Chinese Academy of Sciences Discovers Root Cause of "Room-temperature Superconducting Material" Artifacts

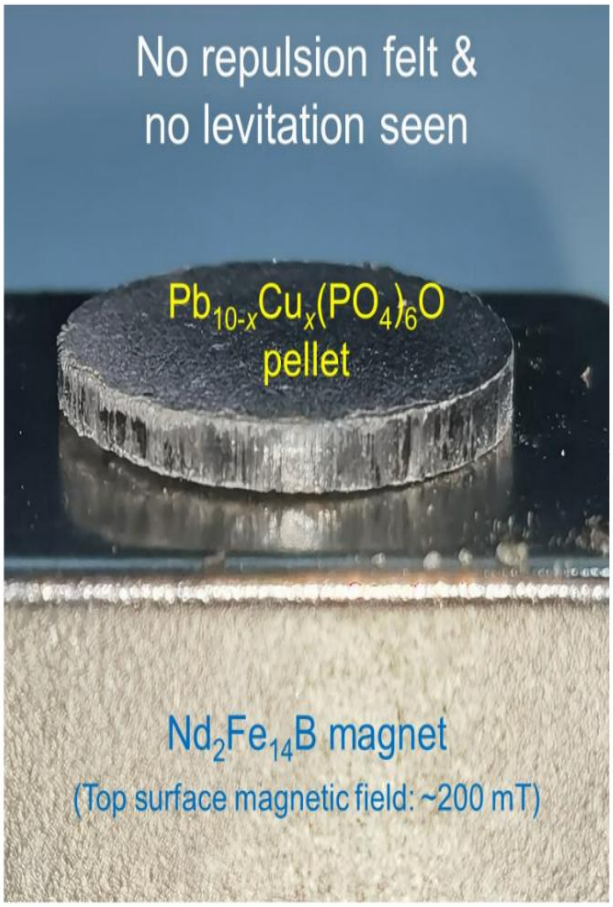


Figure 13. No repulsion felt and no magnetic levitation observed when a tableted pellet is placed on top of a commercial $Nd_2Fe_{14}B$ permanent magnet with a top surface magnetic field of ~200 mT.

A new preprint paper published on the arXiv website by a team of researchers from the Chinese Academy of Sciences may put an end to "LK-99 is a room-temperature superconductor".

Recently, preprint papers on LK-99 have been "flooding" the arXiv website because the material was claimed to be capable of room-temperature superconductivity by a South Korean research team. But that may be coming to an end soon: a new preprint paper published on arXiv not only says that LK-99's ability to superconduct at room temperature is an illusion, but also finds the reason for the illusion - cuprous sulfide impurities.

In addition, from the Center for Quantum Materials Science at Peking University, Princeton University and other institutions of the scientific research team also submitted a preprint paper, said, although it was observed that their "fired" LK-99 samples do not show superconductivity, more like magnets, rather than room-temperature superconductors.

"Our work points out the reason for misidentifying LK-99 as a superconductor," Luo (luò) Jianlin, one of the corresponding authors of the aforementioned paper and a researcher and doctoral supervisor at the Institute of Physics of the Chinese Academy of Sciences, told SurfingTech on August 9. "The experimental results show that (LK-99 can superconduct at room temperature at room pressure) is an illusion, originating from cuprous sulfide." "LK-99 does not superconduct!

Copper sulfide is one of the products of the "firing" process of LK-99, a copper-doped lead apatite material with the composition of Pb10-xCux(PO4)6O (0.9<x<1.1).

In the experiments, Wu Wei and other researchers "fired" two types of LK-99 with different cuprous sulfide contents, measured their resistance, antimagnetism and other parameters, and compared them with the corresponding parameters of pure cuprous sulfide. The "strength ratio" parameter of sample 1 (S1), which reflects the cuprous sulfide content, is about 5%, and that of sample 2 (S2) is about 70%.

The experimental results show that the resistivity of sample S1 jumps at 370 K (96.85 degrees Celsius) with thermal hysteresis, while the resistivity of sample S2 decreases sharply at 370 K (96.85 degrees Celsius), and then increases with decreasing temperature below 100 K (-173.15 degrees Celsius), which is similar to the characteristics of semiconductors.

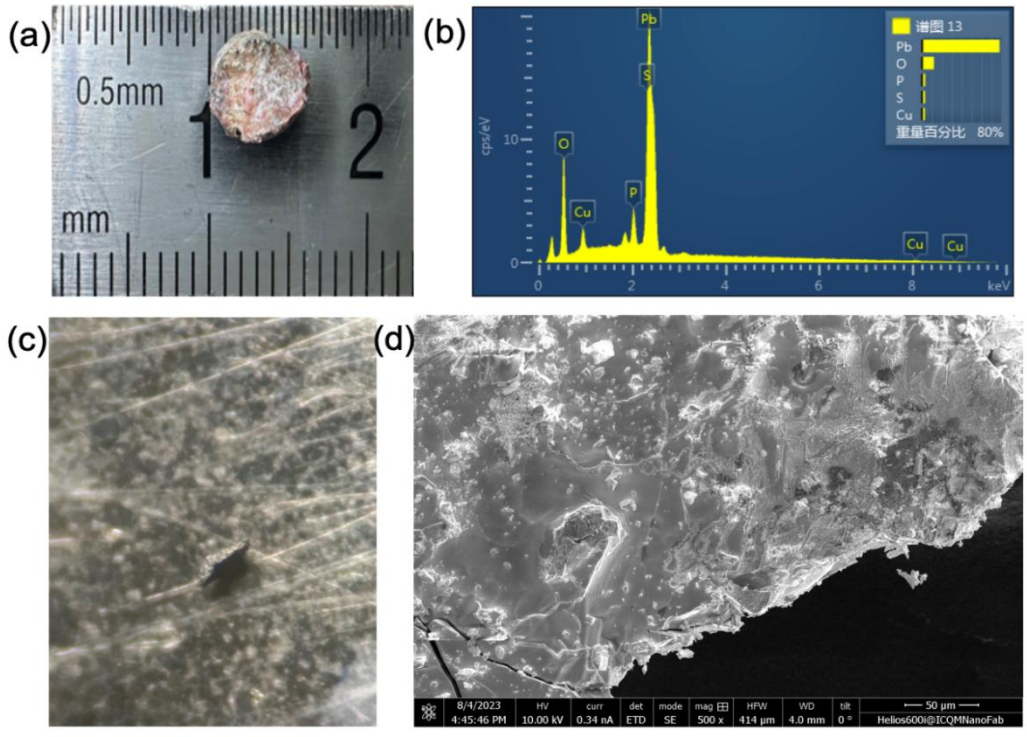
Zero resistance at critical temperatures and complete antimagnetism are two important features of superconductors.

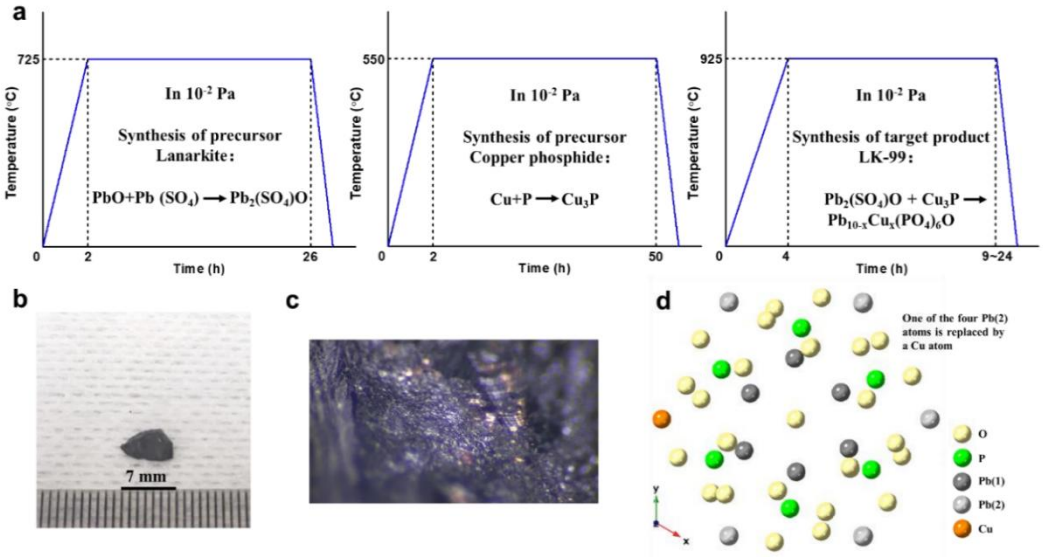
Luo Jianlin told Punch that copper sulfide has a structural phase transition from "hexagonal phase" to "monoclinic phase" near 400K (126.85 degrees Celsius).

In the vicinity of the phase transition point, its resistance drops by more than three orders of magnitude. This looks like a "superconducting" phase transition, but it is not. Current experimental evidence suggests that superconductivity cannot be achieved by increasing or decreasing the amount of cuprous sulfide in the sample or by other means.

"We believe that the so-called superconducting behavior in LK-99 is most likely due to a first-order structural phase transition of cuprous sulfide around 385 K (111.85 degrees Celsius) from the beta phase at high temperatures to the gamma phase at low temperatures, which leads to a decrease in electrical resistivity," the paper reads.

According to the surging news previously reported, on the morning of July 22, South Korea quantum energy research center company related to the research team in the preprint website arXiv has submitted two similar papers, claiming that a copper-doped lead apatite material named LK-99 has "room temperature + atmospheric pressure" superconductivity. Subsequently, a number of international research teams began to repeat their experiments, trying to synthesize LK-99 in order to reproduce the results of the South Korean team's experiments. The related news also had an impact on global stock markets.





At 16:13 on July 31, Professor Liu Zhiqi's team from the School of Materials Science and Engineering at the Beijing University of Aeronautics and Astronautics (BUAA) submitted a paper on the preprint website arXiv. The paper states that the room-temperature resistance of the LK-99 sample it synthesized is not zero, and no magnetic levitation was observed; the material resembles a semiconductor, not a superconductor.

At 14:59 on August 2, Sun Yue, a professor and doctoral supervisor at Southeast University's School of Physics, submitted a paper on the preprint website arXiv stating that its LK-99 sample measured zero resistance at temperatures above 100K (minus 173.15 degrees Celsius) but was not antimagnetic. Sun Yue said in the video that a total of six samples were measured, but zero resistance was observed inside only one sample, with most of the others producing semiconducting behavior. His paper says, "Our findings suggest that Pb10-xCux(PO4)6O has the potential to be a candidate material in the search for high-temperature superconductors."

The BUAA research team submitted a preprinted paper stating that no magnetic levitation was observed in a repeat experiment.

At 3:13 a.m. on August 3, Professor Chang Haixin's team from the School of Materials Science and Engineering at Huazhong University of Science and Technology (HUST), which had caused a sensation by posting a video of the LK-99 validation experiments on the Beep website, submitted a paper on the preprint website arXiv to publicize their experimental progress. The paper is titled Successful growth and room temperature ambient-pressure magnetic levitation of LK-99. The paper says they successfully synthesized the LK-99 material and were able to "semi-suspend" it at room temperature and ambient pressure at a large angle. "Our results demonstrate the importance of crystallinity and proper copper doping, suggesting a fundamental underlying superconducting mechanism for the copper-oxygen induced band changes in this phosphate oxide. We expect that more consistent tests, such as electrical tests at room temperature, will show the great potential of this phosphate oxide."

A video about repeated experiments with the LK-99 material, first posted by Huazhong University of Science and Technology (HUST) on the domestic website Beili Beili (B station) on August 1, has been a big hit on social media both at home and abroad. The video in question was listed as supplementary material for the aforementioned paper.

The synopsis of the related video reads, "Hao Wu, a postdoctoral fellow, and Yang Li, a doctoral student at the School of Materials of Huazhong University of Science and Technology, under the guidance of Professor Chang Haixin, have successfully synthesized for the first time verified LK-99 crystals that can be magnetically levitated, which are levitated at a larger angle than that of the samples obtained by Sukbae Lee et al. The samples are expected to realize the real sense of contactless superconducting magnetic levitation. "

The publisher of the video in question says that the resistance of the sample in question has not yet been measured. This is because measuring the resistance requires micro-nano-machining, which destroys the sample. "Currently there is only a very small piece of sample, do not dare to move, really dare not move." A third batch of samples is being "burned" on an urgent basis.

On August 9, a preprint paper from Princeton University in the United States caught people's attention before it was released. The paper corroborates the experimental results and conclusions of the scientific research team of the Center for Quantum Materials Science of Peking University. The aforementioned paper of Princeton University in the United States has been submitted, but has not yet been officially released by the preprint website, the author has uploaded it to the net disk, and shared it on social media sites on the 9th. The research related to the paper was jointly completed by researchers from the departments of physics and chemistry at Princeton University in the U.S., the Department of Chemistry and Biochemistry at the University of Oregon in the U.S., and the Max Planck Institute for Solid-State Chemical Physics in Germany.

In a series of recent reports, lead-doped apatite (LK-99) has been considered as a candidate ambient-temperature, ambient-pressure superconductor, according to the paper. However, these claims are largely unsubstantiated from both experimental and theoretical perspectives.