Novel strategy for ultrahigh density copper single atom enzymes developed for tumor therapies

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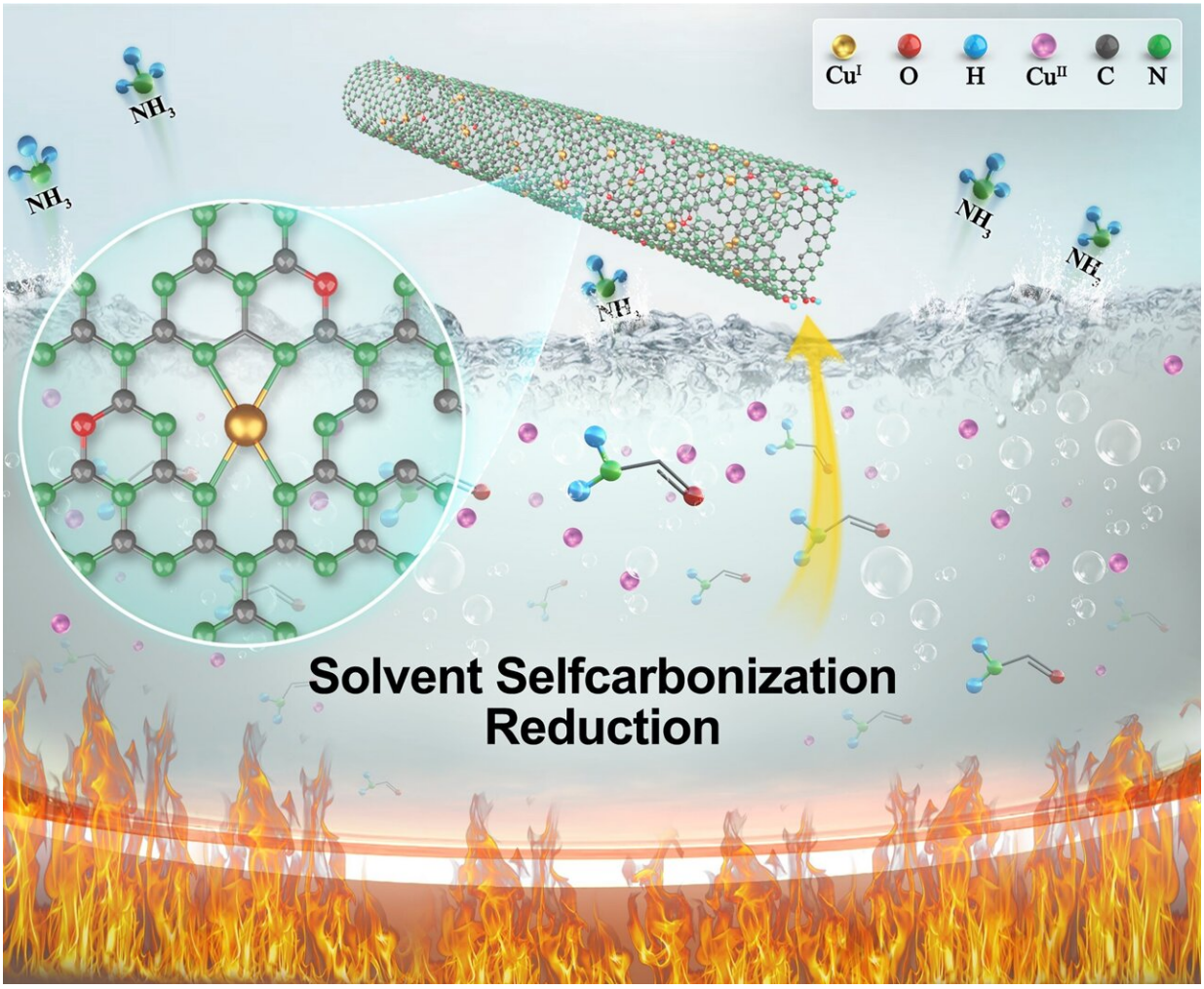

Schematic illustration showing the preparation process of Cu^{I} SAEs. Credit: Liu Hongji

A research group led by Prof. Wang Hui and Prof. Zhang Xin from the Hefei Institutes of Physical Science of the Chinese Academy of Sciences introduced a new strategy to prepare ultrahigh density copper single-atom enzymes for tumor self-cascade catalytic therapy.

"The powerful enzymes can help to fight tumors," said Dr. Liu Hongji, a member of the research team.

The study is published in *Chemical Engineering Journal*.

The low-valence Cu single atom enzymes (Cu^{I} SAEs) contribute to alleviating the inefficient generation of ·OH dilemma in the tumor microenvironment, especially in the presence of overexpressed glutathione (GSH). However, the conveniently controlled synthesis of Cu^{I} SAEs with high atom density remains a challenging task due to the cumbersome process, compositional heterogeneity, poor water solubility, and uncontrollable metal valence.

To solve this dilemma, the researchers proposed a well-controlled one-step solvent self-carbonization-reduction strategy to fabricate Cu^{I} SAEs with ultrahigh atomic density. Formamide can easily be condensed into a linear macromolecular chain for chelating Cu^{II} because of its high N content and vacant ligand sites. The resultant carbon nitride-based fragments reduce Cu^{II} to Cu^{I}.

"The obtained Cu^{I} SAEs has an incredibly high density of 23.36 wt. %, surpassing previously reported metal- or carbon-based supported Cu single-atom catalysts," explained Liu.

This comes from the well-defined Cu^{I} species, whereas aberration-corrected scanning transmission electron microscopy and the X-ray

absorption fine structure spectroscopy corroborate the Cu^{I} species existed in the form of single atoms.

"The Cu^{I} SAEs showed remarkable self-cascade catalytic activities, leading to a tumor inhibition rate up to 89.17 %," he added.

This study provides a novel strategy for fabricating valence-controlled SAEs supported on C_3N_4 for catalytic applications, according to the team.

More information: Hongji Liu et al, Ultrahigh density copper (I) single atom enzymes for tumor self-cascade catalytic therapy, *Chemical Engineering Journal* (2023). DOI: 10.1016/j.cej.2023.148273

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