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HKUST Scientists Discover Superconductivity in World's Smallest Single-Walled Carbon Nanotubes

Hong Kong University of Science and Technology physicists have discovered that, below 15 oK, 4-Angstrom single-walled carbon nanotubes exhibit superconductivity.

This is the first time single-walled carbon nanotubes have been found to show superconducting properties, i.e., conducting electricity without resistance.

In recognition of this major breakthrough, *Science*, the world's top science journal, published the research findings on 29 June 2001, and framed it as one of the most important findings published in this particular issue. The discovery has also been reported by [Chemical & Engineering News](#), [PhysicsWeb](#), [sina.com](#) and [People's Daily](#) so far.

Superconductivity is a property of some materials which, when cooled to temperatures within several degrees above absolute zero (-273 oC, often written as 0 Kelvin, oK), lose all their electrical resistance. However, pure carbon, an element present in all life forms, has never been found to superconduct. The HKUST physicists, led by Prof Ping Sheng, have demonstrated that when pure carbon is rolled into ultra tiny tubes, it becomes superconducting.

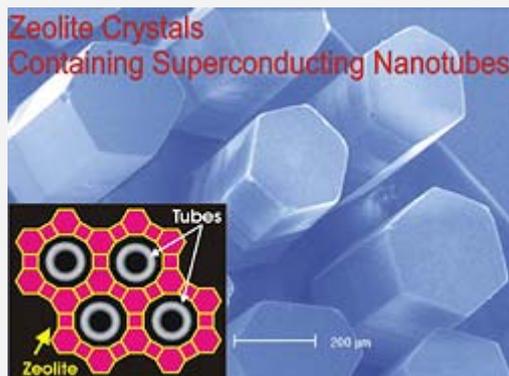
This research represents another major breakthrough for HKUST researchers on single-walled carbon nanotubes. Last November, HKUST physicists used microporous zeolite single crystals as hosts to fabricate the world's smallest single-walled carbon nanotubes (SWNTs), which possess diameters of only 0.4 nm (nanometer).

Dr Zikang Tang, assistant professor of the Physics Department, predicted then that the carbon nanotube could be an ideal one-dimensional conductor although its novel properties were yet to be explored.

Based on the success of their creation, Dr Tang and his colleagues have unraveled one of the most perplexing puzzles and discovered the signature of one dimensionality in superconductivity. As the single-walled carbon nanotubes are uniform in size, regularly arrayed but isolated from each other in the zeolite matrix, they constitute an almost ideal one-dimensional (1D) system.

"In a famous theorem published some 40 years ago, physicists Mermin and Wagner proved that it is impossible for abrupt superconducting transition to occur in one- or two-dimensional worlds. Our experiments and observations have confirmed the one-dimensionality effect, with extensive theoretical calculations. This will open up new horizons in basic and applied research into 1D superconductivity," said Prof Ping Sheng, Head of the Physics Department and Director of HKUST's newly established Institute of Nano Science and Technology.

While the research is significant in terms of its scientific breakthrough, practical applications are yet to be discovered. "It's far too early to predict anything concerning potential applications. Nevertheless, history tells us that all new material properties are eventually translated into useful applications," said Prof Sheng.



"However, as the 0.4nm single-walled carbon nanotubes are at or close to their theoretical limit, they are probably the smallest wire that we can produce, and will open the door to nanocircuitries with low dissipation," he added.

Prof Sheng attributed the success of the research to collaborative efforts by colleagues at HKUST's Physics Department in the past three years. "For any research to succeed, three elements are needed: novel sample fabrication; experimentation and characterization; and theory and simulation. Without any of these elements, we would not have been able to conduct the research, nor could we understand and explain the properties of the materials."

"I also hope that Hong Kong people will be able to share our pride. This discovery has been made in Hong Kong by local researchers, right from its inception to its present publication. This demonstrates that Hong Kong researchers are capable of achieving major scientific breakthroughs," he said.

Led by Prof Ping Sheng, the research on "Superconductivity in 4-Å Single-Walled Carbon Nanotubes" was undertaken by Dr Zikang Tang, Dr Lingyun Zhang, Dr Ning Wang, Dr Xixiang Zhang, G H Wen, G D Li, Dr Jiannong Wang, and Dr Che Ting Chan.

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