Hereditary Genetics: Current Research
ISSN: 2161-1041
2020
Vol.9 No.2

Incorporation of an azurin from Pseudomonas fluorescens 198 coupled to CuInS2 quantum dots as photosensitizer in Grätzel cells

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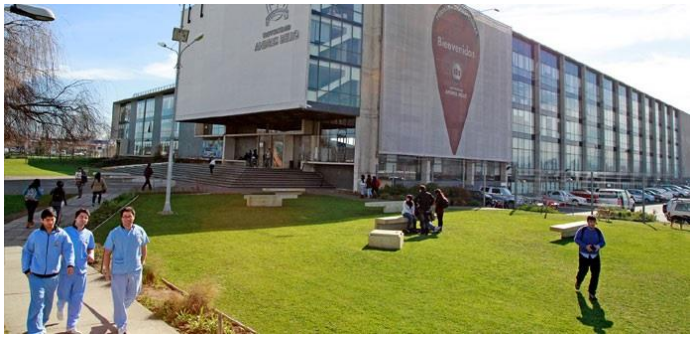
Abstract

The sun is the most clean, abundant and available source of renewable energy. First generation solar cells allow the conversion of solar radiation into electricity with an efficiency of ~25%. Nevertheless, photovoltaic market is evolving to improve production costs, efficiency and sustainability. New generation of solar cells are sensitized with different molecules like dyes, nanoparticles, and more recently proteins have been tested as photosensitizers. In this study, a redox protein (azurin) coupled to CuInS2 quantum dots (QDs) are used as photosensitizers in a Grätzel solar cell. The azurin gene was identified within the genome of a strain from our collection of Antarctic bacteria (Pseudomonas fluorescens 198). This gene was cloned and overexpressed in E. coli, and the His-tag purified azurin + CuInS2 QDs were incorporated in a sensitized solar cell, using TiO2 as anode and Pt as counter electrode. In our laboratory, biomimetic and biosynthesized nanoparticles of CdS and CuInS2, among others, have been successfully used as photosensitizers. Preliminary studies have indicated an increase in 56% of the efficiency when the azurin is incorporated to the cell, compared to the cell sensitized only with CuInS2 QDs. The efficiency is also improved when CdS QDs are coupled to the azurin (42%). The most stable orientation of the His-tag azurin in the TiO2 layer is being studied by hybrid quantum mechanics/molecular mechanics (QM/MM) calculations, in order to determine if any particular position favors the electron transference to the anode. This project is supported by FONDECYT grants 3170718 and INACH RT_26-16.



Biography:

Carolina Quezada has completed her PhD in Biotechnology at the University of Manchester on 2016 and now works as a postodotoral research scientist at the Center for Bioinformatics and Integrative Biology (CBIB) at Universidad Andrés Bello, Chile. Since her PhD she has been studying bacterial redox proteins, managing to cristalise for the first time a reductive dehalogenase with potential applications in bioremediation [Nature 2015; 517(7535):513-516]. Now her work is focused in the design of greener solar cells using biological compounds and biosynthesized nanoparticles.

Speaker Publications:

1. "Biotransformation of 2,4,6-Trinitrotoluene by Pseudomonas sp. TNT3 isolated from Deception Island, Antarctica"; January 2020Environmental Pollution 262
DOI: 10.1016/j.envpol.2020.113922
2. "Biological Synthesis of CdS/CdSe Core/Shell Nanoparticles and Its Application in Quantum Dot Sensitized Solar Cells"; July 2019Frontiers in Microbiology 10:1587
DOI: 10.3389/fmicb.2019.01587

3. "Phosphate Favors the Biosynthesis of CdS Quantum Dots in Acidithiobacillus thiooxidans ATCC 19703 by Improving Metal Uptake and Toleranc"; February 2018Frontiers in Microbiology 9
DOI: 10.3389/fmicb.2018.00234

24th European Biotechnology Congress; September 23-24, 2020, Webinar

Abstract Citation:

Carolina Paz Quezada, Incorporation of an azurin from Pseudomonas fluorescens 198 coupled to CuInS2 quantum dots as photosensitizer in Grätzel cells, Euro Biotechnology 2020, 24th European Biotechnology Congress; September 23-24, 2020 Webinar

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