

Metal-ceramic composites (IPC), investigated in the project, are made of a metal matrix and ceramic foam. These two components that **interpenetrate** each other are called phases. Due to the existence of ceramic foam, the composites are relatively light, and thanks to the metal matrix, the material becomes resistant to brittle fracture. Besides the metal matrix improves impact resistance.

Considering IPC properties, they can be subjected to extreme loads, such as variable dynamic loads, high temperatures, impacts. These unique properties allow for the application of metal-ceramic composites in aviation, space exploration, nuclear energy and the armaments industry.

Because IPCs are new materials with a complex mesostructure and microstructure, interactions between phases are not yet known precisely, that is why they require thorough research. Macro-scratches, which are usually visible signs of the destruction process, depend on the development of cracks at micro- and meso-levels. That is why research is needed with the use of advanced instrumentation for experimental research at impact loads and the development of a methodology for analyzing collected data, starting from the micro level and ending with macro scale. Since the impact loads are very short-lived, it is not possible to observe the creation and growth of cracks occurring in the material, in particular at the level of microscale. Analysis of experimental results is usually carried out *post-mortem*, *i.e.* the sample is tested after its destruction. However, cracking processes can be modelled using numerical methods.

Numerical methods will be widely used in the project for simulation of (a) macro fragmentation of IPC samples, (b) development of cracks at the meso-level, (c) initiation of cracks at the micro-level. Each of these applications requires different calculation techniques. First: in order to simulate macro-fragmentation of IPC, due to very large deformations, peridynamics (meshless method) will be used. Second: to simulate the initiation and development of cracks at the mesoscale level, in most cases, the finite element method is used. All these methods will be used to create a representative volume element of the material that determines the material properties of the composite at the macro-scale level. These elements can be multiplied many times, yielding realistic models, for example, mechanical parts. In other words, this element can become useful in engineering practice, which means that it is suitable for use in CAD / CAM systems. In summary, representative volume elements of these materials can be used for rapid prototyping of advanced composite materials and subsequent design of fragments, e.g. spacecraft, aircraft, car constructions, etc.

The calculations will be performed using PLGRID resources, including the CRAY XC40 supercomputer. The system was implemented at the University of Warsaw about 3 years ago and contains 1084 computing nodes (in total 26,016 cores). In addition, calculations will be performed on other computers with cluster architectures in computational centers TASK in Gdańsk and Cyfronet in Kraków, respectively.