POC-22-rossa-C1net-public-summary-application

PI Claudio Avignone Rossa – University of Surrey

Electroautotrophic bacteria as chassis for electrofermentation of C1 gas

Microorganisms obtain their energy through the oxidation of organic compounds. These supply carbon moieties and energy, extracting electrons which are converted through highly specific pathways into a form of energy that can be used by the microorganisms to produce cellular material. To obtain energy, most species transfer those electrons to an electron acceptor (oxygen, metal ions, sulphate, etc), and some of them are able to utilize an electrode as the electron acceptor. If this electrode is connected to an external circuit, the electrons circulate towards a cathode, where they can be transferred to a suitable oxidized compound, generating an electric current.

Carbon dioxide is a very stable molecule, difficulty to reduce chemically under standard conditions. Plants and some microoorganisms are able to utilize it as carbon source using sunlight as the source of energy through the process of photosynthesis. However, a small number of microbial species, if electrical energy is provided, can reduce CO2 and produce useful compounds.

This project combines the capability of certain microorganisms to generate an electrical current with the capability of other types of microoorganisms to utilize electrical power to convert CO2 into useful molecules. We will initially use natural species to demonstrate this concept, and we will later combine those species to identify their most important metabolic capabilities to carry out this process. We will use an electric current to drive the reduction of CO2, and assess the efficiency of the process. In the final stages of the project, we will attempt to increase the microbial production of electrons by using a consortium of microbial species to oxidise the organic matter present in complex feedstocks (such as wastewater), in order to minimize the input of external electrical power. Finally, we will be able to understand how to manipulate the metabolism of microbial species to optimize bioelectrochemical processes.

This project will have an impact in several issues affecting quality of life and sustainability: It will help to decrease the dependency on fossil fuels by synthesizing chemicals currently obtained from oil; it will assist in reducing the effect of CO2 generated in industrial processes by capturing this important greenhouse gas; and will improve the efficiency of water treatment processes, generating cleaner water with a lower content of pollutants.