



## HORIZON-CL4-2022-RESILIENCE-01-19: Advanced materials modelling and characterisation (RIA)

### Ideas for the project:

The creation of new materials was largely based on changes in their chemical composition or material structure within a continuum. With the rapid development of technologies, new opportunities are emerging to create complex material structures at different size scales, with different physical properties. The properties of metamaterials are, from a macro perspective, different from those of the materials forming their structure in the form of a continuum. For example, it is possible to produce a material that exhibits a negative Poisson's number at the macro level, which is inconceivable for conventional materials. The investigation will be focused on the investigation of the structures of materials, including nanostructures, foam materials and composites, using modern numerical and experimental mechanics methods.

### Our ideas for the project:

In the frame of project, we want to design new internal structures of metamaterials and optimize their mechanical properties in different scales by using optimization based on genetic algorithm (suitable for topological and parameter optimization) as well as combination of modern numerical and experimental methods of mechanics. The aim is to design the structure of metamaterials to obtain suitable mechanical properties, to determine the basic mechanical parameters of these structured materials with respect to their further use in practice. The scientific objectives of the project can be briefly formulated into the following areas: design of optimal structure of metamaterials, linear and non-linear finite element analysis of metamaterials, analysis of properties of nanostructures by means of classical mechanics, homogenization of material properties by modelling their internal structure in necessary scales and determining their effective properties at the macro level, the use of experimental methods for the determination of deformation and stress fields. **We propose numerical modelling combined with experimental verification of results.**

### Infrastructure offered:

- Modeling of Mechanical Systems - Siemens NX, NX Nastran, SIMULIA Abaqus/CAE 6.14, Ansys, SolidWorks, Matlab, MSC.Adams
- Laboratories of Experimental Stress Analysis, Resistance Tensometry and Redistribution of Residual Stresses, Modern Optical Methods of Mechanics, Transmission Photoelasticity, Reflective Photoelasticity, Photostress, etc. - <http://www.sjf.tuke.sk/kamasi/en/research/laboratories-and-classrooms>

### Recent projects solved, related to the issue:

Experience with linear and nonlinear finite element analysis, structural topology and size optimization by genetic algorithm, experimental measurement by strain gage methods as well as contactless optical measurements in static and dynamic area, residual stress measurements, investigation of metamaterials including foams and nanomaterials.

1. Static and dynamic analyses of aluminum foam geometric models using the homogenization procedure and the FEA, Access: <https://www.sciencedirect.com/science/article/pii/S1359836818321607>
2. The computation of bending eigenfrequencies of single-walled carbon nanotubes based on the nonlocal theory, Access: <https://ms.copernicus.org/articles/9/349/2018/>
3. Buckling of single-walled carbon nanotubes with and without defects, Access: <https://link.springer.com/article/10.1007/s12206-017-0330-y>.
4. Sizing and topology optimization of trusses using genetic algorithm, Access: <https://www.mdpi.com/1996-1944/14/4/715>.
5. Solution of project: Research of mechanical properties of materials with complex internal structure by numerical and experimental methods of mechanics.

### Partners in previous research projects:

TU Darmstadt, TU Stuttgart, University of Valencia, University of Wuppertal, CTU in Prague, Brno University of Technology, Sunmoon University - South Korea, University of Zielona Góra

### Contacts with industrial partners:

Oerlikon, Continental, U. S. Steel Košice, BSH Siemens, Eustream, ŠKODA AUTO, IDIADA, Enel, VÚJE, Mondi SCP, Whirlpool, ISD Dunafer, Slovalco, Slovenské elektrárne, Tatrabagónka

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