NEWSLETTER

nanoMECommons

2021 – ISSUE 2

Project Overview

NanoMECommons will establish a transnational and multidisciplinary research and innovation network to tackle the problem of nanomechanical materials characterisation in multiple industries.
The focus of **NanoMECommons** is to employ innovative nano-scale mechanical testing procedures in real industrial environments, by developing harmonised and widely accepted characterisation methods, with reduced measurement discrepancy, and improved interoperability and traceability of data. To achieve this goal, **NanoMECommons** will offer protocols for multi-technique, multi-scale characterisations of mechanical properties in a range of industrially relevant sectors, together with novel tools for data sharing and wider applicability across NMBP domain: reference materials, specific ontologies and standardised data documentation.

PARTNERS

Surface science and nanostructures, Nano-materials (production and properties), Characterization methods of materials, Nanotechnology, nano-materials, nano engineering

Partner's role in project

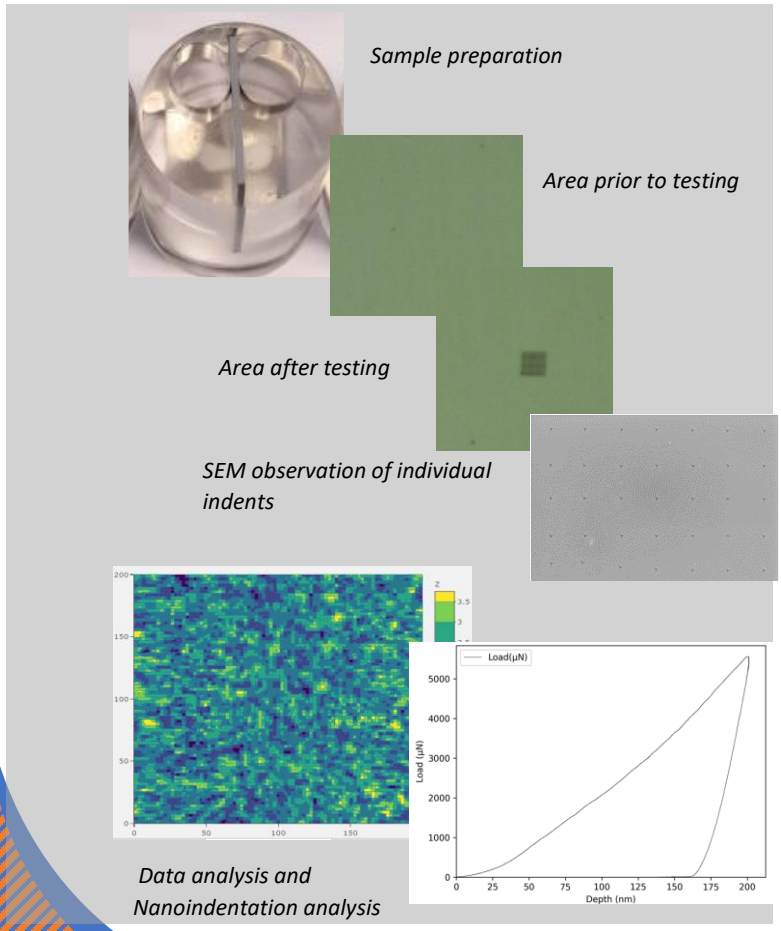
PARTNERS

nanoMECommons

NTUA - RNanoLab

NTUA is one of the key partners in the project, responsible for the coordination and management of the project. NTUA performs high resolution nanomechanical testing, through instrumented indentation, in the framework of WP2. Silicon nitrides, automotive steel, and MEMS are provided by MUL, CRF, and THALES, respectively are characterized about their nanomechanical properties; hardness and modulus. Multiple nanoindentation protocols have been developed tailored to the needs of each materials (thin films, multiphase materials, MEMS), in order to find the best suited measurement conditions.

In addition, NTUA performs data-driven phase recognition and quantification using Machine Learning and Artificial Intelligence models to establish structure-property relationships.



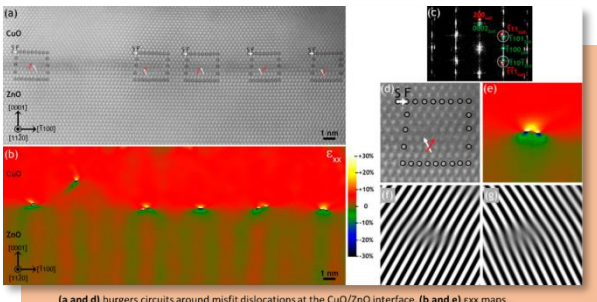
Universita Degli Studi Roma TRE

In this project, Uniroma3 is the coordinator of WP3 (Nano-scale residual stress analysis by Focused Ion Beam). The partner also participates as a core partner to the activities related to the High-Speed in-line nanomechanics, given its recognised expertise in this field and the availability of several nanoindenters in the team. Finally, Uniroma3 is one of the main contributors to activities regarding the development of the ICHADA metadata structure. In addition, Uniroma3 is one of the main responsible partners for the connection of the project with existing European cluster, e.g. EMCC and EMMC.

SINTEF

Experimental activities as follows:

- we will perform Geometrical Phase Analysis to map residual strain at interfacial regions (see figure below).
- performance of multi-technique analysis based on microscopy, spectroscopy and in-situ mechanical properties assessment.



(a and d) burgers circuits around misfit dislocations at the CuO/ZnO interface, **(b and e)** εxx maps
(c) FFT of a indicating the spots used, **(f and g)** (1̄10I) and (1̄01) ZnO Bragg filtered images

Nanotechnology Lab LTFN, Aristotle University of Thessaloniki

LTFN/AUTh is the Leader of the WP4, its role in the nanoMECommons includes:

- The definition of specifications and requirements for OE nanomaterials and devices.
- The selection of specific nanomaterials and device architectures (OPVs, OLEDs) that will be fabricated by R2R printing processes.
- Fabrication of OE nanomaterials in the form of blends combining novel organic semiconductors and luminescent nanolayers for OPVs and OLEDs, respectively.
- R2R printing Pilot to Production Line and integration/adaptation of metrology tools.
- The development of characterization protocols for printed nanomaterials and device architectures by non-destructive, ex-situ and in-line optical metrology tools (Spectroscopic Ellipsometry, Raman Spectroscopy, Photoluminescence) as well as by nanomechanical characterization tools (High Speed Nanoindentation for hardness and elasticity measurements, mechanical testing of flexible OE devices, including stretching, bending and nano-scratching)
- The development of multi-technique characterization protocols combining nanomechanical testing and optical spectroscopy for flexible printed OE devices in order to assess the impact of the mechanical testing on the opto-electronic properties of the printed nanolayer, the structural stability of the printed OE devices and the final OE device performance (e.g. efficiency, life-time).
- Dissemination and exploitation activities. Organization of Special Workshops, Sessions and Summer Schools on the NanoMECommons activities within the world–class multi-event "NANOTEXNOLOGY International Conferences & Exhibition on Nanotechnologies, Organic Electronics & Nanomedicine" that LTFN annually organizes since 2003 in Thessaloniki, Greece.
- Contribution to the connection of the NanoMECommons project with the academic, research and industrial communities, through its huge ecosystems. One of the main networks will be the Research & Innovation Network "NanoNet" "(www.nanonet.gr) coordinated by AUTh.
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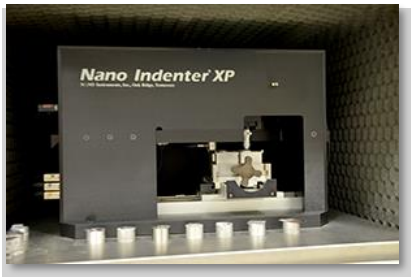
Communication and interaction with other EU Projects. Links and communication with EU clusters/Platforms/Networks as EFFRA, EMCC, EMMC (AUTh member) and EPPN (AUTh member), OE-A, EUPVClusters, Nanosafety.



Montanuniversität Leoben (MUL), Department of Materials Science

MUL main responsibility in the project is the synthesis and characterization of thin films with specific profiles of composition, microstructure and stresses, which will be used as reference samples for the development of the FIB-DIC method for nanoscale residual stress depth profiling and cross-validation of the method with synchrotron X-ray diffraction within WP3 (Nano-scale residual stress analysis by Focused Ion Beam). MUL will also be a core partner for the research activities of WP2 (High-speed in-line nanomechanics), for which specifically designed reference samples with given architecture, mechanical properties and stress state will be synthesized and characterized. With the progress of the development of the FIB-DIC method and multi technique protocols, reference thin film samples will be developed to evaluate and enhance capability of the methods. Besides the state-of-the-art characterization methods including basic microstructural, morphology and stress studies (XRD, EM), characterization of interfaces (EM) and mechanical properties (nanoindentation), MUL will also actively participate to validation of the FIB-DIC method by spatially-resolved stress profile measurements based on transmission electron microscopy and cross-sectional synchrotron X-ray nanodiffraction.

CSIC (Spanish National Research Council)

CSIC participates in NanoMECommons project as a research centre devoted to:

- Spectroscopy & Industrial Catalysis group (Institute for Catalysis and Petroleum Chemistry, ICP)
- Elaborate ontologies as a basis for standardised documentation for methods and protocols for mechanical materials characterisation at microscale and nanoscale.
- Collaboration with existing NMBP characterisation projects, with 2 interaction workshops with relevant NMBP projects and the EMCC.
- Implementation of materials and process information management system (WP8).
- Participate in the implementation of the nanoMECommons database system, alpha version.
- Project management to ensure that the planned activities will be carried out effectively pursuing the project objectives.

Ceramics for Smart Systems group (Institute of Ceramics and Glass, ICV).

- Elaborate ontologies as a basis for standardized documentation for methods and protocols for mechanical materials characterization at microscale and nanoscale.
- Lead the Protocols for in-situ mechanical testing coupled with Microscopy & Spectroscopic methods (Raman spectroscopy and Scanning Electron Microscopy - Energy Dispersive X-ray spectroscopy, SEM-EDX, MOP, DPFM).
- Obtain true 3D optical images and topographies and measure mechanical properties by nanoindentation tests to correlate structural images of the mechanically tested surfaces.
- Collaboration with existing NMBP characterization projects, with 2 interaction workshops with relevant NMBP projects and the EMCC.
- Implementation of materials and process information management system.
- End-user requirements for the nanoMECommons database system.
- Participate in the implementation of the nanoMECommons database system, alpha version.
- Project management to ensure that the planned activities will be carried out effectively pursuing the project objectives

Innovation in Research and Engineering Solutions – IRES

IRES will be mainly involved in the creation of i-CHADA that will be developed as a web platform and the creation of Nanoindentation data analysis tools, including machine learning and protocols. Also, IRES will assist in the development of Industrial case-specific application ontologies and metadata schema, in close collaboration with the other respective tasks. Finally, IRES will create Harmonized protocol for phase-separated compositional and nanomechanical characterisation data.

Fraunhofer (IWM)

Fraunhofer IWM will be involved in the activities related to elaborate ontologies as a basis for standardised documentation for micro- and nanomechanical materials characterisation (methods and protocols) and multi-technique protocols.

Goldbeck Consulting Ltd.

GCL will support NanoMECommons contributions to ontologies data structures and standardised documentation. GCL will also support cooperation towards standardisation and an Industry Commons of characterisation data and protocols. GCL will contribute its experience and expertise in EMMO as well as standardisation to support the development of standardised documentation of characterisation protocols based on widely agreed EMMO compliant ontologies. It will include materials characterisation terminology and metadata standardisation and establishing reliable and standardised connections between characterisation metadata and performance descriptors. GCL will contribute fostering a close collaboration on metadata and ontologies between the European Materials Characterisation Council (EMCC) and the European Materials Modelling Council (EMMC). Further, GCL will support EMCC and EMMC efforts to establish a wider manufacturing/modelling/ characterisation network linked with stakeholder platforms such as EPPN and OIE/OITB Projects (CORNET, MMAMA, OYSTER, TEESMAT, etc.)

European Synchrotron Radiation Facility (ESRF)

The main contribution of the ESRF to the NanoMECommons project is the implementation of a multi-material multi-modal strain microscope. This is based on a prototype developed by the ESRF in research partnership with Nelumbo Digital. It allows the homogeneous straining of thin films and membranes of metals, oxides, semiconductors (organic/ inorganic) and their observation by microscopy, Raman or UV/VIS spectroscopy or X-ray diffraction. The tool allows the dynamic imposition of homogeneous tensile strain over macroscopic areas up to the elastic limit of the material while limiting the impact of local defects and cracks on the strain. The operando investigation by optical means and high energy X-ray diffraction allows for a precise characterisation of the strain itself but also its impact on electronic properties. It has been successfully tested with Si-membranes where strain levels of 1.9 % have been reached. The dynamic application of tensile strain with this apparatus allows the experimental determination of a materials Young's modulus. The deployment of this tool will provide a new extremely user friendly, economic and quantitative strain analysis tool supplying insight in fields ranging from metallurgy over flexible/organic electronics to batteries.

Cambridge Nanomaterials Technology Ltd

Cambridge Nanomaterials Technology Ltd. is leading the exploitation and dissemination activities of the nanoMECommons project. CNT is in charge of the project website (www.nanoMECommons.eu) leaflets, organisation of the Open Day workshops, Intellectual Property (IP) strategy, and preparation of patent landscaping reports. We are also involved in market research, business development and exploitation strategy of the project.

Granta Design Ltd

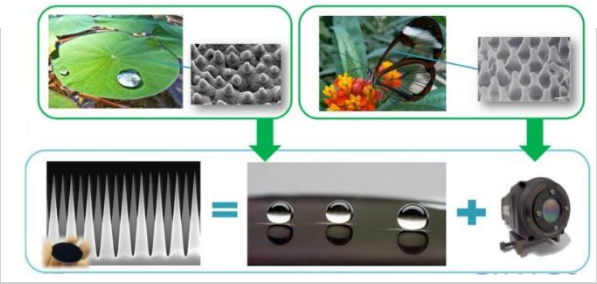
The main role of Ansys Granta in the nanoMECommons project is to establish a central materials and process information management platform for capturing characterisation data/information, digitizing of protocols, searching across multiple datasets and IP protection. This includes the design of appropriate schema and identification of metadata for specific materials and processing domains for the project for full traceability, from material batch to protocols for characterization protocols (experimental and virtual). The database system implementation will also incorporate the experience of other NMBP OITB's in these domains as represented by the project, and industry best practices as established by Granta and its partners over the past 25 years. The materials information system will be linked to other platform (e.g. OITBs and MarketPlaces) using or informing the latest interoperability standards derived from NMBP related activities for materials and processes (EMMC, EMCC, Pilot Plants, ….). The development will ensure the data and information generated within the project will follow FAIR principles. In addition, Ansys Granta will establish collaborative tools for early product design stages (ecological, cost, risk, REACh, health and safety, material & process selection, circular economy), tailored to the life cycle analysis of nanomaterials and related processes (up to 80% of life cycle cost and environmental impact is lock-in at the early product design stages). Finally, Ansys Granta will support development of a sustainable, scalable business model for Open Access to the materials, processes and characterization information and protocols digitized in the project for all relevant stakeholders (industries, SME's, equipment manufacturers, technology developers, RTOs, academia).

Keysight Technologies GMBH

KEYS will develop and harmonize a protocol for the combined testing of batteries, including metrological data evaluation and standardization of the various instruments that are used in the data acquisition. New battery models are being developed including metrological data acquisition hardware and software.

Thales Research & Technology

Thales R&T is industrial case-studies provider in the nanoMECommons project. Its activities based on multifunctional surfaces, exhibiting both superhydrophobic and antireflecting behaviours, and NEMS/MEMS for RF-applications, need fast, reliable and non-destructive characterization methods to get higher TRL and accelerate the technological transfer to Thales entities.



Centro Ricerche FIAT S.C.p.A

CRF Materials Engineering Methods and Tools (MEMT) acts as end user of the automotive supply chain. The expected activities within Nanomecommons project focus on the evaluation of mechanical and residual stresses of bulk materials subjected to surface heat treatment, via the correlation between retained austenite levels and hardnesses levels in real application cases, as gear tooth. The main tasks are:

- Setting specifications and standards for automotive applications in vehicles: standards for in-line and off-line metrology and characterization
- Quality control and assessment of the process for automotive compliance following FCA standards
- Characterization of demonstrators and their applications: metals bulk assessment and coating characterization
- Follow-up manufacturing trials and characterization procedures
- Transferring of developed technical approaches in working automotive standards
- Validation process on demonstrator of automotive applications. Reliability assessment, non-destructive testing and prevalidation.
- Evaluation of metrology and assessment processes for the automotive sectors and exploitation within the automotive market and transfer to Tier1, Tier2 and SI.

Organic Electronic Technologies (OET)

The main role of OET in the project includes:

- Multi-technique characterization protocols (optical, electrical, nanomechanical) for Organic Electronic applications
- R2R manufacturing of OPV and OLED devices and in-situ & ex-situ electrical, in-situ optical, structural and mechanical characterization
- Fabrication of high-efficient OPV and OLED devices with improved mechanical performance and stability

OET is one of the industrial partners and leads the use case of Organic Electronics, where multi-technique characterization protocols will be implemented and applied. OET and AUTh will focus the activity on Flexible Organic & Printed Electronic devices and will demonstrate and exploit the R2R in-line and non-destructive optical characterization methodologies and data analysis approaches developed for the manufacturing of printed flexible OE devices. Specific focus will be given to the high-speed characterization data analysis for the automation of printing processes and manufacturing of high efficiency/stability/lifetime OE devices with improved mechanical performance and stability based on the implementation of nanomechanical characterization protocols from NTUA, SINTEF and Uniroma3. OET will fabricate printed nanolayers for OPV and OLED devices with R2R printing processes, including slot-die coating and rotary screen printing. Printed nanolayers will be characterized real-time by in-line optical metrology tools in terms of their optical properties (refractive index, optical transparency), electronic properties (electronic transitions, optical band gap), structure (surface/interface quality, blend morphology) and their thickness with nanometer scale precision. Moreover, AUTh and OET will employ their in-line metrology tools adapted on the R2R printing pilot line at AUTh to extract information on the electrical properties and device performance. Ex-situ nanoindentation measurements will be also performed for the extraction of elastic modulus and hardness of the printed nanolayers and OPV and OLED devices on plastic substrates. The nanolayer properties (structural, optical, electrical, mechanical) will be used to optimize the mechanical stability of the printed OE devices and their operation and lifetime under certain mechanical deformation (bending, stretching). OPV modules and OLEDs devices of high performance (PCE%, luminance) and mechanical stability will be fabricated and encapsulated based on the optimization of fabrication parameters.

BASF

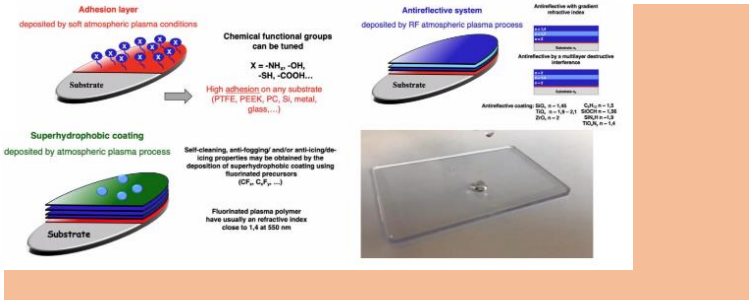
As industrial member of the consortium, BASF contributes in verifying that the proposed protocols and data workflow is applicable in industrial environment to speed up development processes and increase product reliability. **BASF** will propose two industrial case demonstrators (Additive Manufacturing and Coating) for validation of the methods and characterisation protocols in relevant industrial environments.

CONIFY Powder

In **nanoMECommons** project (Grant Agreement No. 952869), **CONIFY** is involved as end-user for additively manufactured metallic components based on dual phase stainless steels (duplex), where a controlled set of samples will be processed with intentional variations in the feedstock quality. These variations will be selected based on the known plausible scenarios in the related to the AM feedstock. This will be realized through processing of relevant advanced alloys by LPBF and DED AM technologies that require understanding of the physical and mechanical behavior down to the nano length-scale. The powders are screened down to ppm level due to different feedstock quality, in terms of purity and oxygen content as well as morphology and shape characteristics. The intention is to identify the phase-separated properties towards correlating the quality of the feedstock with the evolved phases towards the establishment of harmonised interoperable characterisation protocols, data exchange and standardisation procedures for AM products, using DED and LPBF as process models and with special focus on various duplex stainless-steel classes as materials model. **CONIFY** envisions that within the project, by performing metadata correlation analysis, the ensemble of the generated data will lead into higher comprehension of targeting optimised material purity and effect of feedstock, will contribute to the AM production, pilot lines and processing conditions by converging the focus on the challenges that are proved to have substantial effect on the final product.

MESA Consult

The role of **MESA** in this project is to develop and optimize anti-reflective systems combined with superhydrophobic properties based on multilayer architecture by using innovative plasma methods. MESA will manage the development and the implementation of anti-reflective coatings, which will be performed by using vacuum and atmospheric plasma deposition methods. MESA will manage the development and the achievement of such systems by using plasma equipment's and deposition methods available in different MESA partners laboratories such as University of Strasbourg and Molecular Plasma Group.



Examples of antireflective hydrophobic coatings produced by MESA

News

Project Website

The project website (**www.nanomecommons.eu**) and leaflet are now available and will be updated periodically as the project develops and more information is made publicly available.

Cambridge Nanomaterials Technology (**CNAT**) is also responsible of the project Twitter account (**https://twitter.com/commons_me**) and LinkedIn project presence (**https://www.linkedin.com/groups/12525781/**).

nanoMECommons - Workshop on Materials Characterization - 13 December 2021

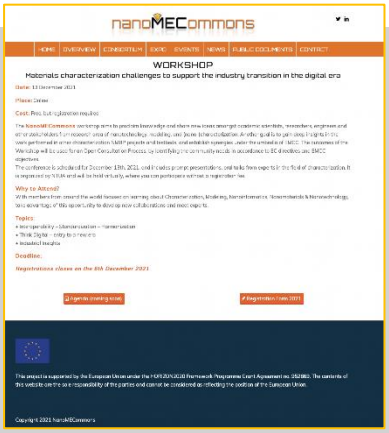
The **NanoMECommons** is organising a Workshiop on Materials Characterization on the 13 December 2021, with the aim to proclaim knowledge and share new ideas amongst academic scientists, researchers, engineers and other stakeholders from research area of nanotechnology, modeling, and (nano-)characterization. The workshop is organized by NTUA and will be held virtuall. Participation is free, but registration is required. For more information and to register, please visit the **EVENTS** page at the nanoMECommons website, following **this link**. Registration closes on the 6th December 2021**.**

EXPO site

CNAT has started with the preparations of a virtual **EXPO** for the **nanoMECommons** partners. Each partner will have a exhibition stand, where they will showcase their products and services, as well as their work on the project.

Screenshot of the Reception area

Screenshot of the EXPO hall



nanoMECommons was present at the NanoTexnology conference

NanoMECommons was represented by **NTUA** in the 11th International Conference & Exhibition on Green Flexible & Printed Electronics Industry organized by AUTh. This Conference and Exhibition that took place in Divani Caravel Hotel, Athens, Greece. The Conference & Exhibition brought together Key Industrial Players, End-Users, Entrepreneurs, Investors, Top-class Scientists, Engineers, Policy Makers and Representatives from the National, European and International Authorities to discuss, network and establish the strategy and policy for boosting the rapidly evolving Flexible & Printed Electronics (FPEs) hundred-Billion euros Industry.

The project coordinator Costas Charitidis gave a speech on the topic "*Materials Characterisation in the era of Digital Transformation: twin transition challenges and perspectives towards a Decarbonized and Circular Economy*".

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