Method to synthesize high-quality copper oxide crystals for quantum photonics

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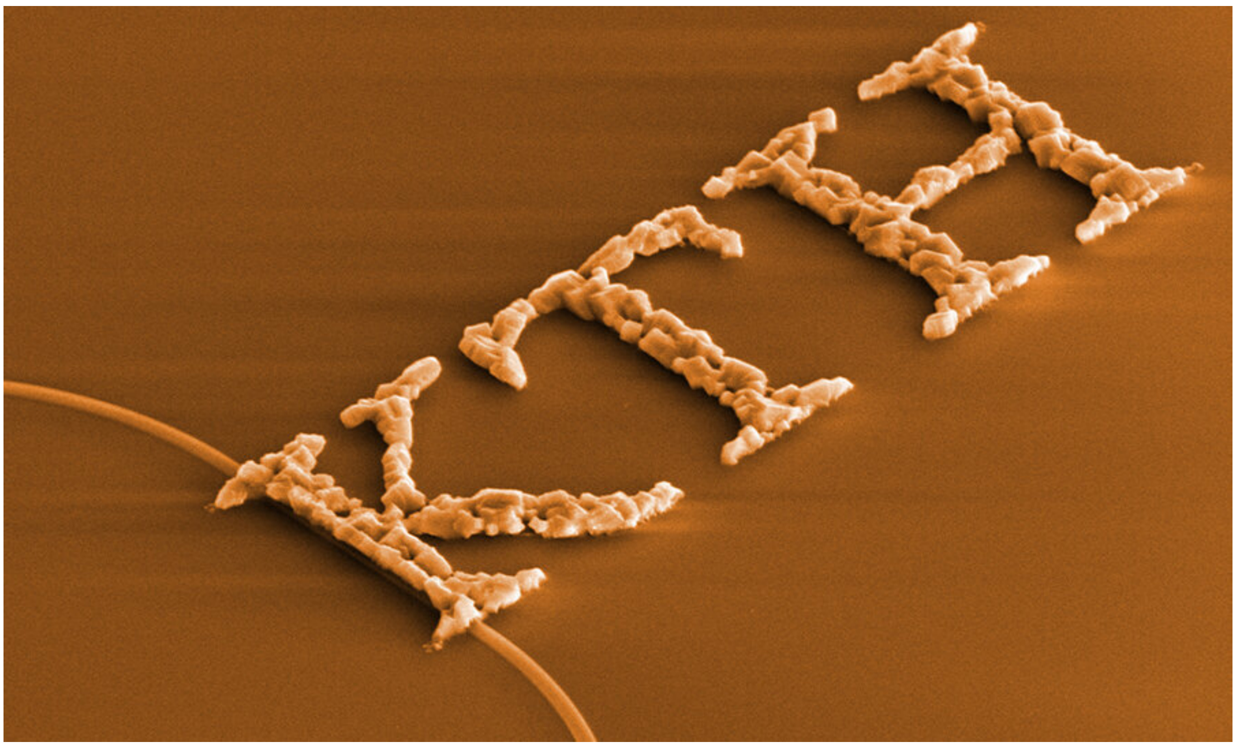

Synthesized copper oxide crystals arranged to spell out the name of the university where the production method originated. Credit: KTH Royal Institute of Technology.

Copper oxidation generally means tarnished surfaces and corroded electronics. But the compound Cu_2O, or cuprous oxide, is a promising material for quantum photonics, optoelectronics and renewable energy technologies. Now, a team of researchers has found a way to synthesize high-quality copper oxide microcrystals.

Researchers from KTH Royal Institute of Technology report that they have developed a scalable production method for cuprous oxide (Cu_2O) micrometer-sized crystals. Also involved in the study were the Institute of Solid State Physics, Graz University of Technology, Austria, and Laboratoire d'Optique Appliquée Ecole Polytechnique, Palaiseau, France.

"The unique properties of Cu_2O can lead to new schemes for quantum information processing with light in the solid state, which are difficult to realize with other materials," says Stephan Steinhauer, researcher in KTH's Quantum Nano Photonics group.

"This work paves the way for the widespread use of Cu_2O in optoelectronics and for the development of novel device technologies."

In order to synthesize the crystals, a copper thin film is heated to high temperatures in vacuum conditions. In their study, which was published in Communications Materials, the researchers at KTH took this method and identified the growth parameters to achieve Cu_2O microcrystals with excellent optical material quality.

The process is compatible with standard silicon fabrication techniques and allows the possibility for photonic circuit integration.

"The majority of quantum optics experiments with this material have been performed with geological samples found in mines—for instance, the Tsumeb mine in Namibia," Steinhauer says. "Our synthesis method is associated with very low cost fabrication, suitable for mass production and does not require gases or chemicals that are toxic or harmful for the environment."

He says the work lays the foundation for realizing quantum technologies based on solid-state Rydberg excitations, which are excited quantum states with high principal quantum number.

These excitations can be interfaced with photonic integrated circuits, aiming at on-chip generation and manipulation of light at the single-photon level, he says. "Exciting challenges lie ahead to translate quantum information processing and quantum sensing schemes previously developed for Rydberg atoms into the solid-state environment of a semiconductor crystal at the micrometer or nanometer scale."

More information: Stephan Steinhauer et al. Rydberg excitons in Cu2O microcrystals grown on a silicon platform, *Communications Materials* (2020). DOI: 10.1038/s43246-020-0013-6

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