Study explores hybrid ultrasmall gold nanocluster for enzymatic fuel cells

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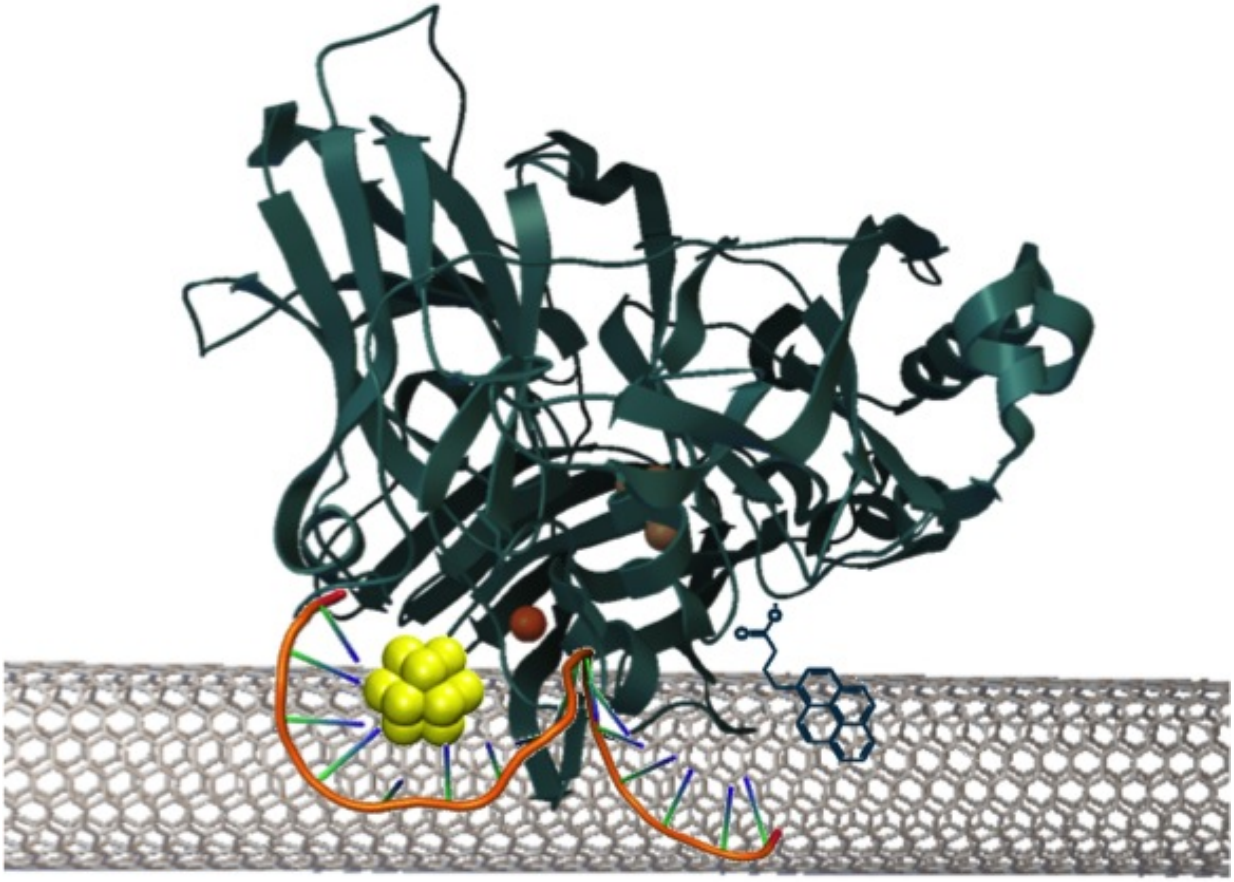

Gold nanoclusters (~1 nm) are efficient mediators of electron transfer between co-self-assembled enzymes and carbon nanotubes in an enzyme fuel cell. The efficient electron transfer from this quantized nano material minimizes the energy waste and improves the kinetics of the oxygen reduction reaction, toward a more efficient fuel cell cycle. Credit: Los Alamos National Laboratory

With fossil-fuel sources dwindling, better biofuel cell design is a strong candidate in the energy field. In research published in the *Journal of the American Chemical Society*, Los Alamos researchers and external collaborators synthesized and characterized a new DNA-templated gold nanocluster (AuNC) that could resolve a critical methodological barrier for efficient biofuel cell design.

"Enzymatic fuel cells and nanomaterials show great promise and as they can operate under environmentally benign neutral pH conditions, they are a greener alternative to existing alkaline or acidic fuel cells, making them the subject of worldwide research endeavors," said Saumen Chakraborty, a scientist on the project. "Our work seeks to boost electron transfer efficiency, creating a potential candidate for the development of cathodes in enzymatic fuel cells."

Ligands, molecules that bind to a central metal atom, are necessary to form stable nanoclusters. For this study, the researchers chose single-stranded DNA as the ligand, as DNA is a natural nanoscale material having high affinity for metal cations and can be used to assembly the cluster to other nanoscale material such as carbon nanotubes.

In enzymatic fuel cells, fuel is oxidized on the anode, while oxygen reduction reactions take place on the cathode, often using multi copper oxidases. Enzymatic fuel cell performance depends critically on how effectively the enzyme active sites can accept and donate electrons from the electrode by direct electron transfer (ET). However, the lack of effective ET between the enzyme active sites, which are usually buried ~10Å from their surface, and the electrode is a major barrier to their development. Therefore, effective mediators of this electron transfer are needed.

The team developed a new DNA-templated gold nanocluster (AuNC) that enhanced electron transfer. This novel role of the AuNC as

enhancer of electron transfer at the enzyme-electrode interface could be effective for cathodes in enzymatic fuel cells, thus removing a critical methodological barrier for efficient biofuel cell design.

Possessing many unique properties due to their discrete electron state distributions, metal nanoclusters (

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