Bioresorbable Self-powered Implantable Device

Rendicontazione

Informazioni relative al progetto

BIOIMD

ID dell'accordo di sovvenzione: 896811

Sito web del progetto

DOI
10.3030/896811

Progetto chiuso

Data della firma CE
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Periodic Reporting for period 1 - BIOIMD (Bioresorbable Self-powered Implantable Device)

Periodo di rendicontazione: 2021-01-15 al 2023-01-14

Sintesi del contesto e degli obiettivi generali del progetto

The Marie Curie Individual Fellowship entitled 'Bioresorbable Self-powered Implantable Device' (BIOIMD) trained the talented research, Dr. Sujoy Kumar Ghosh, in the highly relevant scientific and technological fields of piezoelectric energy harvesting and biomedical devices. Novel implantable

medical devices (IMDs) allow one to perform continuous detection and analysis of physiological parameters as well as of disease evolution inside the human body. Hence, they are very important in the broad framework of human health care, diagnostics, prevention of diseases, and monitoring of therapies. However, a few challenges remain to be addressed, such as the need of IMDs to be supplied with continuous power. This is the key issue being addressed by the BIOIMD project. To overcome problems related with implantable batteries, including limited lifetime and surgical positioning, the pursued strategy is scavenging energy from biomechanical sources using biocompatible and ultimately bioresorbable piezoelectric devices. To this aim, BIOIMD was designed by three interlinked workpackages and focused on the implementation and development of effective arrays of nanopillars based on bio-polymers to be used as (i) biodegradable energy harvester and (ii) implantable biomedical device.

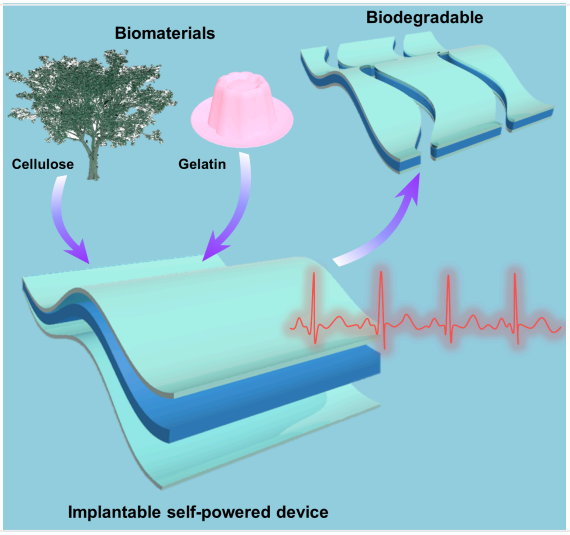
Lavoro eseguito dall'inizio del progetto fino alla fine del periodo coperto dalla relazione e principali risultati finora ottenuti

The BIOIMD project was highly challenging and highly interdisciplinary, and the successful accomplishment of the project goals required extensive work performed in parallel on several and synergistic experimental research lines:
(a) Developing arrays of nanostructures made of bio-polymers on flexible substrates, using soft lithographic methods, and probing their piezoelectric properties at nanoscale;
(b) Integrating piezoelectric configurations of nanostructures in energy harvesters, with applications evidenced in self-powered consumer electronics;
(c) Implementing such developed devices as a self-powered IMD with bioabsorbability tests and other in-vitro experiments.
Various bio-polymers and nanocomposites were tested, producing films covered by nanostructures that are free-standing and flexible. Produced structures were imaged by atomic force and scanning electron microscopies, and the properties of so-obtained materials were analyzed by a set of complementary techniques including micro-Raman mapping, Fourier Transformed Infrared Spectroscopy and X-ray diffraction. The investigation of the piezoelectric properties of the realized systems at the nanoscale was carried out by extensive piezoforce microscopy experiments. Different device architectures were then obtained upon embedding the produced structures and films into multi-layer configurations, and their piezoelectric properties were fully characterized in terms of produced voltage, current, pressure sensitivity and power output. In vitro studies comprised not only bioresorbability tests, but also cell viability. Results were highly promising, both in terms of development of new and well-assessed recipes for micro- and nanofabrication of piezoelectric structures by biocompatible materials, and in terms of device performance. Applications demonstrated were various, and comprised both interfacing and integration with commercial device platforms and monitoring applications, fully in line with the original project objectives.
The Marie Curie Individual Fellow was tightly integrated within the research group of the hosting institution, and he already consolidated his role in the scientific community of energy harvesting and implantable devices. Also, new scientific collaborations were promoted by the project. A paper was

published in the journal ‘Accounts of Materials Research’. Three further journal articles are currently in preparation.

Progressi oltre lo stato dell’arte e potenziale impatto previsto (incluso l’impatto socioeconomico e le implicazioni sociali più ampie del progetto fino ad ora)

A wide-range impact is achieved or will be potentially obtained by the BIOIMD project, both for the Individual Fellow and at socio-economic level, and in terms of interest for the broad and general public.
The research training and management activities, together with the newly acquired scientific skills (both technological and in basic science) strongly contributed to consolidate the scientific position of the Individual Fellow and his career in Science.
In addition, new bioimplantable and bioresorbable devices will open several future directions for healthcare monitoring. Compared with other existing solutions that are based on inorganic materials, semiconductors, or lead-based materials with limited biocompatibility, frequent use of toxic compounds for synthesis, harsh conditions and complex and expensive fabrication steps, the strategies pursued in the BIOIMD project are significantly interesting, since they are eco-friendly and cost-effective while retaining excellent device performance. For these reasons, there is a huge opportunity for socio-economic impact in the sectors of biomedical sciences and engineering, neurotechnologies, and wireless components for health-care support and monitoring. In addition, materials characterization tasks already provided a significant advancement beyond the state of art, highlighting new physical properties in the investigated compounds (including self-healing properties) and contributing to European research excellence. Furthermore, new optimized recipes for micro- and nanofabrication were delivered by the project, which might serve as fundamental basis for future technologies.
All the foreground publications of BIOIMD are to be made Open Access, and the project is also mentioned in review papers and further dissemination action towards the general public, such as the European Researchers’ Night event. These dissemination actions, while enhancing the overall visibility of the project, also contribute to raise awareness towards the critically-important theme of sustainability.



Schematic description of the BIOIMD platform and activities

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