CERTH
CENTRE FOR
RESEARCH & TECHNOLOGY
HELLAS

June - July 2021

RESEARCH - TECHNOLOGY - INNOVATION
FOR SUSTAINABLE GROWTH

Moon to Mars

Key technologies to support the upcoming exploration of Mars and deep space by Prototech and CERTH

CERTH
CENTRE FOR
RESEARCH & TECHNOLOGY
HELLAS

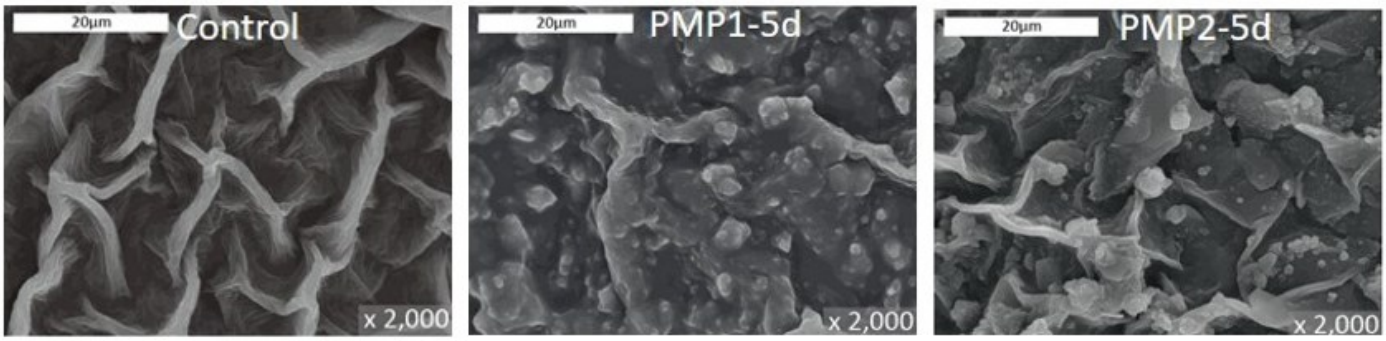
Contents

Investigation of the foliar protective activity of environmental-friendly porous, micro-structured, magnesium-based minerals.

LEAD OF RESEARCH TEAM **ANTONIOS MAKRIS -** Principal Researcher CERTH | INAB, **GEORGE KARAGIANNAKIS -** Principal Researcher CERTH | CPERI

MEMBERS OF RESEARCH TEAM | CO- AUTHORSHIP: **AGGELIKI ANDREADELLI,** Agronomist, M.Sc., INAB/CERTH, **SPYROS PETRAKIS** - Biologist, Ph.D., CERTH | INAB, **PENELOPE BALTZOPOULOU** - Chemical Eng., M.Sc., CERTH | CPERI

Intensive agriculture and extreme use of fertilizers and pesticides raise a pressing need to develop effective, non-persistent and non-bioaccumulative alternatives. Metal oxide nanoparticles indicate have previously shown a promising antifungal and antibacterial activity in laboratory experiments. However, they are not widely used in agriculture due to the complexity and high-cost of their generation. They also often pose risks for human health. In contrast, high-surface bioactive micro-particles are manufactured at low-cost, are environmental-friendly and could be used in agriculture.



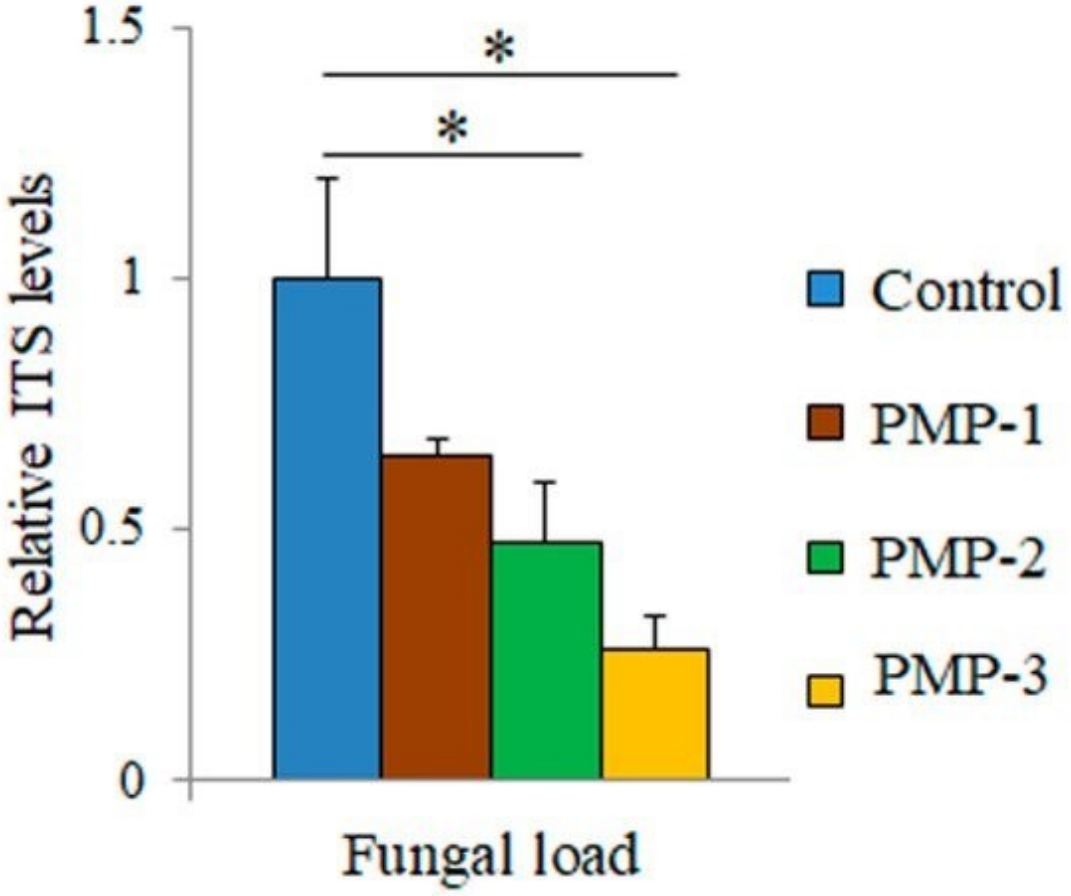
Scanning electron microscopy (SEM) images of the tomato leaves after spraying with the aqueous suspension of the micro-structured magnesium oxide (PMP-1 and PMP-2, in comparison to water sprayed leaves (control).

> “Spraying of magnesium oxide particles did not damage tomato leaves. Instead, **it activated the expression of plant genes which participate in defense mechanisms** against pathogens. Furthermore, **a significant reduction** in the foliar populations of pathogenic bacteria and fungi was observed, Dr. Antonios Makris, Lead of research team and Principal Researcher, CERTH | INAB.

Institute of Applied Biosciences (**INAB**) and Chemical Process & Energy Resources Institute (**CPERI**) of the Centre for Research & Technology, Hellas (CERTH), **joined efforts** to face such challenge and investigated the antibacterial properties of mineral, magnesium-based microparticle materials.

Aqueous suspensions of porous, micron-structured magnesium oxide particles with specific structural characteristics (i.e. high specific surface area and porosity, mean particle size of 5µm consisting of grains in the nano -scale) were sprayed on healthy tomato plants to assess materials’ protective activity and to investigate the plant’s response mechanism.

“Spraying of magnesium oxide particles did not damage tomato leaves. Instead, it activated the expression of plant genes which participate in defense mechanisms against pathogens. Furthermore, a significant reduction in the foliar populations of pathogenic bacteria and fungi was observed. These effects may be attributed to the material’s particle size/ porosity and its homogeneous application on sprayed tomato leaves, ensuring efficient foliar coverage and maximum activity against pathogens”, underlines Dr. Antonios Makris, one of the Lead of research team and Principal Researcher, CERTH | INAB.



Fungal load of the tomato leaves after spraying with 3 different aqueous suspensions of the micro-structured magnesium oxide (indicated as PMP-1, PMP-2 and PMP-3), in comparison to pure water sprayed leaves (control).

The results of this interdisciplinary research collaboration were published in the latest issue of the scientific journal *Microorganisms,* under the title "*Effects of Magnesium Oxide and Magnesium Hydroxide Microparticle Foliar Treatment on Tomato PR Gene Expression and Leaf Microbiome*"*.

The research activities were supported, both technically and financially, by Calix Ltd., beneficiary of the research project *Pathogen Inhibition from Nano-active Oxides* (PINO), funded by the Australian Academy of Technology and Engineering (ATSE). CERTH was a designated subcontractor in PINO project.

* Publication's citation:

Andreadelli A., Petrakis S., Tsoureki A., Tsiolas G., Michailidou S., Baltzopoulou P., Merkestein van R., Hodgson P., Sceats M., Karagiannakis G., Makris A.M., Effects of magnesium oxide and magnesium hydroxide microparticle foliar treatment on tomato PR gene expression and leaf microbiome. Microorganisms 2021, *9*, 1217. (DOI: 10.3390/microorganisms9061217).

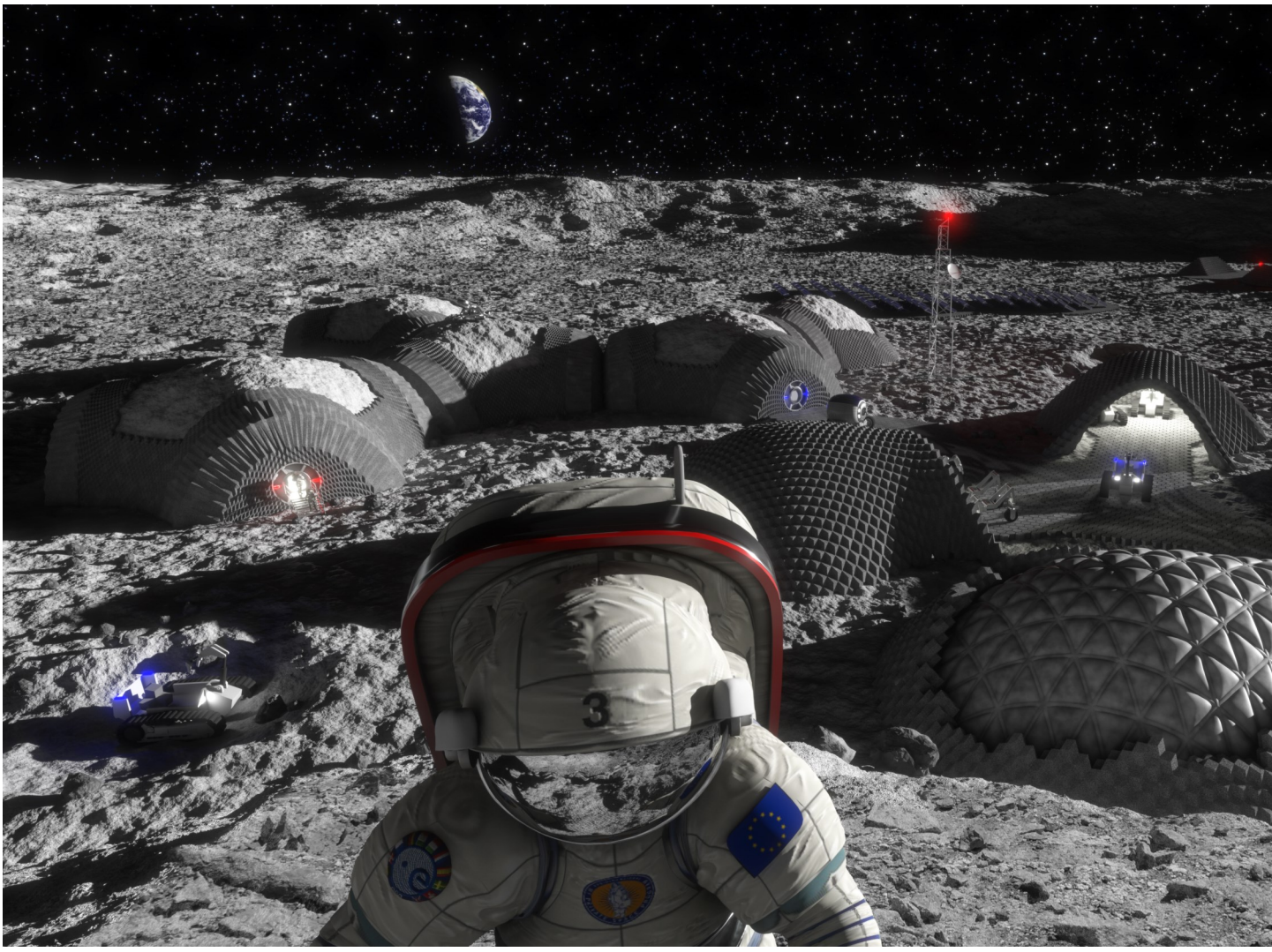
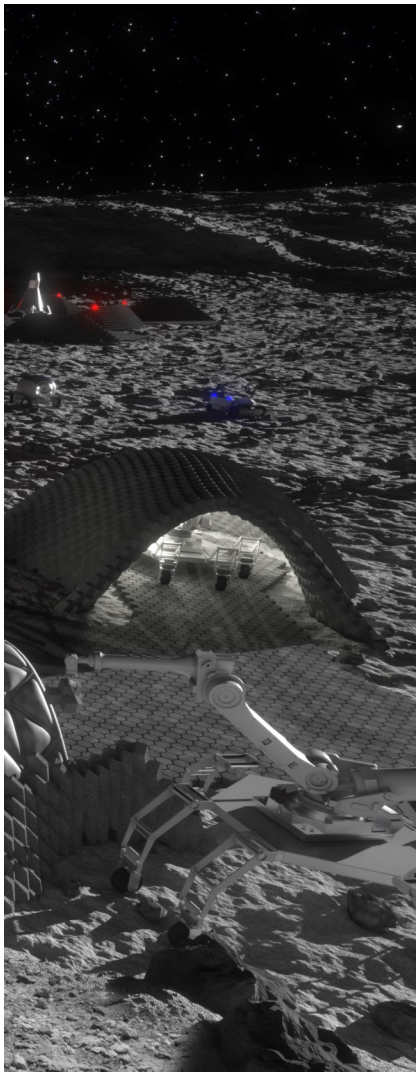


Illustration of Future Moon Base- Απεικόνιση Σεληνιακής Βάσης (ESA credit: RegoLight, visualisation: Liquifer Systems Group, 2018)

Moon to Mars

Key technologies to support the upcoming exploration of Mars and deep space by Prototech and CERTH



INTERVIEW WITH DR. **KALLIOPI PAPAZISI**

INTERVIEW: **AMALIA DROSOU**

Do we need the Moon to go to Mars? As Earth's nearest planetary neighbor, the Moon has profound potential to be a field of new scientific advances as well as economic growth. At the same time, it could be an ideal ground for testing and operations in preparation for the first manned mission to Mars – a field where American and European interest has focused on during the last few years.

Following this, the long-term goal of the technology entrusted by the European Space Agency to Prototech and CERTH is to enable the Moon to act as a pit stop for astronauts travelling to more distance destinations both in terms of fuel supply for return flights and oxygen supply to support human life.

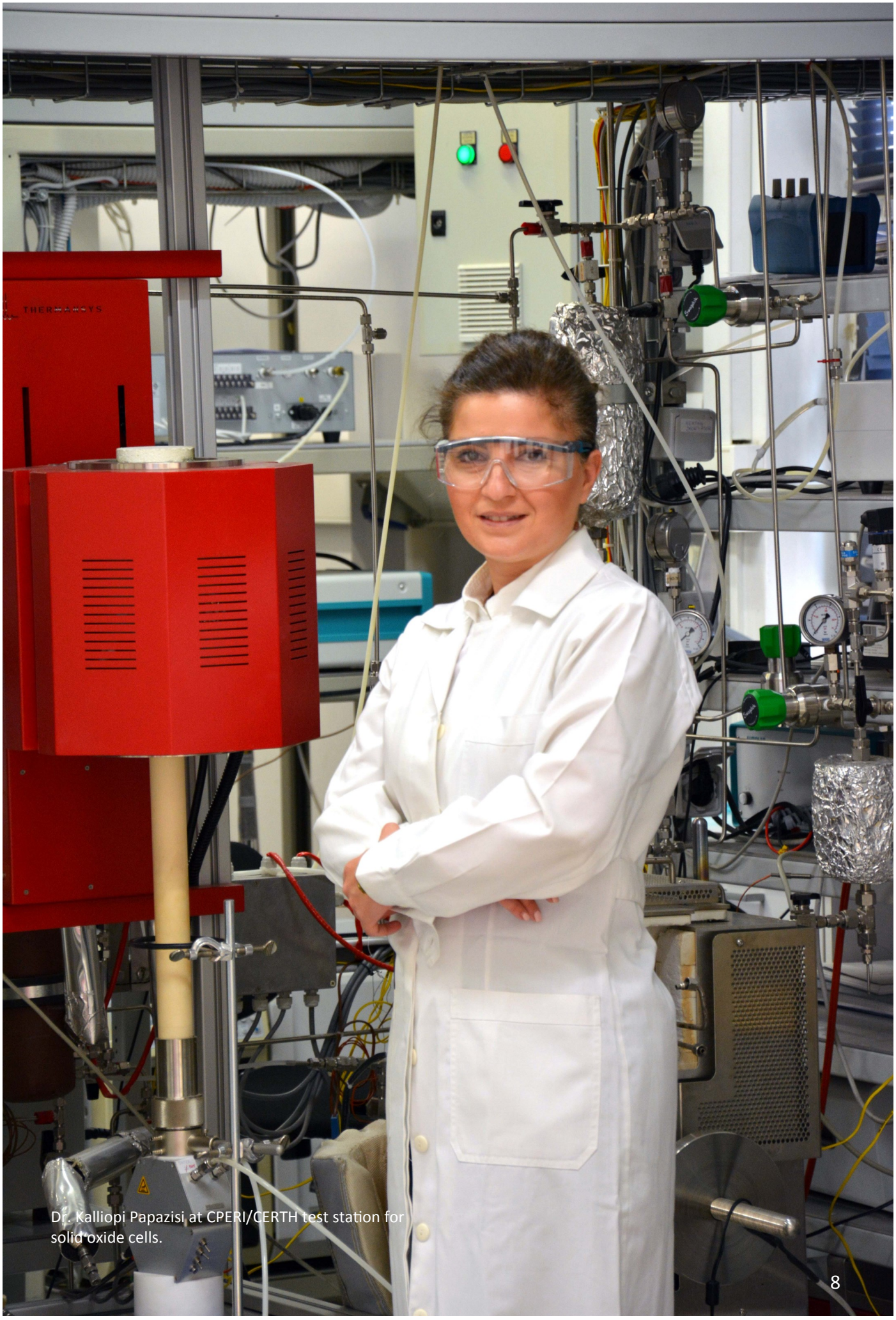
Dr. Papazisi, how is this technology expected to contribute to the exploration of Mars and other distant destinations in our Solar System?

Electrolysis technology, the subject of the development in this project, has been recognized as critical for the implementation of in-situ Resources Utilization (ISRU). ISRU is the concept of making use of resources available locally through the solar system, in order to reduce the amount of materials transported from Earth in support of space exploration objectives. This is essential in the Global Exploration Roadmap where the is considered as the ideal proving ground for the first ISRU missions (Deep Space Gateway), with fuels produced on site, to allow journey to further destinations. Furthermore, the Moon is seen as a natural progression form the International Space Station in terms of learning to live in space. This sustainable approach will play a key role in exploring Mars and other distant planets in our Solar System by supporting the introduction of manned exploration.

> **“ CERTH is responsible for the development of the core of the system, i.e. the components (cells) of the electrolysis stack**

What is in particular the role of CERTH?

In recent years, water existence at the lunar poles has been confirmed, primarily in the form of ice. This water resource can be extracted and converted to hydrogen and oxygen through splitting of water molecule using electricity, the so-called electrolysis process. However, as the Moon's water reserves contain significant amounts of contaminant compounds such as ammonia, methane or sulfur, conventional low-temperature electrolysis technologies are highly sensitive and require complex and energy-intensive upstream purification processes. Thus, high temperature electrolysis (800-900° C) based on solid oxide ceramic materials (Solid Oxide Cells - SOC) is selected as the most suitable technology. Under this ESA Contract , CERTH and Prototech will prove this concept by implementing a SOC electrolysis system and demonstrating its capability to operate at 10 bar pressure, under relevant lunar conditions. CERTH is responsible for the development of the core of the system, i.e. the components (cells) of the electrolysis stack. Specifically, our team synthesizes and manufactures electrocatalysts and integrated cells of appropriate size for a series of prototype SOC electrolysis stacks up to 250 W.



Dr. Kalliopi Papazisi at CPERI/CERTH test station for solid oxide cells.

Dr. Papazisis' team synthesizes and manufactures electrocatalysts and integrated cells of appropriate size for a series of prototype SOC electrolysis stacks up to 250 W.

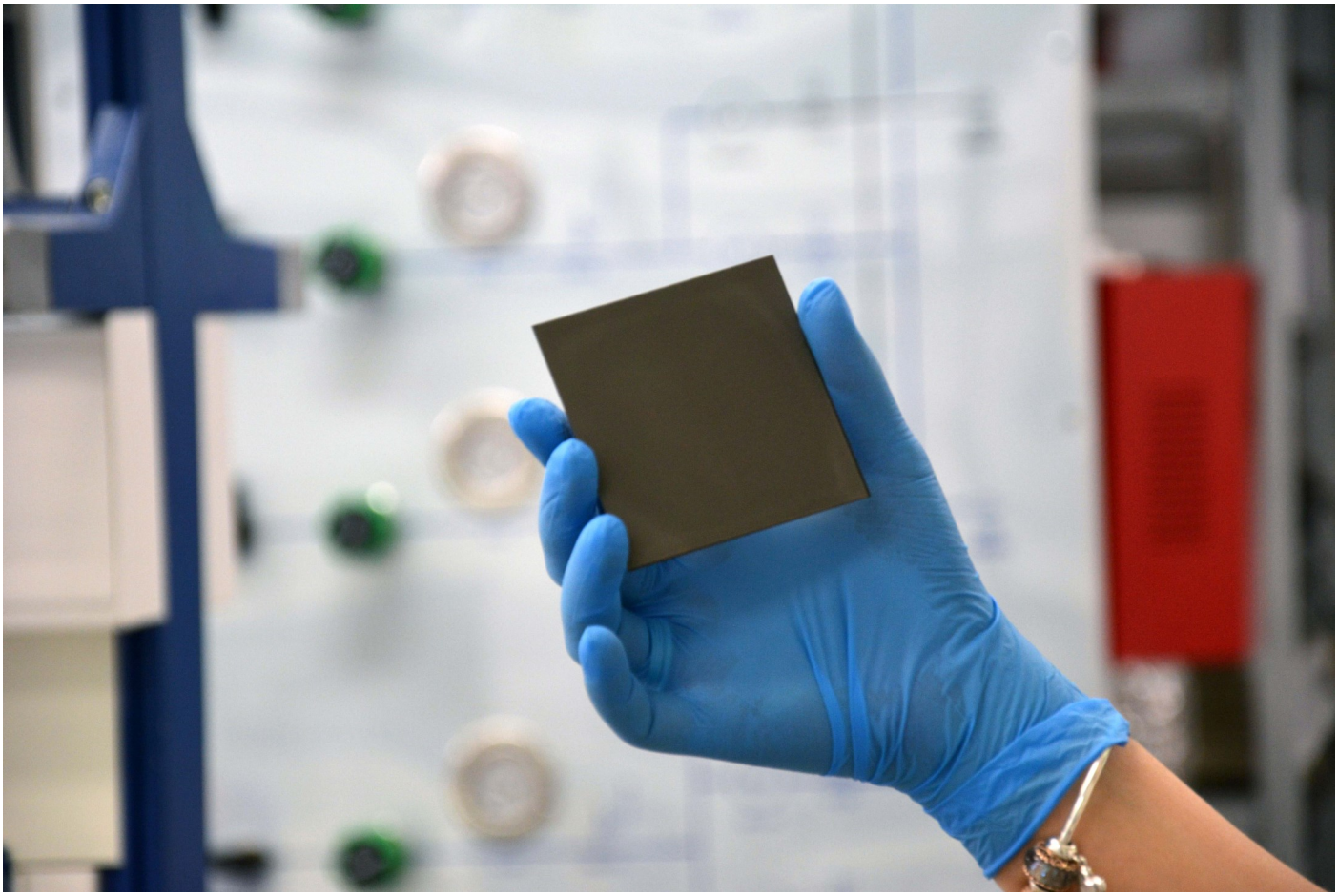
Are there any difficulties that you will probably meet during the development of the technology and if yes what your safety nets in order to overcome them?

This development is based on our 15 years research in materials and cells on SOC technologies for a range of applications, both terrestrial and space, the latter in collaboration with ESA since 2009. Although we feel confident about our technology, tis project is driven by very demanding targets, such as the need for continuous operation with negligible or zero performance degradation and the operation at a pressure of 10 bar allowing the direct storage of the produced gases. To achieve these goals we have developed suitable efficient and durable electrodes, while at the same time we have designed and implemented prototype devices that allow safe, controlled operation

What is the timeline regarding the completion of the project?

This project has started in January 2020 and is expected to be completed in October 2021. Even working through the covid-19 affected period, we are today very happy to say that ESA has given the authorization to proceed with the testing of the first campaign electrolysis stack. Upon successful completion, the activity is expected to continue with scaling up the technology and make it suitable for future space flights.

.



Single cell for the SOC electrolysis stack.

“ The lessons learned from such projects are extremely valuable and can boost our research so drastically that will actually lead in ready-made, mature technological solutions for a wide range of practical applications

What are your expectations concerning the implementation of the technology?

Electrolysis technologies, and in particular SOC technology, are expected to play a key role in transforming the global energy sector towards cleaner energy carriers and sustainable solutions, such as "green hydrogen" and the utilization of carbon dioxide. Contracts like this give us the unique opportunity of testing our materials and devices under the most demanding conditions. The lessons learned from such projects are extremely valuable and can boost our research so drastically that will actually lead in ready-made, mature technological solutions for a wide range of practical applications, suitable but not limited to space exploration, in the immediate future.

BACCHUS: How automation is transforming agriculture

INTERVIEW WITH WITH **DIMITRIOS GIAKOUMIS**
INTERVIEW: **AMALIA DROSOU**

Automation of agricultural production, is a major challenge in the modern world. New precision farming technologies and applications can provide considerable improvement in production. Robotic systems, capable of smart, automated and selective harvesting can make a significant contribution to the primary sector. To this end, BACCHUS intelligent mobile robotic system, is going to push to that direction, since it promises to reproduce hard harvesting operations.

Dr. Dimitris Giakoumis, researcher at the Information Technologies Institute (ITI) of CERTH, talks about the potential of the European research project BACCHUS, at a time when a large number of farmer operations are already transitioning to autonomy.

> **“ The support of the daily working conditions of the vinedresser comes through innovations that concern both the most efficient planning of the cultivation and harvesting works as well as the harvesting of grapes in the vineyard**

Dr. Giakoumis, the incorporation of intelligent robotic technologies into agricultural production is expected to reduce the production cost, provide higher product quality and improve the working conditions of farmers and labourers. What is the aim of the research project BACCHUS?

BACCHUS is developing a smart robotic system, capable of reproducing manual harvesting work, focusing on the field of viticulture. During the project, new technologies will be developed, that will allow mobile robotic units to navigate in the vineyard, to inspect the vineyards and their grapes, leaving the unripe product in the field to mature. Finally, with subtle robotic handling, the robots will perform the grape harvesting autonomously in a way that the corresponding human activity will be simulated.

The bi-manual harvesting robot BACCHUS recently arrived at Ktima Gerovassileiou, one of the partners of the consortium. How is it going to support the daily working conditions of the viticulturist?

Indeed, we are currently at the stage of the integration of the artificial intelligence and robotic technologies -developed in the framework of the project- on the bi-manual harvesting robot and in fact this robot is here aiming at carrying out the initial evolution tests in a real vineyard. The support of the daily working conditions of the vinedresser comes through innovations that concern both the most efficient planning of the cultivation and harvesting works as well as the harvesting of grapes in the vineyard in an automated but also skillful way in order not to injure the grapes and simultaneously to protect the product quality.

“During the project, new technologies will be developed, that will allow mobile robotic units to navigate in the vineyard, to inspect the vineyards and their grapes, leaving the unripe product in the field to mature. Finally, with subtle robotic handling, the robots will perform the grape harvesting autonomously in a way that the corresponding human activity will be simulated”

So far, the project has developed several methods of vineyard mapping, automated recognition of vine grapes and their maturity level through robotic vision as well as methods enabling the automated robots' navigation and their handling during harvest.

BACCHUS research project started 1,5 year ago. What has been achieved so far?

BACHUS is in the phase of integrating the technical specifications and developing the first version of the artificial intelligence methods of the proposed robotic system. So far, the project has developed several methods of vineyard mapping, automated recognition of vine grapes and their maturity level through robotic vision as well as methods enabling the automated robots' navigation and their handling during harvest. In parallel, the project has developed the initial prototypes of the robot units where several individual technologies will be gradually embedded in.

Could you please explain us the role CERTH - ITI in the project?

The Information Technologies Institute (ITI) of CERTH has the role of the Technical Coordinator, developing at the same time artificial intelligence methods for the robotic units aiming among others at: (a) grapes recognition through robotic vision (b) optimized design of robot gripper for harvesting, (c) robotic mapping of the two viticulture and navigation of the bi-manual robot (d) autonomous decision making for the optimized robotic units management during harvest.

Dr. Giakoumis, do you think that the utilization of this robotic system could be extended in the future to other areas of the primary sector?

Yes, both the individual artificial intelligence and robotic technologies developed by the BACCHUS project and the integrated robotic system itself, can be used in the future in various areas of the primary sector. Focusing specifically on the integrated system, the capabilities of autonomous robotic navigation and crop surveillance as well as the delicate bi-manual harvesting handling, are features that could be applied to various other crops in addition to vineyards.

The consortium of BACCHUS consists of the following partners: Aristotle University of Thessaloniki, Information Technologies Institute and the Institute of Bio-economy and Agri-technology of CERTH, Robotnik Automation SLL, SAGA Robotics, University of Lincoln, and University of Torino DISAFA Department

nPets - Solutions for tackling **nanoparticle emissions** generated by transport

The nPETS project aims to contribute to better public health policies **by developing new knowledge in transport** generated sub 100 nm particle emissions and their toxicology and **providing solutions for effective mitigation measures.**

TEXT **NIKOLAOS DIMOKAS**
EDITING: **AMALIA DROSOU**

Adverse health effects of airborne particles links to their size and chemistry, and a major fraction of outdoor ultrafine particles is traffic generated from road, rail, air, and sea transportation. The nPETS project aims to contribute to better public health policies by developing new knowledge in transport generated sub 100 nm particle emissions and their toxicology and providing suggestions for effective mitigation measures.

Adverse health effects of airborne particles links to their size and chemistry, and a major fraction of outdoor ultrafine particles is traffic generated from road, rail, air, and sea transportation. The nPETS project aims to contribute to better public health policies by developing new knowledge in transport generated sub 100 nm particle emissions and their toxicology and providing suggestions for effective mitigation measures.

"Today, there are no existing methods for measuring sub 100 nm particle emissions from various individual sources. nPETS will identify these sources and their impact on health risks to understand and build knowledge so that new policies will be targeting hot-spots, which are responsible for the most health damage. For the identified critical sources, an average of 50% reduction in sub 100 nm particle number could be expected", says Professor Ulf Olofsson, the nPETS project coordinator from KTH.

Particle emission measurements will be carried out in lab and field using state-of-the-art instruments and a new mobile experimental set-up to quantify toxicity. nPETS will evaluate sub 100 nm particle emissions from different engine technologies, exhaust after-treatment systems, and fuel combinations on a chassis dyno and engine test cells at AUTH and KTH. Lab tests are also including mechanical brake (BREMBO and KTH), tyre-to-road (KTH), and clutch (Lund) emission measurements. The nanoparticles sampling in near-source field locations will take place in four cities (Barcelona, Stockholm, Thessaloniki, and Milan), with the main goal of discerning the particle number size distribution of different transport modes in ambient air and providing samples for the toxicology assay, the physico-chemically characterization and source apportionment.

nPETS is an innovative project for Greece. Greek experts from both CERTH and AUTh joined force in order to study the impact of nanoparticles emitted by all transport modes. It is a task that requires the synchronized effort of mechanical engineers, chemists and biologists, who have to conduct several chemical analyses and biological tests within a tight schedule. We are really happy that we will contribute to the reduction of air pollution by studying fine particles concentration, composition and toxicity at that extend in our country", says Mr. Dimitri Margaritis, CERTH representative and WP8 leader.

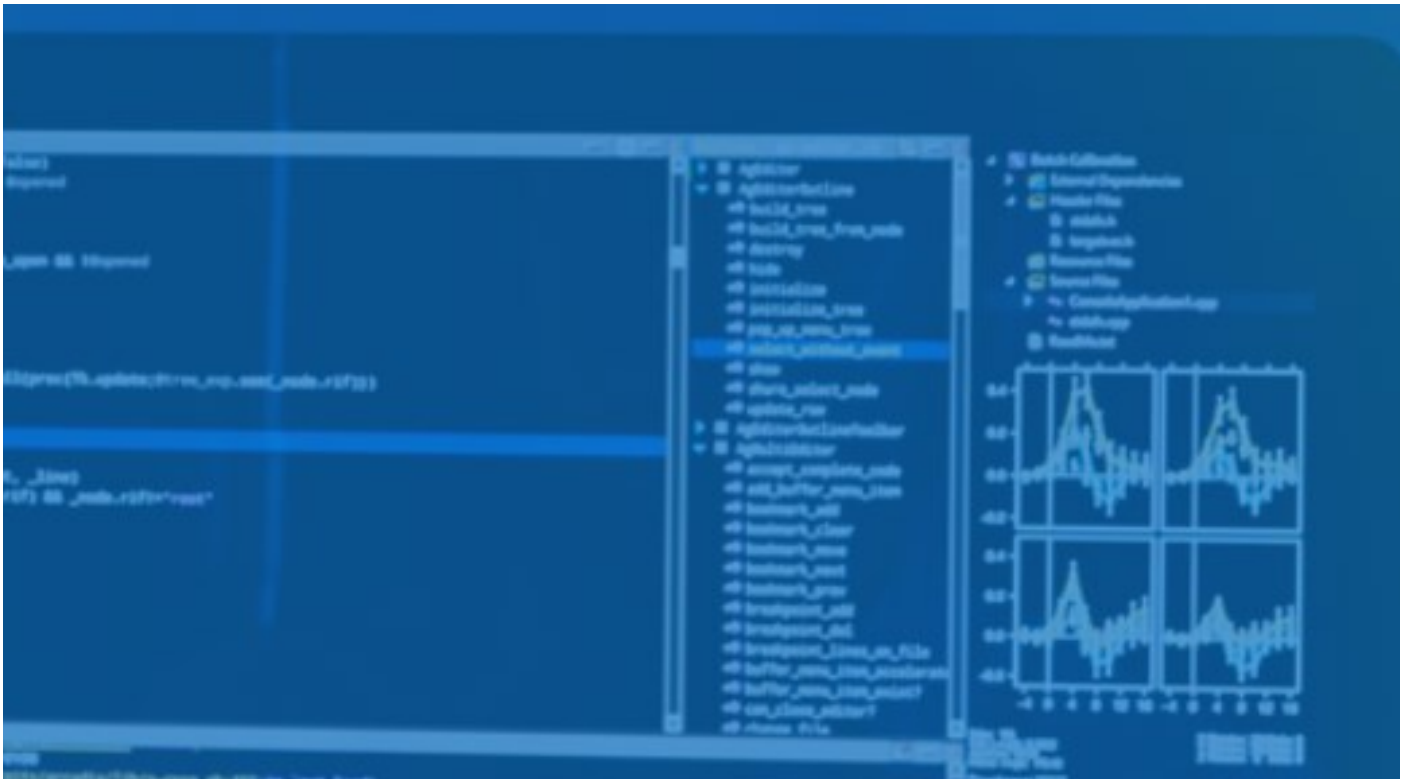
CERTH is the leader of the "WP8 Communication and Dissemination". It also leading the realization of the electronic database tool and is responsible for the sample collection, the chemical characterization and the biological testing for the Thessaloniki sites.

Funded under Horizon 2020, the EU framework programme for Research and Innovation, the project started 1 June 2021, lasting 36 months. nPETS is led by KTH Royal Institute of Technology with a consortium of a further 12 European beneficiaries. The nPETS consortium consists of seven highly ranked universities in four countries (KTH, Stockholm University, Karolinska Institute, University of Leeds, Aristotle University of Thessaloniki, Lund University, and Tampere University). The consortium also includes well-known European research institutes (CSIC, Mario Negri, and CERTH), one world-leading European company (Freni BREMBO Spa), and two local administrations (Stockholm and Barcelona).

8th Technology Forum

TECHNOLOGY
FORUM
Share IT 2grow

In the modern economic environment, competitiveness relies upon the development of innovative products with international appeal. In the innovation process, the contribution of industry and research community (academia, research organizations) is important because: a) the exploitation potential of the knowledge and technology these communities have b) the cooperation among them creates value.



Matchmaking event during a past Technology Forum

In this context, 25 bodies, among them CERTH, have joined their forces and during the last 8 years organize a series of congresses under the name Technology Forum. The 8th Technology Forum will take place on 14.10.2021, 09:00-18:00 in the framework of Beyond4.0 at Helexpo premises.

Among others key note speakers of the 8th T.F are **Toli Lerios**, serial start upper and worldwide start up mentor, **Danna Eletheriadou**, European Commission, DG Internal Market, Industry, Entrepreneurship and SMEs, **Timos Sellis,** Professor at Swinburne University of Technology and **Nico Gariboldi,** Senior Director – Site Lead Pfizer, Thessaloniki.5

CERTH
CENTRE FOR
RESEARCH & TECHNOLOGY
HELLAS

The **Centre for Research and Technology-Hellas (CERTH)** founded in 2000 is one of the leading research centres in Greece and listed among the TOP-15 E.U. institutions with the highest participation in competitive research grants.

Today CERTH includes the following five institutes with indicated major fields of research:

- **Chemical Process and Energy Resources Institute (CPERI)** Sustainable & Clean Energy, Environmental Technologies, Chemical & Biochemical Processes, New Functional Materials
- **Information Technologies Institute (ITI)** Informatics, Telematics and Telecommunication Technologies, Safety and Security
- **Hellenic Institute of Transport (HIT)** Smart Sustainable Mobility, Transport Safety
- **Institute of Applied Biosciences (INAB)** Agri-biotechnology, Health Translational Research, Informatics for big bio-data
- **Institute for Bio-Economy and Agri-Technology (IBO)** Bio-economy, Agri-technology

Δείτε μας στο YouTube