IISc researchers observe superconductivity at ambient temperature, pressure

For the first time, researchers from the Indian Institute of Science (IISc) Bengaluru have been able to achieve superconductivity at ambient temperature and pressure. A large number of materials have been found to undergo normal to superconducting transitions. But such transitions require extremely low temperature and/or extremely high pressure. Achieving this transition at ambient temperature and pressure therefore gains great significance. The pre-print findings are reported in *ArXiv*.

A material is said to exhibit superconductivity when it is able to conduct electric current with practically zero resistance. So unlike the conventionally used materials such as copper and steel, a superconductor can carry a current indefinitely without losing any energy.

Superconductors are already used for many applications such electronics, levitation of trains, particle accelerators, and superconducting coils.

However, they need to be cooled to very low temperatures, which restrict their use in our everyday life. The ability to achieve superconductivity at ambient temperature and pressure therefore becomes very significant.

A two-member team, led by Professor Anshu Pandey from the Solid State and Structural Chemistry Unit at IISc, observed superconductivity in nano-sized films and pellets made of silver nanoparticles embedded in a gold matrix. Superconductivity was observed at minus 37 degree Celsius. The resistance observed is very low — 10-4 ohms — but not zero. The limitation to measure even lower resistance arises from instrument sensitivity, the authors claim.

Though gold and silver are not known to exhibit a superconducting state independently, the team was able to achieve superconductivity in nanostructures made by embedding silver particles of 1 nanometre size into a gold matrix. The nanosized silver particles were prepared separately before they were incorporated into a gold matrix.

“The results look robust and interesting. At the same time, it is a surprising result as a mixture of two metals — silver and gold — shows superconductivity,” said Professor Pratap Raychaudhuri from the Superconductivity Lab at Tata Institute of Fundamental Research (TIFR), Mumbai.

It’s a remarkable achievement and I am very excited about it. To me it is a pleasant surprise but not a shock,” said Dr. Ganapathy Baskaran from Chennai’s Institute of Mathematical Sciences who has been working in the field of superconductivity for nearly 30 years. “They didn’t observe zero resistance but the resistance seen is very low, much lower than any metal.”

Meissner effect

Professor Pandey’s team did observe the Meissner effect though the effect is relatively low. Meissner effect is where the magnetic fields are completely expelled by the superconducting state and is a crucial evidence for superconductivity.

“Though they didn’t observe perfect Meissner effect, they did observe samples becoming strongly diamagnetic, which is consistent with superconductivity,” said Dr. Baskaran, a SERB Fellow. A diamagnetic material is repelled by magnetic field and is consistent with superconductivity.

Though the diamagnetism observed is not complete it is strong enough. “There may be several reasons why they didn’t observe complete diamagnetism. For instance, it is difficult to observe

complete diamagnetism in the material that they have used," said Professor Raychaudhuri.

"The observed diamagnetism is far stronger than the values associated with most normal materials, as well as with previous reports of nanostructured gold or silver. The magnitude of the observed diamagnetism is thus consistent with a granular superconductor," the authors write.

"Even granular superconductivity at this temperature is a remarkable achievement. Now other scientists should be able to reproduce this," comments Dr. Baskaran.

"The temperature at which diamagnetism is observed is the same as when the resistance goes to nearly zero," said Professor Raychaudhuri. The authors have observed superconductivity up to 320 K but haven't measured the diamagnetism.

The device was tested in the open ocean at a depth of 1,600 to 2,300 ft.

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