Replication of room-temperature superconductor claims fails to show superconductivity

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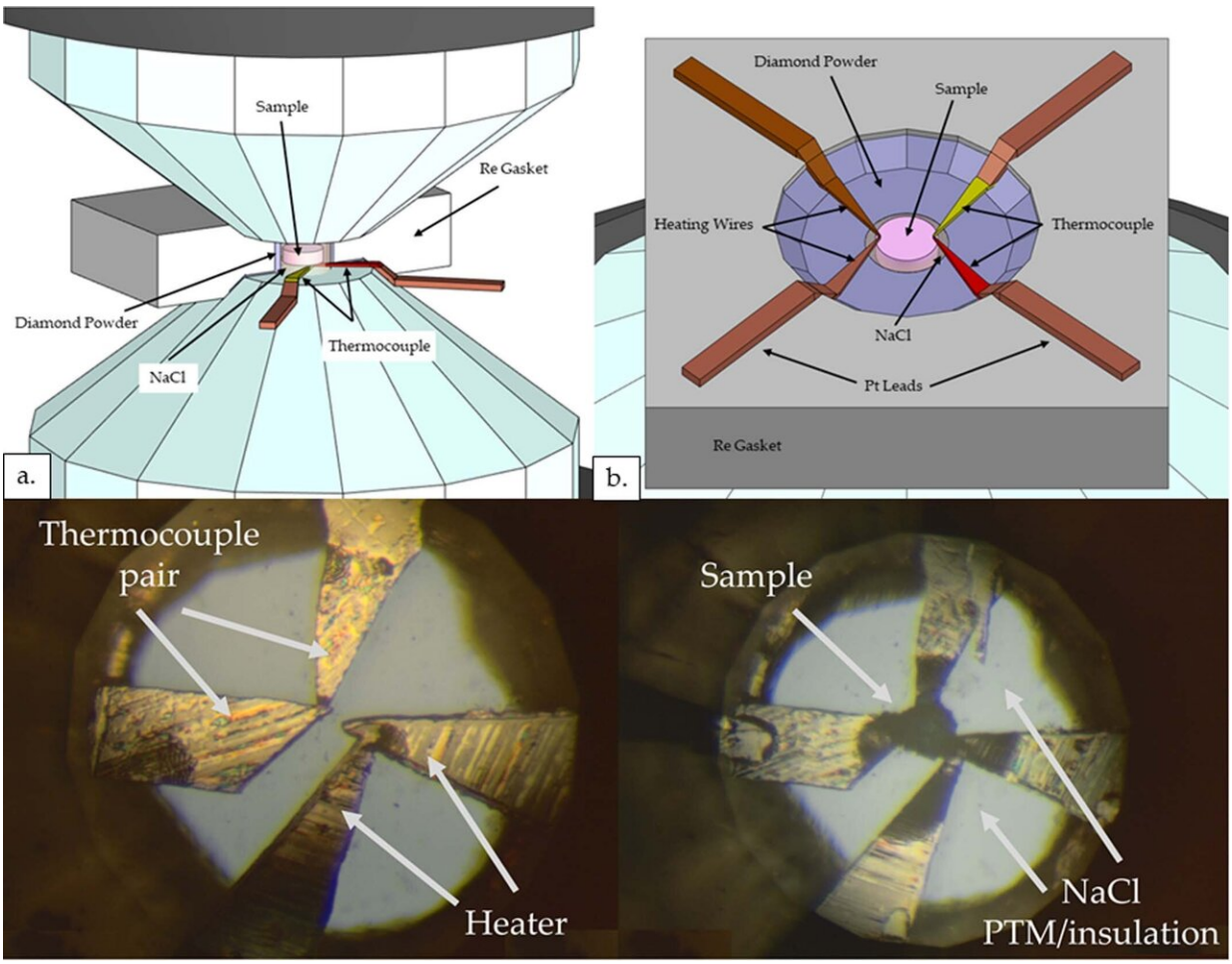

The heat-capacity setup [from the March 2023 article published by the University of Rochester team]. Top, schematic rendering of the new a.c calorimetry technique (not to scale). The sample is surrounded by a NaCl insert with a heater and thermocouple making contact with the sample. a, View of the

preparation as seen from the side showing the thermocouple making contact with the sample inside the DAC. b, View of the preparation as seen from the top of the sample area showing the configuration of heater, thermocouple and Pt leads. Bottom left, heat-capacity setup before loading sample. The thermocouple consists of a shorted alumel/chromel pair. The heater pair consists of a shorted metal, nichrome, Ti or Pt. When driven at frequency f, the sample temperature modulates at frequency 2 × f, which manifests as a voltage on the thermocouple pair that can be measured by a lock-in amplifier. Bottom right, after the sample is loaded, in contact with both the heater and the thermocouple, a small piece of NaCl is placed on top to thermally insulate it from the diamond. Credit: *Nature* (2023). DOI: 10.1038/s41586-023-05742-0

A team of physicists at Nanjing University, attempting to replicate the superconductivity results from an experiment conducted by a team at the University of Rochester, produced the desired material but also found that it was not superconductive. In their study, reported in the journal *Nature*, the group replicated the work by the prior team and tested the resulting material.

In 2020, a team of engineers and physicists at the University of Rochester in New York, led by mechanical engineer Ranga Dias, published a paper in the journal *Nature* claiming to have created a compound that, when exposed to extreme pressure, became a superconductor at room temperature. Soon thereafter, *Nature* retracted the paper due to the use of undocumented data by the research team.

More recently, the same team published another paper in *Nature* claiming to have created a different material that became superconductive at room temperature—at much lower pressure than the material described in their first paper. In this new effort, the team in China duplicated the work, hoping to find the same results.

The work involved following the same steps taken by the team at the University of Rochester (UoR), doping a lutetium-hydrogen chemical with nitrogen. The idea behind the effort is that hydrogen-rich chemicals can, under the right conditions, incite the formation of Cooper pairs of electrons, which have been associated with superconductivity.

The team in China found that the process did lead to the formation of a compound that at first glance appeared to be identical to that created by the team at UoR. A closer look using energy dispersive X-ray spectroscopy showed its structure, a hydrogen-lutetium-nitrogen compound, that looked nearly identical to the UoR compound. And testing with Raman spectroscopy showed it had the same vibrational frequencies. The Chinese team even found the same color changes reported by the UoR team as the material was subjected to high pressure.

Unfortunately, things did not look the same when the material was tested for superconductivity. The team in China was not able to detect any transition changes, even when they tested it at super-cold temperatures.

The Chinese team is not rejecting the results obtained by the team at UoR—instead, they suggest it is possible that the nitrogen dopant present in their material was of insufficient quantity to produce the desired effect. They also note that in their sample, the dopant was unevenly distributed. They suggest further testing is needed to verify the results obtained by the group at UoR.

More information: Xue Ming et al, Absence of near-ambient superconductivity in LuH2±xNy, *Nature* (2023). DOI: 10.1038/s41586-023-06162-w