was measured be electrical contacts (inset in the middle) and electromagnetic coils (inset at the bottom).

A study led by Washington State University researchers has turned a fairly common non-metallic solvent into a superconductor capable of transmitting electrical current with none of the resistance seen in conventional conductors.

"It is an important discovery that will attract a lot of attention from many scientific communities—physics, chemistry, and materials science," said Choong-Shik Yoo, a professor of chemistry and Institute for Shock Physics. The National Science Foundation-funded discovery, which grows out of research by Yoo doctoral student Ranga Dias, appears in the *Proceedings of the National Academy of Sciences*.

The field of superconductivity has a wide variety of potentially revolutionary applications, including powerful electromagnets, vehicle propulsion, power storage and vastly more efficient power transmission.

Three years ago, Yoo used super-high pressures similar to those found deep in the Earth to turn a white crystal into a "super battery," or what he called "the most condensed form of energy storage outside of nuclear energy."

This time, Yoo saw how carbon disulfide subjected to high pressure and cold started to act like a metal, taking on properties like magnetism, a high energy density, and superhardness as its molecules reassembled in three-dimensional structures like those found in diamonds.

Typically, non-metallic molecules are too far apart from each other–three times farther apart than metal molecules—for electrical energy to move across them. But Yoo and his colleagues, including researchers at the Carnegie Institution of

Washington, compressed the compound in the small, compact space of a diamond anvil cell to 50,000 atmospheres, a pressure equivalent to that found 600 miles into the Earth. They also chilled the compound to 6.5 degrees Kelvin, or nearly -447 F.

The pressure and temperature not only brought the carbon disulfide molecules together but rearranged them into a lattice structure in which the natural vibrations of the molecules can help electrons move so well the material becomes a resistance-free superconductor.

Yoo's research provides new insight into how superconductivity works in unconventional materials, an area that has intrigued scientists for several decades, he says. These unconventional materials are typically made of atoms with lower atomic weights that let them vibrate at higher frequencies, increasing their potential as superconductors at higher temperatures.

Yoo acknowledges that electronic materials are not about to be cooled to near absolute zero or subjected to extreme pressures. But he said this work could point the way to creating similar properties under more ordinary conditions, much as science paved the way to make synthetic diamonds at lower temperatures and pressures.

"This research will provide the vehicle for people to be clever in developing superconductors by understanding the fundamentals that guide them," said Yoo.

Provided by Washington State University