DIPARTIMENTO DI INGEGNERIA
CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE -
PHD COURSE IN INDUSTRIAL AND INFORMATION ENGINEERING - 36TH CYCLE

Title of the research activity:	Enzymatic fuel cell technology for energy production from bio-sources
State of the Art:	Enzymatic biofuel cells (EFCs) are bioelectronic devices that use oxidoreductase enzymes as electrocatalysts for the oxidation of an organic substrate and/or the reduction of oxygen or peroxide, finalized to direct energy conversion to electricity. Enzymes provide excellent specificity towards the substrates, avoiding, in some cases, the need of membranes and noble metals, thus realizing very compact systems suitable for miniaturization. Other advantages include high catalytic activity with low overvoltage for substrate conversion, mild operating conditions, like ambient temperature and near-neutral pH and low cost. EFCs can be utilized in a variety of applications, which need low power input and the biocompatibility of the device, including implantable or wearable biofuel cells, self-powered biosensors and, generally, portable battery-free power solutions. For enzymatic biofuel cell design, an effective immobilization of enzymes on the electrodes is an important challenge to obtain direct electron transfer without mediators, resulting in higher performance and improved long term stability. The use of conductive nanomaterials and different types of polymers as electrodes allow to achieve high specific surface, increasing the number of wired enzymes per volume unit, and facilitate the electron transfer between enzyme active site and electrode.
Short description and objectives of the research activity:	The research activity focuses on the development and prototyping at lab scale of an innovative EFC design with particular attention to glucose fuel cells (GFCs), a subtype of conventional EFCs able to oxidize glucose provided by a lot of metabolic processes. Specifically the activity aims to the prototype realization with continous substrate feeding at both cathode and anode realizing a flow cell The design of both bioanode and cathode are mainly focused on the use of glucose oxidase (GOx) and glucose dehydrogenase (GDH), but also different enzymes (e.g. copper oxidases, such as laccase or bilirubin oxidase (BOD) for biocathodes) could be considered. Since glucose is an essential, relatively abundant and almost unlimited source of energy in living organisms, possible applications are the development of implantable GFCs as well as the exploitation of agro-industrial wastes in the framework of a circular economy.
Bibliography:	
Scientific coordinator (s)	Prof.ssa Linda Barelli
Contact (s)	linda.barelli@unipg.it

	Phone: +39 0755853740