mCBEEs – Open PhD positions in the H2020-MSCA-ITN Project

Advanced integrative solutions to Corrosion problems beyond micro-scale: towards long-term durability of miniaturized Biomedical, Electronic and Energy systems

mCBEEs

15 OPEN PhD Positions

mCBEEs Innovative Training Network is a joint venture between academy and industry with a primary goal to train young researchers in the field of **corrosion and corrosion protection** of **micro-** and **nanodevices**. The network focuses on the study of corrosion mechanisms beyond microscale of components in miniaturized systems in different environments using localized techniques, and the development of multifunctional protective coatings to increase the long-term durability of such components.

Three main strategic fields where corrosion could seriously compromise the performance of micro- or nanodevices have been identified: **biotechnology** (micro/nano-robotic implants, micro/nano-electrodes for recording and stimulating neuronal activity, or microfeatured prosthesis implants); **electronics** (micro/nano-components in electronic boards, magnetooptical thin films, multiferroic micro/nano-devices); and **energy technology** (metallic foam-based micro- and nanostructured electrodes, self-standing nanoarchitectures). Several disciplines (physics, electrochemistry, engineering, biology and robotics) converge to provide a multidisciplinary approach to accomplish mCBEEs goals.

The ITN brings together 15 beneficiaries and 5 partners including 4 research institutes and 4 private companies belonging to 11 countries. The Consortium complementarity will enable a highlevel, multifaceted educational programme, where specials efforts will be done to bridge fundamental research with industrial applications. The educational programme is integrated with training in soft skills and aims at providing a network of highly qualified researchers able to tackle challenges both in Academia and Industry.

Applications are now open through http://mcbees.eu

For more information contact us: mcbees@uniud.it

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Benefits and salary

The successful candidates will receive an attractive salary in accordance with the MSCA regulations for Early Stage Researchers (http://ec.europa.eu/research/mariecurieactions/) in the form of a scholarship.

The exact salary will be confirmed upon appointment and is dependent on the country correction factor (to allow for the difference in cost of living in different EU Member States). The salary includes a living allowance, a mobility allowance and a family allowance (if already married). The guaranteed PhD funding is for 36 months.

In addition to their individual scientific projects, all fellows will benefit from further continuing education, which includes secondments to other institutes members of the mCBEEs consortium, 3 trainning schools and 2 workshops within the mCBEEs and active participation in conferences.

Eligibility criteria

Applicants need to fully satisfy the following criteria:

- Be **Early-stage researchers** (ESR). ESRs are those who are, at the time of recruitment by the host, in the first four years (full- time equivalent) of their research careers. This is measured from the date when they obtained the degree which formally entitles them to embark on a doctorate.
- **Have a diploma granting access to doctorate** studies and not have already a PhD.
- Not have resided or carried out their main activity (work, studies, etc.) in the country of their host organization for more than 12 months in the 3 years immediately prior to their recruitment.
- **English language**: Network fellows (ESRs) must demonstrate that their ability to understand and express themselves in both written and spoken English is sufficiently high for them to derive the full benefit from the network training.

Open Positions

ESR 1 – University of Udine, Italy

Project Title: Localized corrosion mechanisms on micro- and nano-devices in the biomedical field

Objectives: Fundamental research of the main mechanism of corrosion of micro- and nanodevices in simulated biological fluids. Corrosion will be explored using first model samples with controlled shapes, sizes and chemical composition and later on real devices. The corrosion of metallic micro- and nanocomponents will be studied using localized electrochemical techniques such as electrochemical micro-cell, AFM-SKPFM, SVET and SECM. Additional investigation will be performed on corroded specimens after exposure to aggressive environments using microscopy techniques.

Expected Results: Understanding the corrosion mechanisms at micro- and nanoscale, to verify the limits of the existing localized electrochemical techniques.

ESR 2 – Swiss Federal Institute of Technology Zurich, Switzerland

Project Title: Rolled-up three-dimensional multi-ferroic electrode microsystems for neural cell stimulation

Objectives: 3D-dimensional multilayered structures (i.e.: compact and porous tubes and helices) containing layers of ferromagnetic shape memory/magnetostrictive metals (i.e.: Fe-, Co-, NiMnGa) and piezoelectric components (i.e.: ZnO, $BaTiO_3$) will be realized by means of the rolled-up manufacturing approach. The structures will be prepared using lithography and vapor deposition techniques and characterized using SEM, TEM, XRD and

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magnetometry. The generation of electric potential will be mediated using external magnetic fields due to the coupling between the piezoelectric and the piezomagnetic layers.
Expected Results: These microelectrodes are envisioned as implantable wireless systems for in vitro neural cell stimulation. Implantable long-term biocompatible devices with reduced corrosion and biofouling effects are expected.

ESR 3 – Delft University of Technology, Netherlands
Project Title: Study of localized corrosion of micro- and nanodevices: pushing localized electrochemical methods to the limit
Objectives: Fundamental research on the main mechanism of corrosion in micro- and nanodevices. Establishing kinetics, galvanic factors, electrical bias, and influence of corrosive environment. Corrosion will be studied first taking model samples with controlled properties (composition, film thickness, geometry etc.) and later on real devices. Research will be based on the application of scanning electrochemical techniques (SECM basis). Additionally, electrochemical AFM measurements will be performed for in-situ monitoring of the degradation processes (dissolution rate) with resolution in the nanometer domain.
Expected Results: Understanding the corrosion mechanisms in the micro- and nano-scale, verify the limits of the existing localized electrochemical techniques.

ESR 4 – Istanbul Technical University, Turkey
Project Title: Fabrication of corrosion resistant nanowire-based electrodes produced by template-assisted electrodeposition for different energy related applications
Objectives: Metal foams, in particular Ni, are being suggested as electrode materials for supercapacitors. One of the aims of the project is to use self-standing nanowire structures as an alternative to foams. Single metal (e.g. Ni) and alloy (e.g. Ni-Mn) nanowires with tunable aspect-ratio will be produced by electroplating using pore bottom activated AAO templates. Other than supercapacitor applications potential of large area free standing nanowires will also be sought for electrolysis of water and bipolar electrodes.
Expected Results: The expected benefit of using free-standing NW structures instead of foams is a higher capacity per area. Potential of these structures for using in other energy applications. Optimization of the structure and composition to increase corrosion resistance.

ESR 5 – Universitat Autònoma de Barcelona, Spain
Project Title: Electrosynthesis of porous metallic films for energy-related applications
Objectives: Electrodeposition of porous metallic films (e.g. Ni, Cu-Ni, Ni-Mn, Fe-Pt, Ni-Pt). Two different porosities will be targeted: macroporosity by means of hydrogen co-evolution or colloidal templating, and nanoporosity (e.g. by adding surfactants to the bath, eventually at large concentrations in order to create lyotropic liquid crystal phases); Characterization of magnetic and mechanical properties; Assessment of their electrocatalytic performance (e.g. hydrogen evolution reaction); Evaluation of their durability in targeted media (e.g. KOH).
Expected Results: Control over pore size, pore distribution and stoichiometry; enhanced electrocatalytic performance compared to non-porous counterparts. Optimization of the microstructure and composition to enhance corrosion resistance.

ESR 6 – Magnes AG, Switzerland
Project Title: Electrodeposition of corrosion-resistant ferromagnetic microparts for microelectromechanical systems
Objectives: Development of soft- and hard-magnetic microparts with good mechanical and corrosion properties. Micro gears with magnetic actuation to be utilized in micropositioners for use in optics, bioelectronics, and mobile applications will be developed. As the miniaturized parts are intended for log-term usage in different environments, they are prone

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to corrosion and alteration of magnetic properties. The corrosion performance of the developed parts under simulated environments will be assessed using localized techniques. Expected Results: Establishment of the correlation between plating parameters and structure with mechanical and corrosion properties. To explore the potential of localized techniques in the characterization of microstructures' properties. Understanding of the corrosion behaviour of the studied alloys at localized level. Integration and validation of the developed microparts.

ESR 7 – Research Institutes of Sweden, Sweden
Project Title: Assessment of the effect of corrosion on the efficiency and reliability of electrochemical energy conversion systems
Objectives: 1) To understand the mechanism of micro-corrosion phenomenon in the application environment (multi-materials, bias, strong electrolyte, elevated temperature, cyclic exposure, etc.) of electrochemical energy conversion. 2) To understand the effect of micro-corrosion on degradation of functionality in electrochemical energy conversion (e.g. poisoning of catalyst). 3) To develop accelerated methods for evaluation of durability of electrochemical energy conversion systems.
Expected Results: Improved efficiency and lifetime of electrochemical energy conversion systems (fuel cells, electrolyzers, batteries, supercapacitors).

ESR 8 – Jozef Stefan Institute, Slovenia
Project Title: ALD inorganic and hybrid coatings for versatile applications
Objectives: Main objective of the PhD thesis is to develop inorganic ALD oxide coatings (e.g. HfO_2, ZnO, Al_2O_3, ZrO_2, TiO_2) and hybrid multilayer coatings using ALD and sol-gel deposition. Their physicochemical and protection properties will be characterized at micro- and nano-scale using different techniques (FIB, AFM, Raman, iR, etc) as a function of deposition parameters. Two types of coatings will be developed aiming at applications in (i) biomedical devices, where coatings with potential antibacterial ability to reduce incidence of bacterial infection of implanted biomedical devices will be developed, and (ii) electronic components requiring the protective coatings when exposed to potentially harsh environments.
Expected Results: Development of protective coatings by ALD method for targeted applications.

ESR 9 –Vrije Universiteit Brussel, Belgium
Project Title: Numerical modelling including mass transfer in thin electrolyte films
Objectives: Development of a numerical model to study and predict corrosion in systems with decreasing electrolyte layer thickness (< ~500 μm). To make use of data collected at TUD and UNIUD in special electrochemical reactors where the electrolyte film thickness will be varied in a controlled way. Validation of the model will be done based on experimental results coming from the other network partners.
Expected Results: Dynamic film thickness evolution will be included into the corrosion model to fully take into account the strong dependency of the electrochemistry on the electrolyte film. We expect accurate modelling of the evolutions in concentrations and effects of these concentrations not only on the electrochemistry, but also the film thickness itself.

ESR 10 – University Politehnica of Bucharest, Romania
Project Title: Electrodeposition of nickel and tin based alloys for electronic devices
Objectives: Binary Sn-Cu, Sn-Ni, Sn-Co and ternary Sn-Ag-Cu, Sn-Cu-Ni alloys coatings will be developed using electrochemical deposition from aqueous and ionic liquids based electrolytes. The influence of the main operating parameters including electrolyte

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composition, metals content, metal ion ratios in the electrolyte, applied current form (DC and pulsed current) and density and temperature on the final composition, quality and aspect of the alloy coating layer will be investigated. The alloy coatings will be analyzed for structure, morphology, wettability. The obtained coatings will be tested for corrosion by electrochemical methods including potentiodynamic polarization and electrochemical impedance spectroscopy and by microscopic analysis.
Expected Results: The aim is to prepare improved products comparing to traditional coatings by using environmental friendly media to be applied on micro-devices in order to increase their durability.

ESR 11 – AGH University of Science and Technology, Poland
Project Title: Improvement of corrosion resistance of biodegradable magnesium alloys in simulated body fluids
Objectives: Improvement the corrosion resistance of magnesium alloys by means of biocompatible coatings. The corrosion studies will be performed on Mg-Ca, Mg-Ca-Si and Mg-Ca-Zn magnesium alloys in simulated body fluids. In order to improve the corrosion resistance of magnesium alloy chitosan and polypyrrole coatings will be deposited. These coatings will be doped by bioglass, antibacterial nanoparticles. The corrosion of Mg-alloys at the micro-scale will be studied using localized electrochemical techniques such as electrochemical micro-cell, pH microelectrodes, SVET. Additional investigation will be performed on corroded specimens after exposure to aggressive simulated body fluids by means of microscopic techniques (SEM, TEM). The properties of biodegradable coatings will be investigated by using electrochemical impedance spectroscopy and spectroscopic techniques (FTIR-ATR, Raman spectroscopy, XPS).
Expected Results: Understanding the corrosion mechanism of magnesium alloys at micro- and nanoscale by means of localized techniques. Reduction of corrosion rate of magnesium alloys in simulated body fluids thanks to deposition of the biocompatible coatings.

ESR 12 – Jonkoping University, Sweden
Project Title: Chemical and electrochemical passivation for corrosion protection of Cu and Al alloys for electronic and energy applications
Objectives: Development of conversion coatings for the corrosion protection of micro-featured systems. Two systems will be target: Cu and Cu alloy in electronics and Al and Al alloys for energy applications. Wet chemistry route will be applied in order to obtain surface passivation due to conversion coatings. Ain focus will be RE containing conversion coating by chemical or electrochemical deposition. Microstructure, chemical and electrochemical characterization of the passivated surface will be carried out with FIB-SEM, AFM and localized electrochemical techniques.
Expected Results: Definition of the optimal deposition condition (chemical composition of the solution, pH, oxidant concentration, current application). Definition of the relationship between deposition parameters, composition, and protection capability. Understanding the corrosion protection mechanism at localized level.

ESR 13 – Instituto Nancional de Engenharia Biomédica, Portugal
Project Title: Long-term assessment of nervous tissue response to implantable micro-electrodes
Objectives: Evaluate in vitro the morphological and functional modifications of the neuronal tissue surrounding an implantable micro-electrode. Cell viability, electrical and morphological coupling in long-term experiments with micro-electrode arrays will be conducted in cortical primary neuron cultures. Furthermore, these parameters will be further monitored in the context of cultures of organotypic adult rat brain slices. This will allow the

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assessment of astrogliosis and inflammatory response (microglia) in the context of micro-stimulation, towards the design of strategies to prolong the lifetime and efficiency of implanted micro-electrodes.
Expected Results: Optimization of micro-electrode fabrication from both the electronical perspective and from the biocompatibility and anti-corrosion components.

ESR 14 – Elsyca NV, Belgium
Project Title: Implementation and validation of a deterministic pitting corrosion model
Objectives: The first objective is the development of a mathematically sound deterministic pitting corrosion model that includes conservation equations for the pit population, and kinetic equations for the accumulation rate of metastable and stable pits, and for the re-passivation of large pits. The aim is to bring in the local electrochemical effects in the numerical modelling. The second objective consists in embedding the deterministic pitting corrosion model in a more general existing model for galvanic and atmospheric corrosion, and performing the numerical implementation into an existing corrosion simulations software platform.
Expected Results: Demonstrator of a simulation model that is capable of accurately predicting local pitting corrosion rates on passivating surfaces.

ESR 15 – LimaCorporate S.p.A., Italy
Project Title: Development and characterization of an anti-bacterial and corrosion resistant coatings on micro-porous substrates
Objectives: The main goal is to provide a solution to decrease the infection risk in the implantation of an orthopaedic prosthesis. The purpose will be addressed by designing an appropriate scaffold for implant-tissue interaction and adding anti-bacterial functionality on its surface/material. One of the key success factors will be based on realizing the substrate according to the most suitable manufacturing technology (TT EBM). The anti-bacterial functionality will be added with the development of various treatments containing Ag nano-particles on the produced TT EBM scaffolds. The produced systems will be then tested according to the reference structures and standards. An additional goal is to provide adequate resistance to corrosion phenomena acting on titanium components and surfaces.
Expected Results: TT EBM microporous implants with improved corrosion resistance and antibacterial properties

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