BioNanoCat: Biogenic Nanoparticles Prepared from Bacterial Biofilms for Electrocatalysis

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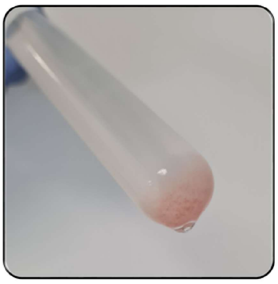
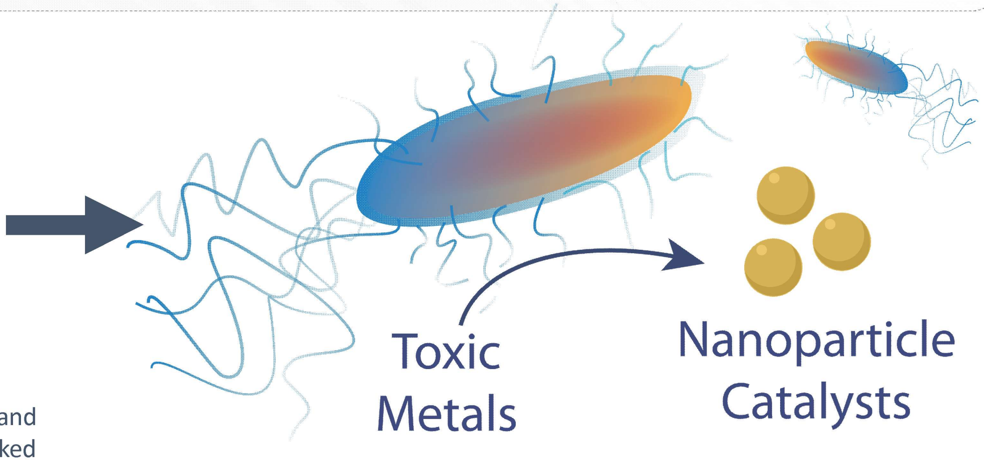
Introduction

Supported nanomaterial catalysts are frequently employed in important processes for generating green electricity such as **hydrogen-oxygen fuel cells.** These catalysts often exploit precious and semi-precious metals such as Platinum, Copper, Ruthenium and Cobalt in processes such as the **Oxygen Reduction Reaction** and **Hydrogen Evolution Reaction.** Many of these metals are present in natural environments as **toxic pollutants.** Bacteria have evolved mechanisms to neutralise these toxic metals for their own survival. The result? **Nanoparticles!** BioNanoCat exploits these natural survival mechanisms to use bacteria as **living factories for green catalysis.**

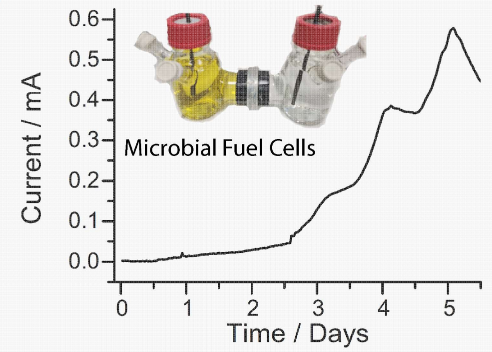
Bacteria are Living Factories

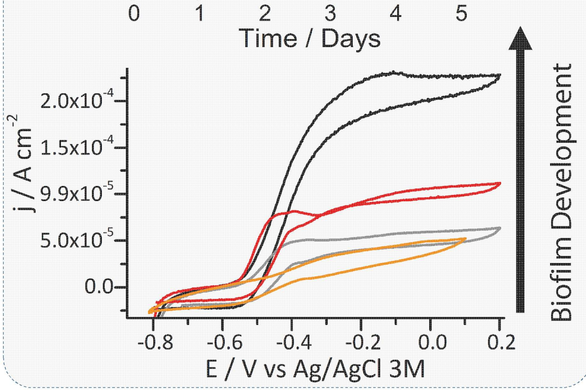




We grow cultures of bacteria in the lab and encourage them to form **biofilms** – interlinked communities of bacteria – in the presence of toxic metals. We grow biofilms attached to electrodes that can be used to directly **produce electricity while producing metal nanoparticle catalysts.** These catalysts can then be repurposed for other energy applications

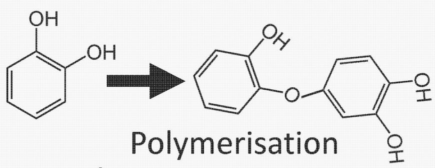
Direct Electricity From Biofilms

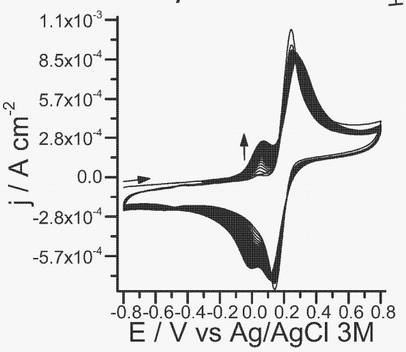




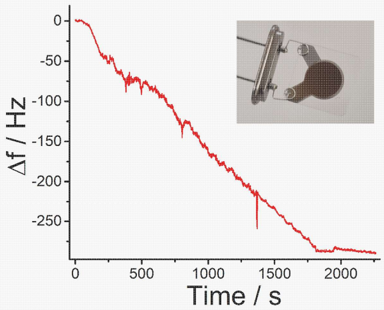
Attaching biofilms of **exoelectrogenic bacteria** to conductive surfaces allows us to couple their metabolism to electricity generation. These bacteria **effectively 'eat' toxic metals to produce electricity and biosynthesise nanoparticles in the process!**

Modifying Surfaces for Biofilm Attachment



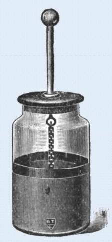


Quartz Crystal Microbalance Studies



We also modify our materials with biocompatible coatings suitable for attachment of bacteria. This requires a knowledge of surface and polymer chemistry. We can monitor our coating process using an oscillating **quartz crystal microbalance**, which changes frequency as the coating thickness increases. We can also use the same technique to detect if our bacteria have attached to the surface and started growing as a biofilm.

BioNanoCat & Leiden



The Leiden Jar – Electrical Energy Storage Device Discovered in **Leiden** by **Pieter van Musschenbroek in 1746. van Musschenbroek** was the son of **Johann van Musschenbroek,** a famous instrument maker in Leiden who designed **microscopes used to view microbes including bacteria!**

BioNanoCat

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Related Publications

Behan, J.A.; Mates-Tores, E.; *et al. Small*, 15 (48), **2019,** 1902081.
Behan, J.A. *et al. Electrochimica Acta,* **2019,** 304, 221-230.
Iannaci, A.; Myles, A.; **Behan, J.A.** *et al. Bioelectrochemistry,* **2020,** 136
Zen, F.; Angione, M. D.; **Behan, J. A.** *et al. Sci Rep-Uk*, **2016**, *6*, 24840.

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