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Optimization of the molecular interface for oriented immobilization of electroactive proteins in biosolar nano devices

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Now-a-days the world produces energy primarily from fossil fuels. However, these are predicted to be exhausted by the end of the century. The main challenge for the present civilization is to create innovative technologies aiming at fulfilling the increasing energy consumption while at the same time reducing the carbon footprint. The production of high-efficiency biohybrid photoelectrodes is a highly promising approach to meet these challenges. This project focuses on the production of solar fuels by the construction of biohybrid photoelectrodes of increased efficiency compared to the present day biophotovoltaic technologies. The device will be composed of graphene substrate and robust (photo) electroactive proteins (photosystem I and cytochrome c553) to combine them into an entire fuel cell that would use water as a source of photo generated electrons and protons. The aim of the current project is to improve the direct electron transfer within a novel class of biophotoelectrodes. One protein of choice as the biocomponents is cytochrome c553, the soluble electron donor to the photo-oxidized reaction centre of photosystem I. A library of novel His-tagged cyt c553 variants is currently genetically engineered to contain 7-amino acid peptide linkers, optimized for Gibbs free energy levels, at carboxyl terminus between the cyt holoprotein and a His6-tag. The peptide linkers will allow for optimization of both distance and orientation of the redox-active heme center of cyt c553, ultimately leading to improved DET and better cathodic photocurrent output. The second device will generate anodic photocurrent by using modified His-PsaD-PSI as the photoelectroactive protein layer. Here, we show the results of the genetic engineering, as well as the biochemical expression and purification of the above mentioned protein components of the biophotocathodes and biophotoanodes that ultimately will be incorporated in full solar-to-fuel devices.

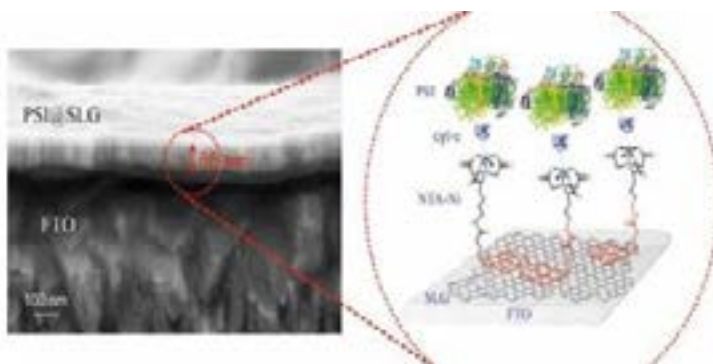


Figure: Cross-sectional SEM imaging of the PSI@SLG (PSI conjugated through His6-tagged cyt c553 with the graphene-pyrene-NTA-Ni) electrode.

Recent Publications:

1. Mazor Y, Borovikova A, Caspy I and Nelson N (2017) Structure of the plant photosystem I supercomplex at 2.6 angstrom resolution. *Nature Plants* 3:17014–17014.
2. Kargul J, Janna Olmos J D and Krupnik T (2012) Structure and Function of Photosystem I and its application in biomimetic solar-to-fuel systems. *Journal of Plant Physiology* 6:1639–1653.

Biography

Miriam Izzo is a PhD student at faculty of Biology at University of Warsaw. Her work is focused on the photocurrent and solar fuel generation by nano structuring of robust photosystem I from *Cyanidioschyzon merolae* on semiconductive electrode materials. Currently, she is the PI of DSM grant 2018/2019.

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