Title: Call for Expressions of Interest for the submission of MSCA-IF projects in nanomaterials for energy conversion

Job Description

IREC, in Barcelona, Spain, is interested in receiving Expressions of Interest of potential candidates for the Marie Skłodowska-Curie Actions – Individual Fellowship (MSCA-IF) 2020 call.

The Functional Nanomaterials Group (FNG) focuses its activities on the development of nanostructured materials for energy technologies. More specifically, the group is interested in the synthesis, surface modification and organization of semiconductor, oxide and metal nanostructures and on the use of nanomaterials for energy conversion and storage, including conversion of heat and solar radiation through thermoelectrics and (thermal, electro)catalysis, and the storage of energy in metal/sulfur batteries and liquid energy vectors. The group is currently formed by 19 researchers and it actively collaborates with several research groups in Europe, USA and China. It participates in several National and International projects developing nanomaterials for different energy technologies. The group laboratories are equipped with the necessary set-ups to undertake every stage in the development of nanomaterial-based energy conversion devices, including nanomaterials synthesis, manipulation and us for the fabrication of devices, material functional characterization and device test.

We are interested in candidates willing to work in one of the following areas:

1. **Thermoelectrics**: The recovery of the huge amounts of energy wasted in the form of heat in transportation and in all industrial and domestic processes is an extremely appealing pursuit both from economic and environmental points of view. This goal requires the use of a distributed network of modular and cost-effective systems that convert heat into electricity. With the steam turbines being not suitable for small scale and portable generation, solid state thermoelectric (TE) devices become a worthwhile alternative. TE devices contain n-type and p type semiconductors connected thermally in parallel and electrically in series. They can be manufactured with virtually any size, are highly durable and can be adapted to harvest energy from any temperature gradient. However, their widespread implementation requires improving their cost-effectiveness by increasing energy conversion efficiency and/or reducing manufacturing costs. The energy conversion efficiency of a TE device can be analytically expressed in terms of the temperature at the hot and cold sides and a unique material-dependent figure of merit (Z), which is generally expressed in a dimensionless form: ZT = σS2T/κ, where T is the absolute temperature, σ the electrical conductivity, S the Seebeck coefficient and κ the thermal conductivity. Commercial TE materials have ZT values just below 1. Using a bottom-up solution-based process, we were able to produce bulk materials with worldwide record ZT values: ZT=1.96 for the p-type compound and ZT=1.31 for the n-type compound. These values would allow up to 60% higher energy conversion efficiencies than current commercial devices. Besides, we have obtained record ZT values for other systems including PbS, CZTS, Ag_2Se, etc. Overall we have demonstrated that the bottom up engineering of nanomaterials is an ideally suited strategy to produce high performance thermoelectric materials and potentially to reduce their cost (S. Ortega et al., Chem. Soc. Rev. 2017, 46, 3510). We are looking for postdoctoral researchers willing to continue this exciting work.

2. **Novel strategies to produce high-surface area nanomaterials with high crystallinity and tuned facets:** Porous nanocomposites are critical components in the fields of catalysis, chemical

sensing and filtering, to mention just a few. Such nanomaterials are frequently produced in two steps; first a porous matrix is obtained using sol-gel chemistry methods, and later this base material is impregnated with the second component, which adds the required complementary functionality, e.g. a co-catalyst or a light sensitizer. This approach presents important limitations. Sol-gel chemistry routes generally result in amorphous materials that require a thermal sintering to attain proper crystallinity. This sintering step strongly reduces the material surface area and prevents tuning grain size, crystal facets and in some cases crystallographic phase. Additionally, widely used impregnation methods offer a limited control over the distribution and structural/chemical parameters of the impregnated component. We have developed alternative strategies to produce porous nanomaterials and nanocomposites based on the cross-linking and gelation of colloidal nanocrystals. Our new strategies allow the formation of porous materials with high crystallinity and unmatched control over structural and chemical parameters. In particular, we developed a strategy of gelation of colloidal NC solutions driven by the electrostatic interaction of oppositely charged NCs. We achieved this goal by means of functionalizing NCs with inexpensive and non-toxic amino acids such as glutamine. In this way, porous nanocomposites with virtually any combination can be produced. We are involved in an European project to produce porous materials and we are looking for postdoctoral researchers willing to work in this stimulating field, with applications in several fields, including energy storage and conversion, filtering, etc.

3. 3D printing. We have demonstrated the possibility to move a jet with accelerations above 500,000 m/s^2 and speeds close to 10 m/s using electrostatic fields. We are using this concept to develop a new 3D printing technology that makes use of electrostatic fields to deflect the material jet and to control in this way the positioning of the added material. The use of a fast positioning will further allow increasing the jet generation speed to 1-10 m/s. We are validating this new and revolutionary technological concept, which will allow printing speeds over 100 times faster than current technologies based on material jetting. At the same time, the use of charged jets potentially allows creating filaments with a thickness down to 100 nm, thus potentially providing sub-micrometer resolution. This technology will be initially based on inks, which will allow creating 3D structures with any composition, including metals, semiconductors, oxides, and even proteins and biological material. The possibility of fabricating 3D structures with submicron resolution at high speed and with an unlimited material versatility, will allow to advantageously compete in a number of fields where conventional additive manufacturing technologies has been already entered and opening new blue ocean markets for 3D printing strategies. We are looking for postdoctoral researchers with experience in ink jet printing, electrospinning and/or 3D printing that are willing to continue the development of this new system

Benefits

The annual budget includes funding for salary, research costs and a contribution to the management and overheads of the project. The salary will be in accordance with the H2020 Marie Skłodowska-Curie rates.

Fellows will be based at the IREC headquarters in Barcelona.

Elegibility criteria:

According to the MSCA-IF-2020 call, the fellows, at the deadline for the submission of the proposals:

- Must be experienced researchers, i.e., e in possession of a doctoral degree or have at least four years of full-time equivalent research experience.
- May not have resided or carried out their main activity (work, studies, etc.) in Spain for more than 12 months in the three years immediately before September 9th 2020.

Application:

Researchers willing to apply should check that they meet the eligibility requirements and send the expression of interest, including:

- Their CV
- A motivation letter
- A summary of their research proposal

Expressions of interest should be sent by email directly to the KTT Office (ktt@irec.cat) indicating "Call for Expressions of Interest for the submission of MSCA-IF projects in nanomaterials for energy conversion" in the subject.

Nr of positions available: 1

Research Fields

Thermoelectricity

Nanostructured materials

Li-S batteries

Li-air batteries

Electrocatalysis

Direct alcohol fuel cells

Direct formic acid fuel cells

Porous materials

Aerogels

3D printing

Electrospinning

Researcher Profiles

Recognised Researcher (R2)

Established Researcher (R3)

Application Deadline: 15/07/2020