H.F.R.I.
Hellenic Foundation for Research & Innovation

Description of the funded research project

2nd Call for H.F.R.I. Research Projects to Support Post-Doctoral Researchers

Title of the research project: **Tuning the prOPerties of CuZn-based nanostructured CATalysts for fuel cell applications (TOPCAT)**

Principal Investigator: **Joan Papavasiliou**

Reader-friendly title: **Tuning the prOPerties of Copper Zink-based nanostructured CATalysts for fuel cell applications**

Scientific Area: **Environment & Energy**

Institution and Country: **Greece**

Host Institution: **University of Patras**

Collaborating Institution(s): **University of Ioannina, Maria Curie-Sklodowska University (UMCS) in Lublin, Poland, Faculty of Chemistry**

Budget: **190.000 €**

Duration: **36 months**

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Research Project Synopsis

The overarching aim of this proposal is to initiate and advance a research program in an emerging area of CuZn methanol reforming catalysts for fuel cell applications, via nanostructuring the parent material and employing atomically dispersed metals (e.g. Au).
The main innovation impact will be the development of highly active and selective catalysts, which will be able to selectively operate at temperatures lower than 200^{o}C. From experimental point of view, significant improvements of methanol reforming catalysts are required with regards to their mass activity in order to be functional within the targeted temperature range (160-200^{o}C). The state of the art CuZnOx catalyst exhibits an appreciable mass activity at temperatures >210^{o}C, which makes it improbable to be used at lower temperatures. In this respect, in order to achieve practically functional methanol reforming catalysts, the following goals will be accomplished: (i) Optimization of CuZn-based catalysts, (ii) Development of atomically dispersed catalysts, (iii) Elucidation of the mechanistic pathways of methanol reforming process, (iv) Demonstration of the functionality of CuZn-based nanostructured catalysts in a methanol fuel cell.

The proposal goes substantially beyond the state of the art by introducing highly ambitious and challenging, novel ideas via combination of different research fields. From a fundamental point of view, the proposal clearly targets novel breakthrough advances in the design of nanostructured fuel processing catalysts, while it will be a great technical advantage that might boost the entire market of fuel cells, since the commercialization of these products demands reformate based fuel cells with operating temperatures at ~160-180^{o}C.

Expected results & Research Project Impact

TOPCAT aims to establish a new generation of highly efficient methanol reforming catalysts operating at temperatures < 200 ºC. This, will boost the reforming technology thus simplifying the portable HT PEM systems; Wide application of PEM FCs. Atomically dispersed Au/CuZn-based nanostructures will promote the scientific knowledge and the interactions in the fields of materials science-catalysis-nanotechnology, opening new paths for catalyst design. Alteration of the hydrogen inhibition effect, will enable methanol processors to operate at much lower temperatures and with lower loading, thus resulting in light weight and volume devices. Finally, combining fuel cell-fuel reformer in a single compact unit, will lower the system costs by avoiding external reformer and expensive oil cooling. Easier penetration of the fuel cell system in the energy market.

Fuel cells will create (i) economic benefits (energy savings, creation of highly specialised jobs, massive production of renewable fuels, reduction of dependence from oil markets), (ii) energy benefits (high quality energy produced from fuel cells, energy security, energy production distribution and decentralization, (iii) environmental and health benefits (long-term solution for drastically reducing greenhouse gases, air quality). Moreover, according to the US DoE, H_2 and fuel cell technologies development will result in 750,000 new jobs by 2030. The TOPCAT innovative technological outcome will promote high level scientific career opportunities.

The importance of this funding

HFRI implemented specific calls for research proposals dedicated to postdocs, promote their career prospects and restrain the phenomenon of brain drain. Regarding the postdoc phase, the goals of these calls, including the present call, are to strengthen the independence of postdocs and their incentives for excellent research as well as to lower the age at which a successful researcher can make the transition to a tenured professorship. Moreover, the postdoc acting as a principal investigator of these research project will have the right to supervise MSc and PhD students. This call creates strong incentives for academic research, providing additional skills in order to succeed in an academic career.

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