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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

Fluorescent metal-organic frameworks as sensors for the detection of nitroaromatics

Principal Investigator: Dr. Theodore Lazarides

Acronym: NO_2LMOFs

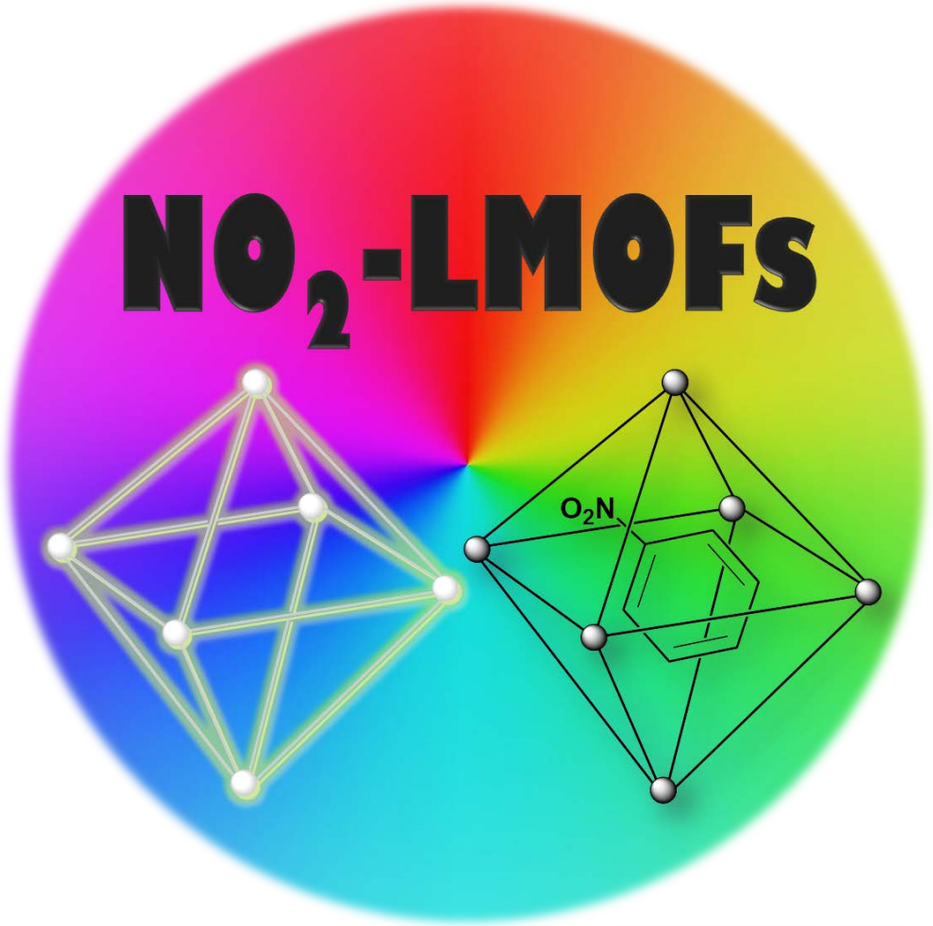
Scientific Area: Natural Sciences/Chemical Sciences/Inorganic and Nuclear Chemistry

Institution and Country:
Aristotle University of Thessaloniki/Greece

Host Institution: Aristotle University of Thessaloniki

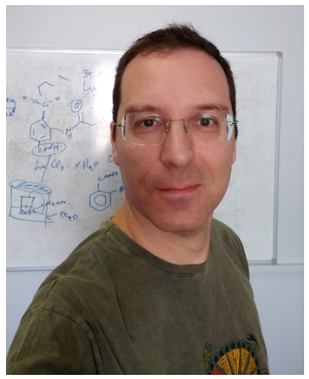
Collaborating Institution: University of Ioannina

Project webpage: https://tlazarides.webpages.auth.gr/



Budget: 200000 Euros

Duration: 36 months



Theodore Lazarides

Amina Chatz-Giachia

Athanasia Psalti

Anastasia Pournara

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Research Project Synopsis

Nitroaromatic compounds account for a significant portion of the threat posed by environmental pollution due to their potent toxicity and carcinogenicity and their wide environmental distribution since they are commonly used in a wide range of industrial chemical processes. The relatively low, albeit significant, solubility of the majority of nitroaromatics in water and their relative inertness towards oxidation has contributed to their ability to persist and migrate in the environment over long periods of time. Additionally, the use of nitroaromatics in explosives (e.g. TNT) adds one more vital parameter to the importance of their simultaneously effective, direct, rapid and selective detection.

Currently, nitroaromatics are determined with the use of “traditional” analytical techniques chiefly based on chromatography coupled with mass spectrometry which, although effective, suffer from high costs, the requirement for highly trained personnel and lack of portability thus being unsuitable for in-field use. There is therefore a need for the development of inexpensive and reliable field-based detection systems.

NO_2LMOFs is a research project which aims at the rational design, synthesis and study of porous luminescent materials based on Metal-Organic Frameworks (MOFs) which possess favorable features to function as optical sensors for the detection of nitroaromatic compounds in aqueous environments and/or in the gas phase.

We therefore synthesize strongly fluorescent MOFs with appropriately functionalized pores. This way, a nitroaromatic guest interacting with the fluorophores of the MOFs will lead to the production of a detection signal by inducing pronounced changes in the material’s emission which can lead to the detection and quantification of the targeted analyte.

Project originality

Currently, the fluorescence sensing devices for nitroaromatics are based on fluorescent conjugated polymers (CPs), which, despite their undisputed success, suffer from their expensive and elaborate synthesis and lack of inherent porosity.

In contrast, metal-organic frameworks are materials with inherent porosity, with pores and channels being defined by their crystal structure. Additionally, at this stage of worldwide research on MOFs, there are many structural types which can be synthesized in a controllable and repeatable fashion in a concept termed as “isoreticular chemistry”. The most important advantage of MOF materials making them particularly favorable for research on sensors is their ability to be substituted with a range of functional groups while retaining the material’s structure thereby possibly introducing selectivity towards certain targeted species.

In NO_2LMOFs we conduct a systematic study, based on rational design and the concepts of supramolecular chemistry, on the development of luminescent MOFs which can selectively host nitroaromatic species therefore offering a favorable platform for their detection and quantification.

Expected results & Research Project Impact

NO_2LMOFs is anticipated to result in new MOF materials with unprecedented capability to selectively detect nitroaromatic compounds by PET fluorescence quenching. We expect that the new MOFs will show, in addition to their sensing ability, air and water stability and reusability so that they can form the basis of future materials for the development of sensory systems for in field applications.

Additionally, NO_2LMOFs will give the opportunity to young researchers to develop their skills in a variety of ways by allowing them to work in a hot scientific field which involves the use of multiple advanced synthetic, characterization and spectroscopic techniques.

Therefore, NO_2LMOFs is expected to contribute significantly to the improvement of the overall research output of the host and collaborating institutions and the country in general.

The importance of this funding

This funding is of crucial importance for both the PI and the young investigators of the research team for the following reasons

- ❑ It gives the opportunity to the PI to continue his research at a high level in an active research area and transmit his knowledge and experience to young researchers.

- ❑ It gives the chance to young investigators in Greek Universities to conduct research in an active research field in par with their peers in the rest of the EU thereby making them competitive at an international level and greatly improving their future career prospects.

- ❑ Thanks to the available travel budget, the team members are given the opportunity to participate in international conferences and workshops, which helps them to keep in touch with the latest scientific developments at a global level and fosters the development of international scientific collaborations.

- ❑ Thanks to the available budget for the purchase of equipment, the research team was able to vastly improve its ability to materialize their ideas and conduct high-level research in an efficient manner. Furthermore, the young investigators are given the chance to learn new advanced experimental techniques and creatively apply them to their research.

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COMMUNICATION

185 Syggrou Ave. & 2 Sardeon St. 2
171 21, N. Smyrni, Greece
+30 210 64 12 410, 420
communication@elidek.gr
www.elidek.gr