Bacterial biofilms facilitate biocompatible bio-abiotic interfaces for semi-artificial photosynthesis

May 9 2022, by Li Yuan

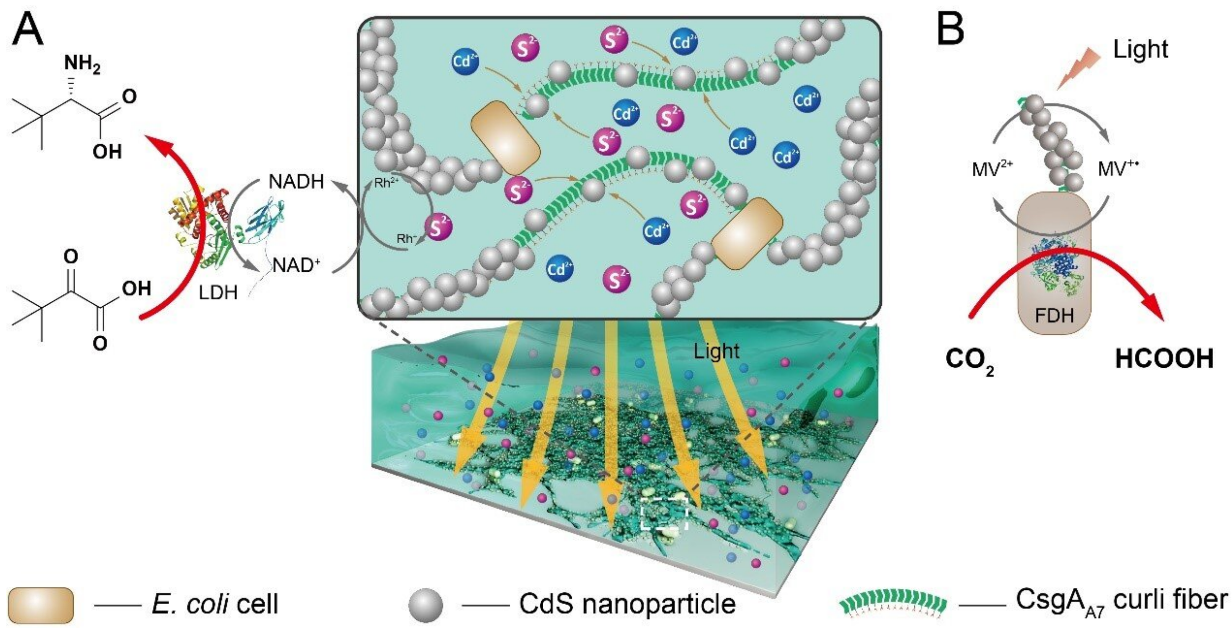

Fig. 1. Schematic of living bio-abiotic interfaces for single enzyme to whole cell photo-catalysis. Credit: SIAT

Semi-artificial photosynthesis integrates the high selectivity of living biosystems and the broad-range light-harvesting of semi-conductive materials, which enables sustainable light-driven chemical production. The bio-abiotic interfaces between living cells and semiconductors are the key for semi-artificial photosynthesis.

Through cell membrane immobilization or intracellular uptake of semiconductors, light-driven fixation of CO_2 to commodity chemicals has been achieved. Whereas, the direct contact would impair living cells, which impedes their sustainability.

Recently, a research team led by Prof. Zhong Chao from the Shenzhen Institute of Advanced Technology (SIAT) of the Chinese Academy of Sciences proposed the use of photocatalyst-mineralized biofilms as living bio-abiotic interfaces to implement diverse photocatalytic applications.

The research was published in *Science Advances* on May 7.

Biofilms are natural consortia embedded within a slimy extracellular matrix. Due to their superior resilience to external environmental stresses, biofilms have been adopted for the design of engineered living materials (ELMs) with applications in underwater adhesion, catalyst immobilization and medical therapy.

The researchers adopted E. coli biofilms with amyloid curli fibers. A7 peptides were first fused to curli subunit CsgA protein to create CsgAA7 nanofibers. It endowed biofilms with capability of in situ mineralization of CdS nanoparticles (NPs).

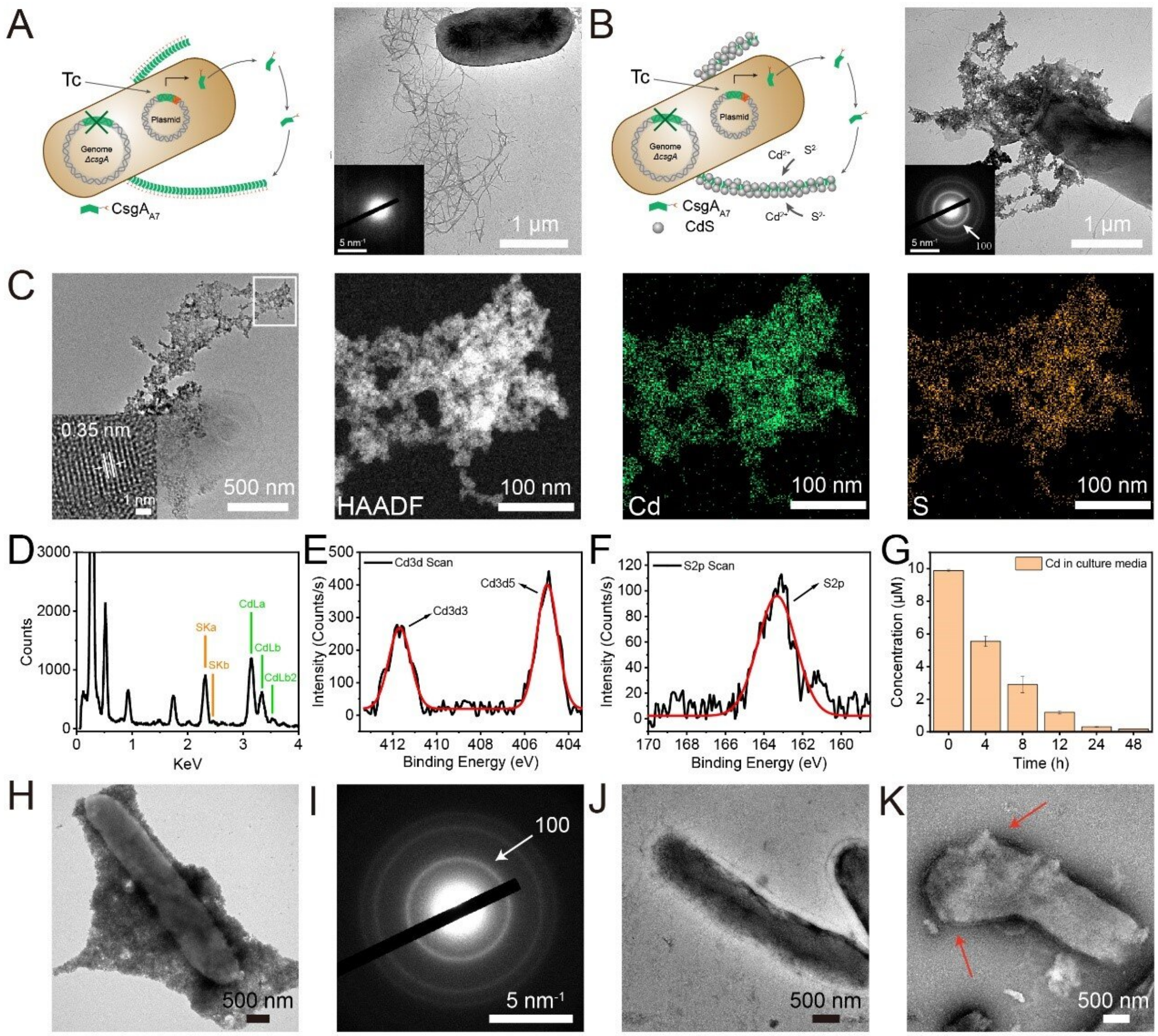

Fig. 2. Characterization of photocatalyst-mineralized biofilms. Credit: SIAT

The photocatalyst-mineralized biofilms were obtained and directly used in photo-catalytic applications after cultivation. Through segregation of CdS NPs from bacterial cells, the system could retain the catalytic property as well as alleviate the impairment.

To demonstrate the resistance of biofilms, researchers constructed another strain to display A7 peptides on cell membranes, which enabled mineralization of CdS NPs on cell membranes. The photocatalyst-mineralized bacterial cells were used as controls. After irradiation for 24 hours, the cells in photocatalyst-mineralized biofilms were almost integral, while the controls exhibited partial damage or even fractures.

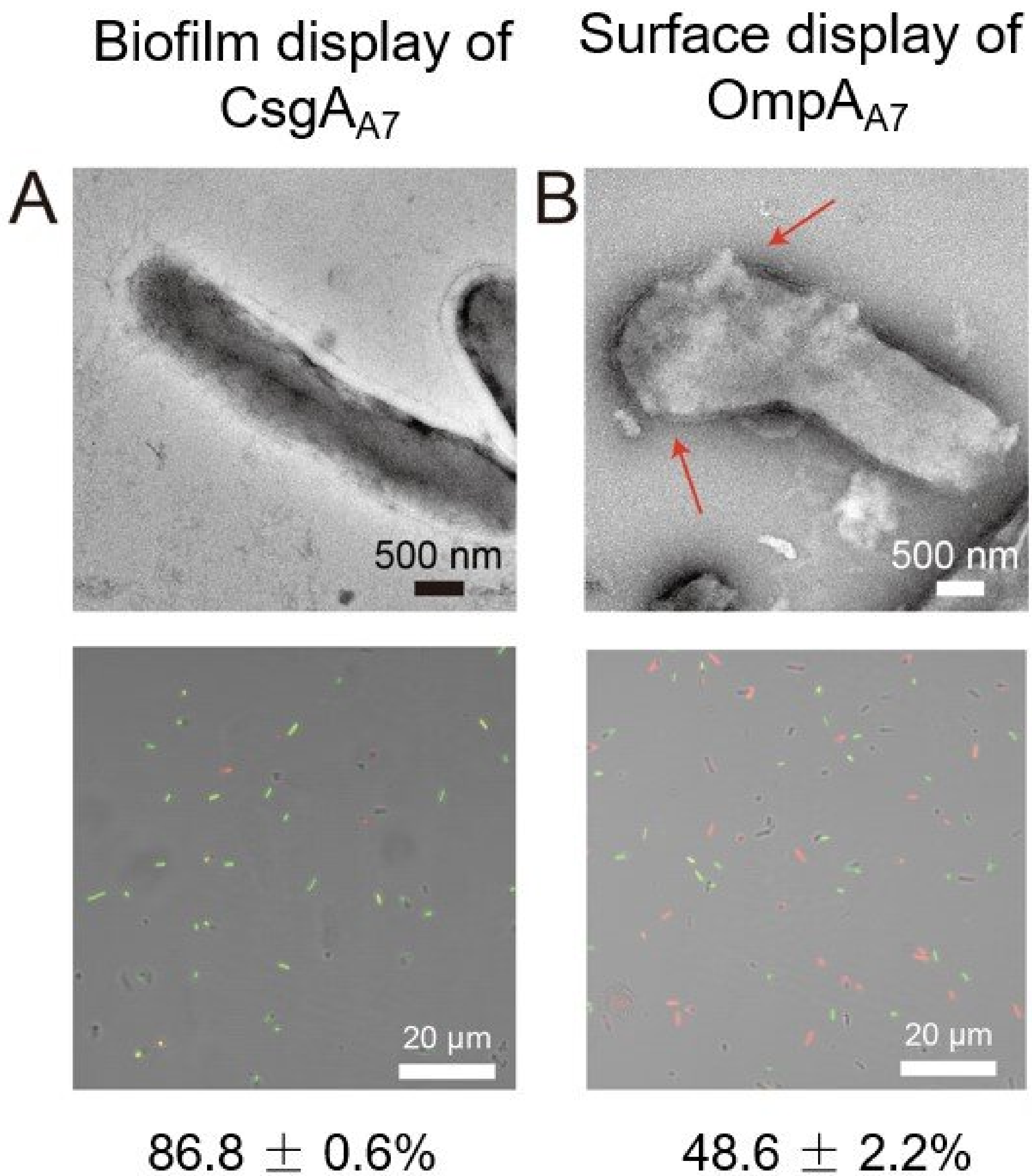

Fig. 3. The protection effect of engineered biofilms. Credit: SIAT

"The results indicated a biocompatible bio-abiotic interface by mineralized biofilms," said Prof. Zhong, the corresponding author of the study, "it could promote the sustainability of semi-artificial photosynthesis in principle."

Compared with planktonic cells, biofilms featured larger surface area, stronger environmental resistance, and easier functionalization, which made them superior chassis for the design of semi-artificial photosynthesis.

"The semi-artificial photosynthesis has the potential to solve future energy and environmental problems," said Prof. Zhong.

More information: Xinyu Wang et al, Photocatalyst-mineralized biofilms as living bio-abiotic interfaces for single enzyme to whole-cell photocatalytic applications, *Science Advances* (2022). DOI: 10.1126/sciadv.abm7665

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