UNIVERSITY OF BRESCIA

PhD Program
in
TECHNOLOGY FOR HEALTH

PRINTED SENSORS ON NON-CONVENTIONAL SUBSTRATES

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[XXXIV Cycle]

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Background

Printed electronics has emerging as promising candidate in fields like diagnostics or tissue engineering with technological platforms giving feedbacks on biological samples or physiological processes. Moreover, the recent attention for disposable, low-cost and reliable biomolecule-to-chip interface systems is becoming an urgent need due to novel international regulatory guidelines.

Objectives

The aim of this work is to develop a paper-based disposable miniaturized electrochemical platform for protein biomarkers detection, by means of Aerosol Jet Printing, extending the results obtained during previous works performed on ceramic and glass substrates.

Methodologies

AJP with paper-based substrates will allow the development of a new disposable low-cost paper-based platform, combining the high resolution and repeatability of AJP with low-cost and disposable property of paper-based substrates.

Wax printing will give to paper hydrophobic properties in specific areas if necessary: once printed on the surface of the paper, a hot plate melts the wax which penetrates the full thickness of the paper, creating complete hydrophobic barriers.

Sintering of printed lines will be performed thanks to Photonic sintering technique, which allows to sinter on low-temperature substrates like paper.

Electrical, mechanical and electrochemical will be performed to fully test and validate the proposed platform.

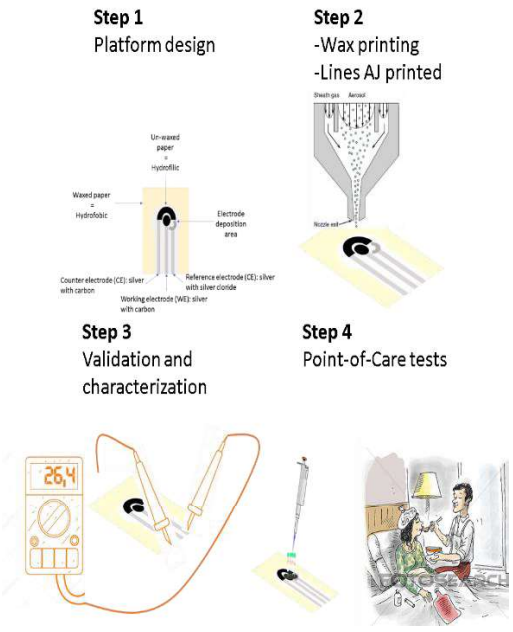

FIGURE 1. A CAPTION HERE.

Expected Results and Impact

After a preliminary validation in a laboratory environment, the use of paper-based substrates disposable and with peculiar fluid handling capability, will allow to address the optimization of the device for a PoC use, outside the laboratory, directly at patient bed-site or at home.

Wearable technologies and biomechanical modeling: a subject-specific approach to the analysis of human movement

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XXXIV Cycle

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Background

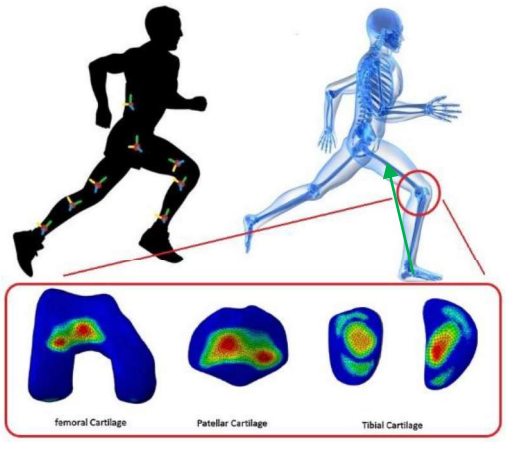
Gait analysis is a common tool exploited in clinical practice for the assessment of gait disturbances, evolution of neuromusculoskeletal diseases, and personalized rehabilitative treatment. Nevertheless, classical gait analysis methodologies are intrinsically indoor evaluation instruments, which may be not representative of everyday outside world. In order to overcome this limitation, the use of wearable sensors is emerging as solution for kinematics monitoring in realistic daily life conditions, thereby allowing the acquisition of a larger amount of individual data for better diagnostic and prognostic purposes.

Objectives

The main objective of the project is the development and optimization of an Inertial Measurement Units (IMUs) system able to accurately quantify both kinematics and ground reaction forces during various motor tasks. A multifactorial analysis of the collected data will provide information about pathophysiological conditions of articulation tissues.

Methodologies

Wearable sensors technology will be calibrated against video-based gait analysis and an algorithm for the ground reaction forces detection will be implemented. Subject-specific multiscale modelling will elaborate kinematic and kinetic data, allowing the assessment of various parameters such as joint contact forces, joint contact areas and stresses on articular tissues. The relationship between kinematics and kinetics with tissues condition will be investigated in order to develop an injury risk algorithm.



Expected Results and Impact

The exploitation of wearable technologies in gait analysis will contribute to the improvement of knowledge around load bearing capacities of body articulations. An early individuation of aberrant modifications of gait pattern will have the potentiality to support the planning of the most appropriate corrective treatment for prevention of joint degenerative pathologies or injuries.

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DEASPHOR – Design of a product for substitution of phosphate rocks

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Background

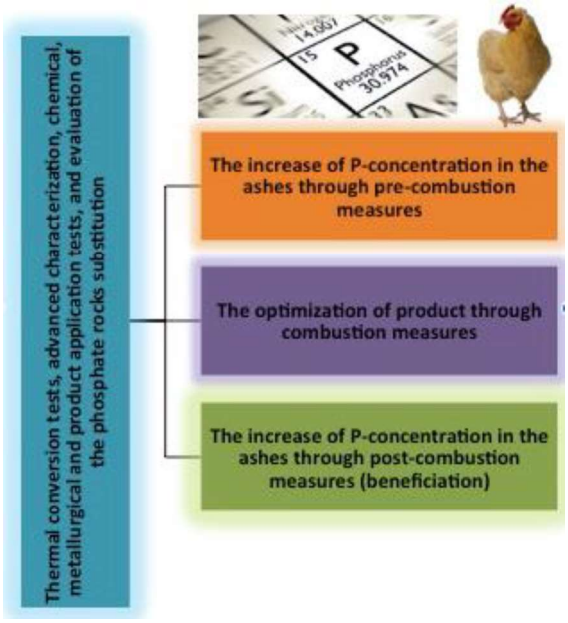
Phosphate rock production (included in the list of critical raw materials for the EU) is abundant but finite, and controlled by few countries with Morocco and Western Sahara controlling 77% of the reserves. To complicate, there are no substitutes for phosphorus as a plant nutrient, and no P-recycling is being made. Therefore to prevent a sustainable P supply, and food in a world growing population, one option is to reduce demand of phosphorus, and the other is P-recycling from primary sources (e.g. manure). Aviary litter is the richest-P manure, but its direct utilization "burns" plants since it has eight times more P than plants need. However, the incineration of aviary litter concentrates P and generates ash that is a readily available and huge P-source.

Objectives

The global objective of this project is the recycling of phosphorus from poultry litter ash to be used as a substituting material of phosphate rocks.

Methodologies

DEASPHOR project considers a multidisciplinary approach in collaboration with industry. Therefore, it is composed of a set of complementary and subsidiary research teams. For what concerns Ario's work, it provides for sampling using mostly rice husk as aviary bed; then regarding characterization, the poultry litter ash should be characterized in terms of basic and advanced techniques (e.g. XRD, Raman, XPS, SEM/EDS, EMPA). The results obtained will be used to understand the P-partitioning and materials formed, and provide the information to optimize the product and its applications, and the efficiency of the P-extraction. Finally, regarding the product evaluation, the evaluation of the phosphate rocks substitution will be based on embodied energy and the CO_2 footprint parameters.



Expected Results and Impact

The use of ash waste as a substituting material of critical raw material is an essential part of increasing resource efficiency and closing the loop in a circular economy. This will contribute to turn one industry's by-product into another industry's critical raw material. As consequence, it will improve EU competitiveness through development of industrial technologies related to the recycling of substitutes of phosphate rock, finally resulting in the creation of technological knowledge, value, economic reinforcement, specialized skills development and jobs, pushing EU to the forefront in P-recycling.