MICRO-MECHANICAL MODELLING OF CELLULAR MATERIALS WITH REFINEMENTS ON FRACTURE AND DAMAGE

Goal of the project

Cellular materials are widely used as cores in sandwich composites, for packing and cushioning. The main characteristics of foams are light weight, high porosity, high crushability and good energy absorption capacity. Present project propose to develop micro-mechanical models in order to predict the mechanical properties of cellular materials with a focus on modeling the fracture and the influence of damage on the mechanical response.

Short description of the project

Project combines analytical methods, with numerical micro-mechanical finite element analysis and experimental investigations: materials testing and investigating the damage mechanisms by Digital Image Correlation and Thermoelastic Stress Analysis. The novelty of the project will be highlighted by the size and notch effect for cellular materials, and by investigating the effect of microstructural damage on the mechanical response of cellular materials.

Project implemented by

- Politehnica University of Timisoara
- Lublin University of Technology, Lublin, Poland
- Slovak Academy of Science, Bratislava, Slovakia
- Polymer Competence Center Leoben, Austria
- ILK, TU Dresden, Germany

Implementation period

05.10.2011 – 04.10. 2015

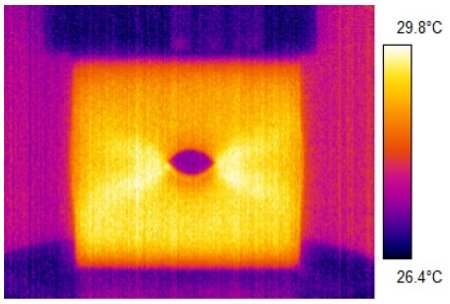
Main activities

- Better understanding of mechanical behavior of cellular materials.
- Develop micro-mechanical models to estimate mechanical properties of cellular materials.
- Implementation of constitutive material models in Finite Element Analysis.
- Investigating the size effect and notch effect on cellular materials Evaluating the behavior of cellular materials under dynamic (impact and fatigue) loading.
- Identification of damage mechanisms in cellular materials.
- Investigating the effect of microstructural damage on the mechanical properties of cellular materials.

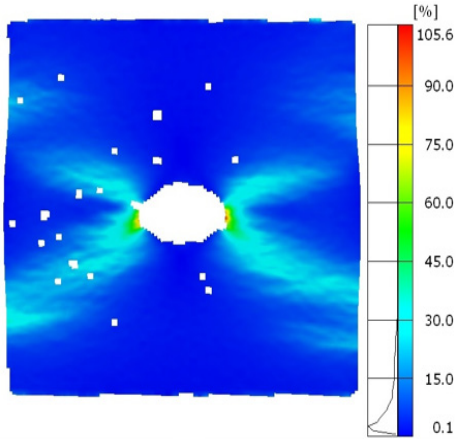
Financed through/by

Grant PN-II-ID-PCE-2011-3-0456, Contract Nr. 172/2011, by Romanian Ministry of National Education, through UEFISCDI

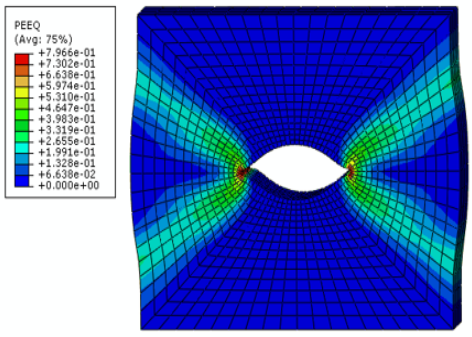
Investigating the damage of PUR foams with different densities and holes



by thermography



by Digital Image Correlation



by Finite Element Method (equivalent plastic strain)

Main results for 2014 year:

Journal Papers:

1. L. Marsavina, D.M. Constantinescu, E. Linul, D.A. Apostol, T. Voiconi, T. Sadowski, Refinements on fracture toughness of PUR foams, Engineering Fracture Mechanics, 129, 54-66, 2014, DOI: 10.1016/j.engfracmech.2013 (ISI);
2. T. Voiconi, R. Negru, E. Linul, L. Marsavina, H. Filipescu, The notch effect on fracture on polyurethane materials, Frattura ed Integrita Strutturale, 30, 101-108, 2014 (SCOPUS);

Conference Papers:

1. L. Marsavina, E. Linul, T. Voiconi, R. Negru, Experimental investigations and numerical simulations of notch effect in cellular plastic materials, The 3rd International Conference on Competitive Materials and Technology Processes, Miskolc, Hungary, 2014;
2. E. Linul, T. Voiconi, L. Marsavina, Determination of Mixed Mode Fracture Toughness of PUR foams, New Trends in Fatigue and Fracture NT2F14, „Fatigue and fracture at all scales", Belgrade, Serbia, 2014, published in Structural Integrity and Life, Vol 14(2) 87-92, 2014;
3. T. Voiconi, L. Marsavina, E. Linul, J. Kováčik, Determination of elastic and damping properties for closed-cell aluminium foams using Impulse Excitation Technique, Proceedings of XIIIth Youth Symposyum of Experimental Solid Mechanics, 141-145, 2014;
4. E. Linul, D.A. Serban, T. Voiconi, L. Marsavina, T. Sadowski, Energy-absorption and efficiency diagrams of rigid PUR foams, Key Engineering Materials, 601, 246-249, 2014 (ISI Proceedings, Scopus);
5. D.A. Apostol, D.M. Constantinescu, L. Marsavina, E. Linul, Analysis of Deformation Bands in Polyurethane Foams, Key Engineering Materials, 601, 250-253, 2014 (ISI Proceedings, Scopus) ;
6. T. Voiconi, E. Linul, L. Marsavina, J. Kovacik, M. Knec, Experimental determination of mechanical properties of aluminium foams using Digital Image Correlation, Key Engineering Materials, 601, 254-257, 2014 (indexat ISI Proceedings, Scopus);
7. T. Voiconi, E. Linul, L. Marsavina, T. Sadowski, M. Knec, Determination of flexural properties of rigid PUR foams using digital image correlation, Solid State Phenomena, 216, 116-121, 2014 (Scopus) ;
8. L. Marsavina, D.M. Constantinescu, E. Linul, T. Voiconi, D.A. Apostol, T. Sadowski, Evaluation of mixed mode fracture for PUR foams, Procedia Materials Science, 3, 1342-1352, 2014 (ScienceDirect)

Book Chapter

L. Marsavina, D. Constantinescu, Failure and Damage in Cellular Materials in Failure and Damage Analysis of Advanced Materials, Eds. H. Altenbach, T. Sadowski, Springer, Udine, 2014.

Applicability and transferability of the results

- Results will be used by foams manufacturers Necumer and Spumotim to improve their technologies. Also, companies using foam components like TRW Automotive and Adidas will benefit by our developed micro-mechanical models to characterize their components and in the product design.

Fields of interest:

- Composite and cellular materials
- Mechanical testing
- Finite Element Analysis
- Fracture and Damage Mechanics

Research team

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Dan A. ȘERBAN, PhD – Postdoc Researcher
Eng. Tudor VOICONI– PhD student
Eng. Florin STUPARU– PhD student

"There are no secrets to success. It is the result of preparation, hard work, and learning from failure."
Colin Powell

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