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

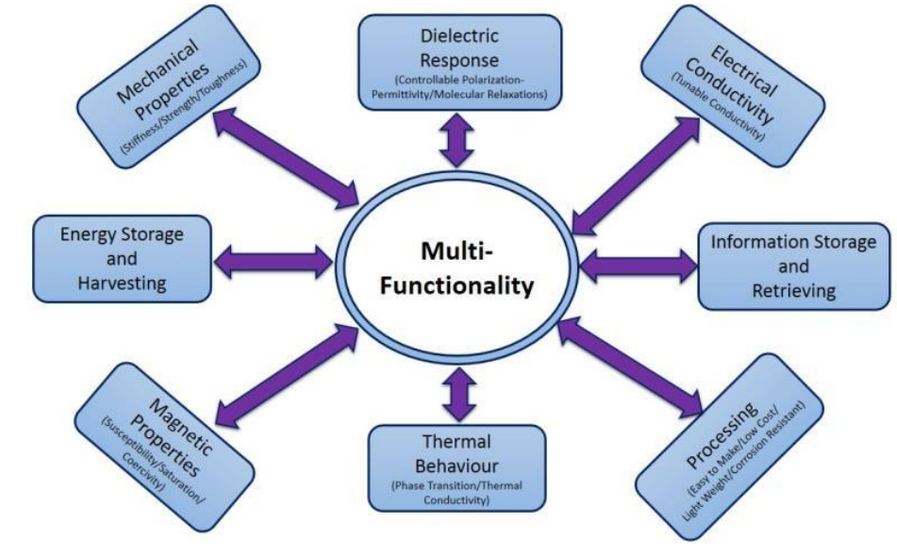
Description of the funded research project

1st Call for H.F.R.I. Research Projects to Support Faculty Members & Researchers and Procure High-Value Research Equipment

Title of the research project:
Integrating Multi-Functionality and Smart Performance in Hybrid Polymer Nanodielectrics

Principal Investigator: **G. C. Psarras**

Reader-friendly title: **Multi-Functional Hybrid Polymer Nanodielectrics**



Scientific Area:
Engineering Sciences & Technology

Institution and Country: **University of Patras, Greece**

Host Institution: **University of Patras**

Collaborating Institution(s): **NCSR-"Demokritos", University of Thessaly**

Project webpage (if applicable): **pending**

Budget: **187.999,16 euro**

Duration: **36 months**

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Research Project Synopsis

The present research project aims to the development of multi-functional polymer based nanodielectrics. The nanodielectric materials under study are polymer matrix nanocomposites, reinforced with: (i) ferroelectric/polar oxides, (ii) ferromagnetic, and (iii) carbon allotropes nanoparticles (CNTs). A suitable epoxy resin is used as the polymer matrix, because of its thermomechanical stability, low shrinkage, flexibility in processing, enhanced environmental and corrosion resistance, high dielectric breakdown strength, and low cost. Each of the employed nanoreinforcements provides specific properties and behaviour contributing to the overall system's performance. In particular, ferroelectric/polar oxides nanoparticles increase the dielectric permittivity of the composite nanodielectrics and induce variable polarization and tunable permittivity as a function of temperature. Ferromagnetic nanoparticles add magnetic properties to the nanodielectrics, while carbon nanoparticles increase systems' conductivity and mechanical strength. The simultaneous presence of two different reinforcing phases and the resulting combination of the matrix/fillers properties will induce multi-functional behaviour to the composite nanodielectrics.

The challenge of the project is the development of a material/device being able to execute several functions (such as variable polarization, tunable dielectric response, adjustable conductivity, varying magnetic performance, energy storage and others), while being easy to make, light weight, cost effective exhibiting at the same time posessing structural integrity and suitable thermal response.

Project originality

Materials exhibiting smart performance are expected to be able to tune their behaviour responding to an external or internal stimulus. Certain properties of these systems can be varied in a controllable way, such as stiffness, shape, damping capacity, natural vibration frequency, polarization, conductivity, energy storing efficiency etc. Smart structures are usually material systems incorporating functional constituents that can perform the operations of sensing, actuation and control. The smart behaviour of the whole system is induced by the large changes in amplitude of specific properties of the functional constituents, responding in real time to an imposed stimulus.

The novelty of IMUPSON project relies on the introduction of a light weight, cost-effective, corrosion resistant multi-functional material-device, which integrates structural integrity, suitable thermal properties, variable polarization, tunable dielectric response, adjustable conductivity, varying magnetic behaviour and is able to store and retrieve energy.

Expected results & Research Project Impact

The successful completion of the current research project aims to produce and develop hybrid multi-functional material(s)/devices which can be employed as structural components, are able to store and retrieve energy, with controlled variation of their polarization and conductivity properties, good dynamic mechanical response, ability of sensing external stimuli, ability to work in a corrosive environment, while being easy to be produced and cost effective. All these functions should be performed by a complex system of materials, incorporating suitable ingredients without any external links and co-regulatory circuits.

The importance of this funding

H.F.R.I. provides the possibility to conduct cutting-edge research. Prior to the establishment of H.F.R.I. the funding opportunities in Greece were scarce. Besides the expected scientific results and their technological impact, the successful completion of the current research project will be proved beneficial to the involved young researchers (PhD students and Post-Doctoral researchers). Financial support to young researchers allows them to be dedicated to the project and to obtain valuable experience in experimental methods, data analysis and presentation. In addition, the funded project gives the opportunity to young researchers to be exposed to the international scientific community via publications and their participation in international conferences.

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