


MICRO – NANO SYSTEMS LABORATORY**Contact details**

Name	MICRO – NANO SYSTEMS LABORATORY
Acronym	MiNaS
Logo	
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Areas of expertise

Micro systems, Nano-systems, Nano-mechanics, MEMS, Nano Tribology, Micro structures, Adhesion, Friction, Fatigue and Reliability.

Team and key skills

Prof. Dr. Eng. Marius PUSTAN – conducting the courses in the field of Machine Elements, Mechanisms and Tribology and the laboratory of Micro-Nano Systems (MiNaS),
Publications: 10 books; more than 80 scientific papers, Researcher of Région Wallonne from Belgium at Liege University (2 years) and Researcher within the European project FP6 – Advanced Methods and Tools for Handling and Assembly in Microtechnology-ASSEMIC (Warsaw University of Technology, Department of Mechatronics – one year)

Prof. Dr. Eng. Corina BIRLEANU – full professor at UTCN since 2007, with expertise in Machine Elements, Mechanisms and Tribology and also a member of Micro-and Nano-Systems Laboratory. She specialized in advanced ceramic materials and had been working at IWF, Technische Universität from Braunschweig, Germany.
Publications: 11 books; more than 130 scientific papers

Prof. Dr. Eng. Cristian DUDESCU - conducting the courses in the field of Mechanics of materials and Finite element method with expertise in experimental mechanics, material testing and numerical simulations.
Publications: 5 books; more than 60 scientific papers, Marie-Curie postdoctoral researcher in Neu-Ulm, Germany, TU Chemnitz, Germany - Alexander von Humboldt Foundation- research fellowship.

Dr. Eng. Violeta MERIE – Research Assistant, with expertise in development and tribological characterization and structure of new composite friction materials based on iron for applications in the automotive industry and powder metallurgy.

PhD. Mathematician Florina Maria RUSU - with expertise in the Nano mechanics and Nano tribological characterization of MEMS design reliable resonators and also in optimization and mathematical modelling.

PhD. Eng. Radu CHIOREAN – involved in optical methods of the state of strain and stress in the microstructures (MEMS) also in languages for technical computing (MATLAB), PLC programming, Computer Aided Design (Solid Works), element simulation software (ANSYS).

Infrastructure

- Clean Room - made modular, surface 30 m²; cleaning class – 1:1000; air flow 7000 m³/h; air humidity control
- Acoustic Enclosure
- AFM multifunctional XE70 – with Nano indentation module; in spectroscopy mode points, the lateral force, dynamic mode and Nano indentation mode.
- Heating system with Peltier elements - possibility of temperature control between (- 4°C ... 180°C)
- AFM NT- 200 - in spectroscopy mode points, with the resolution of 2 nm and modules as normal mode, lateral force and dynamic modes - are used to estimate the mechanical and tribological properties of MEMS materials and structures
- Zeiss optical microscope - max.1000x
- Machines for experimental analysis of friction with 4 modules with the possibility of measurement at macro and micro scale

- 3D optical measuring system for displacement & strain analysis in components based on digital image correlation technique are used for analysis of the stress-strain behavior.

Development strategy

The research strategy of Micro - Nano Systems Laboratory include the following aspects:

- Nano-mechanical and nano-tribological characterization for reliability design of micro-electro-mechanical systems (MEMS)
- Robust design of micro-electro-mechanical systems (MEMS)
- Development of sensors for the measurement of harmful particles in atmosphere (mass-detection applications)
- Development of software for reliability design of micro-electro-mechanical systems (MEMS)
- Characterization of the microstructure surface in order to increase the lifetime of micro systems
- Computational modeling of the tribomechanical behavior of the micro systems
- Comparative study of macro-micro-nano mechanical and tribological properties of materials
- Nano-mechanical and nano-tribological characterization of dental materials

Representative projects

PN-II-RU-TE-2011-3-0106 / 2011 - 2014 - Nano mechanical and Nano tribological characterizations for reliability design of MEMS resonators (NARDEMS)

The scope of this project is mechanical and tribological characterizations of MEMS materials and structures for reliability design of MEMS resonators. Mechanical properties include analysis of the static and dynamic responses of MEMS resonator (micro bridge and micro cantilevers). The tribological investigations include Nano friction and stiction analysis. The resonators are used as the main components in sensors and actuators.

FP7 – ERA.Net / 2012 – 2015 – 3 Scale modeling for robust-design of vibrating micro sensors (3SMVIB)

This project aims at improving the efficiency of the manufacturing process while decreasing the production cost by considering at the design stage the uncertainties in such a way that a range of the MEMS properties can be predicted for the manufactured products. Six partners from Belgium, Romania and Poland are involved in this project.

Romanian Space Agency - STAR nr. 32 / 2012 - 2015 - Reliability design of RF-MEMS switches for space applications, The Research, Development and Innovation Space Technology and Advanced Research – STAR (REDEMS)

The main focus of this project is orientated on the experimental investigations and methodology for reliability design of MEMS for space applications. Monitoring the flexible component motion for different space conditions is becoming essential, both to evaluate their performance and to development process reliability improvement.

Romanian Space Agency - STAR nr. 97 / 2013 - 2016 - Tribomechanical Characterization of MEMS Materials for Space Applications under harsh environments (MEMSMAT)

Research activities are performed in this project in order to determine the behavior of MEMS materials in harsh environmental conditions from space applications. Analytical models and simulation of mechanical and tribological properties of MEMS materials and structures for different operating conditions are included in project development.

Significant results

The most representative publications:

1. M. Pustan, C. Birleanu, C. Dudescu, J-C. Golinval (2013) - Dynamical behavior of smart MEMS in industrial applications, Chapter 12, Book - Smart sensors and MEMS for industrial applications, WOODHEAD PUBLISHING LIMITED, Cambridge, CB22 3HJ, UK. ISBN 0 85709 502 1, ISBN-13: 978 0 85709 502 2, 510 pages
2. Pustan M, Dudescu C, Birleanu C, Rymuza Z (2013) Nanomechanical studies and material characterization of metal/polymer bilayer cantilevers MEMS Structures, **International Journal of Materials Research**, 104 (4), ISSN 1862-5282, 408-414, DOI: [10.3139/146.110879](https://doi.org/10.3139/146.110879).
3. Pustan, M., Birleanu, C., Dudescu, C. (2013) Simulation and experimental analysis of thermo-mechanical behaviour of microresonators under dynamic loading, **Microsystem Technologies**, 19 (6), ISSN 1432-1858, 915-922, DOI: [10.1007/s00542-012-1728-1](https://doi.org/10.1007/s00542-012-1728-1).
4. Pustan M, Belcin, O., Birleanu, C. (2013) Mechanical seals with oscillating stator, **Meccanica**, 48 (5) Print ISSN 0025-6455, On-line ISSN 1572-9648, 1191-1200, DOI: [10.1007/s11012-012-9660-0](https://doi.org/10.1007/s11012-012-9660-0).
5. Pustan M, Rochus V, Golinval J-C. (2012) Mechanical and tribological characterization of a thermally actuated MEMS cantilever, **Microsystem Technologies**, 18 (3), ISSN 1432-1858, 246-250 DOI: [10.1007/s00542-011-1423-7](https://doi.org/10.1007/s00542-011-1423-7).
6. Pustan M, Muller R, Golinval J-C. (2012) Nanomechanical and nanotribological characterization of microelectromechanical system, **Journal of Optoelectronics and Advance Materials**, 18, ISSN 1454-4164, 246-250.
7. Wu, L., Noel, L., Rochus, V. Pustan, M., Golinval, J.C. (2011) Micro-Macro Approach to Predict Stiction due to Surface Contact in Micro Electro- Mechanical Systems, **IEEE/ASME Journal of Microelectromechanical Systems**, 20 (4), ISSN 1057-7157, 976-990-412, DOI: [10.1109/JMEMS.2011.2153823](https://doi.org/10.1109/JMEMS.2011.2153823).
8. Pustan M, Paquay S, Rochus V, Golinval J-C. (2011) Modeling and finite element analysis of mechanical behavior of flexible MEMS components, **Microsystem Technologies**, 17 (4), ISSN 1432-1858, 553-562, DOI: [10.1007/s00542-011-1232-z](https://doi.org/10.1007/s00542-011-1232-z).
9. Pustan M. (2011) Nanomaterial behaviour of a gold microcantilever subjected to plastic deformations, **Digest Journal of Nanomaterials and Biostructures**, 6, ISSN 1842-3582, 287-292.

Remarkable results:

- Development of a new method for stiffness measurement of micro and nanostructure by using atomic force microscope

- Macro-Micro-Nano determination of the materials mechanical and tribological properties
- Design-Fabrication-Testing of micro membranes with high flexibility
- Software development for lifetime estimation of vibrating MEMS structures

The offer addressed to the economic environment

Research & development in core areas	- Micro and Nano – Systems - Micro and Nano - Tribology - Micro and Nano - Mechanics
Research & development in applied fields	Team members have great knowledge in: reliability design of micro and Nano systems, Nano /micro / macro tribological characterizations, experimental mechanics, material testing and numerical simulations.
Consulting	Consulting in any of the above mentioned fields can be done.
Applied engineering services	Due to a close collaboration with the productive sector, the research team is capable of collaboration with various industrial partners and research institutes.
Training	The members of the team have a vast experience in the educational field (academics). Also, the team has experience in the development of the professional formation and reorientation trainings for engineers in the field of micro and Nano system design, advance testings at micro and Nano devices.

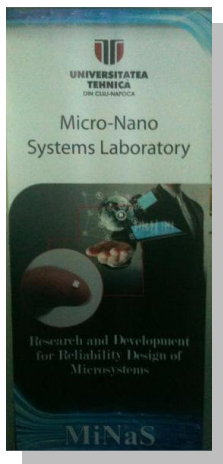


Fig. 1. Laboratory Mesh



Fig. 2. AFM - XE70 Multifunctional



Fig. 3. Atomic Force Microscope AFM NT- 200

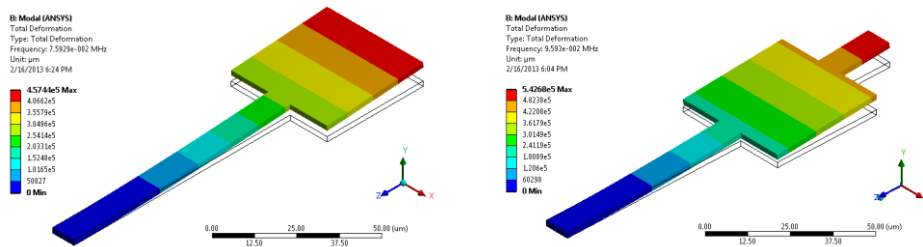


Fig.4. Simulation and Finite Element Analysis of mass-detection sensor



Fig.5. Experimental testing with AFM in cleanroom laboratory