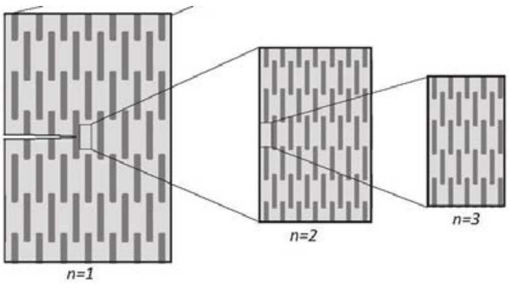
PhD or Postdoctoral position in Solid Mechanics, Tel Aviv

Brittle fracture of hierarchical materials

Using systems with structural hierarchy is an important principle of toughness enhancement, which we can learn from nature. The research project addresses composite materials with hierarchical periodic microstructure. Mathematical models of brittle fracture of lattices and solid materials will be developed. The analysis approach is based on combination of analytical and numerical methods. An example of its application can be found in [1].



Composite with hierarchical microstructure

[1] Ryvkin, M. and Hadar, O. "Employing of the discrete Fourier transform for evaluation of crack-tip field in periodic materials", *International Journal of Engineering Science,* 2015, 86, 10-19.

Background: Solid Mechanics, Programming skills, Theory of Complex Variable.

Language: English

Timing: Project beginning – autumn 2017, postdoctoral position 1 year with possibility to extension for the second year.

Contact information: Prof. Michael Ryvkin, Tel Aviv University, Engineering Faculty,

E-mail: arikr@eng.tau.ac.il   Homepage: http://www.eng.tau.ac.il/~arikr/

Application No. 1494/16,

PI1 Name: Shmuel Ryvkin

Scientific abstract - **Brittle Fracture of Hierarchical Periodic Materials**

Structural hierarchy of many biocomposites is a well known reason for their high strength and toughness. Recent technology advances provide an attractive opportunity for manufactoring of new micro-architectured materials utilizing this feature, and prediction of their mechanical behavior is necessary. Significant progress has been made in studying bulk properties of hierarchical materials; however, their fracture behavior is rarely investigated due to difficulties in solution of corresponding multiscale problems. The proposed research suggests a way to overcome these difficulties in a case when composite microstructure at each hierarchical level is periodic. The biocalcite-like composites produced as a system of soft inclusions or voids in a hard matrix are addressed.

Two problems of brittle fracture are considered, macrocrack nucleation from initial flaw and its arrest. In the first problem the flaw is embedded in the center of a rectangular domain including many repetitive cells, and in the second one this domain represents a semi-infinite crack-tip vicinity. The boundary conditions are formulated in terms of jumps in the displacements and traction values at the opposite sides of the domain, they are determined from the solutions of the corresponding problems for homogeneous material possessing effective elastic properties. This formulation makes it possible to transfer between the neighboring hierarchical levels by application of the discrete Fourier transform, which allows to reduce the analysis of a large periodic domain to the analysis of a single repetitive cell. The latter analysis is carried out several times in the space of complex-valued Fourier transforms.

High numerical efficiency of the suggested method will enable one to accurately determine stress field in damaged hierarchical biocalcite-like composite and predict its damage-tolerance and fracture toughness. A stress criterion for crack (flaw) propagation is adopted, i.e., a critical situation occurs when the maximum stress in the hard phase approaches the tensile strength of the bulk material. Both self-similar and not self-similar layouts will be considered, and impact of inclusion shape will be examined. The suggested method will be also used in analysis of the fracture toughness of hierarchical honeycombs.