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Genetically Expanded Microbial Protein Nanowires with Tunable Functionalities

Protein nanowires, which are composed of self-assembled monomeric protein units, have many functional and sustainability related advantages over traditional nanowire-based materials which already yielded novel electronic devices for sustainable electricity production, sensing and bio-electrosynthesis applications. (Lovely and Yao, 2021) Using genetic code expansion, an alkyne-containing unnatural amino-acid (UAA) was incorporated into extracellular type IV pili filaments of *Pseudomonas aeruginosa* (in vivo). These self-assembled biological nanostructures were analyzed for the first time using Cryo-EM, where their three-dimensional structure has been determined. Thus, revealing long protein filaments with a diameter of 5 nm and a length of several micrometers. The unique functional groups of the repeating UAAs along the filament can serve as orthogonal anchoring points for the attachment of many azide-containing/clickable molecules. Site-specific attachment of electroactive molecules, including redox active metalloproteins and polymers, will allow the synthesis of highly-conductive nanowires with tunable electrochemical properties. In addition to their potential use as components in nano-electronics, their expression outside the bacterial cell can allow the direct transfer of electrons between the cells and an electrode, thus improving the performance of established bioelectrochemical technologies. Furthermore, the resulting pili nanostructures can serve as scaffolds for the attachment of different organic and inorganic functional groups and catalysts. Thus, may increase the selectivity and efficiency of designated chemical reactions performed on the protein, bacteria and even in the biofilm level.

Reference:

Lovley, D. R., & Yao, J. (2021). Intrinsically Conductive Microbial Nanowires for 'Green' Electronics with Novel Functions. *Trends in Biotechnology*, *39*(9), 940–952. https://doi.org/10.1016/j.tibtech.2020.12.005