Keynote Lecture

abst. 1014
Room DANTE
Tuesday
September 3
10h40

Data-based micromechanical modelling of the dynamic response of interpenetrated composites

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The interpenetrating composites (IPCs) are built up of a ceramic skeleton and metallic matrix, which fills the ceramic foam under pressure and high temperature. The specific examples of IPCs analysed in the paper are made of the ceramic skeleton - SiC or Al2O3 - which is a brittle material, whereas the matrix is created by AlSi12 alloy – elasto-plastic material. Both phases of IPCs are crushable and their degradations under the loading are subjected to two different damaging processes. The ceramic foams are brittle throughout the loading process, but the AlSi12 alloy is brittle during the elastic phase; then, its behaviour becomes viscous-plastic. The presentation concerns the experimental testing and simulations of the impact and fragmentation of metal matrix composite - AlSi12/(SiC or Al2O3). The microstructure of the composite is complex and consists of a metallic phase (85%), ceramic skeleton, porosity, and a system of imperfect interfaces. The presented data-driven micromechanical numerical model is based on micro-CT scanning of composite material to get information about the internal structure and the assessment of local thermo-mechanical properties done by Alemnis observations under SEM at nanoscale or microscale using nano- or microindetation technique. The description of the dynamic response of IPCs by impact is investigated in a few scenarios. The exemplary scenario is realised by imposing the initial conditions on the sample that hits a hard elastic barrier. The second one corresponds to SHPB experiments. The last one is the hitting of an elastic impactor against the sample. The influence of the impact velocities and material parameters of the phases on the failure modes is observed. Previously, analyses of the modes of loading application on the micromechanical failure of metal matrix composite were analysed in [1, 2]. An analysis of the empty SiC scaffolds is presented in [3]. The proposed finite element model of the AlSi12/SiC composite behaviour describing gradual degradation under impact loading was tested for different impact scenarios. In all cases, the damage growth in the composite is very realistic. These results conclude that the proposed finite element model is very effective. Acknowledgement: The results presented in this paper were obtained within the framework of research grant No. 2019/33/B/ST8/01263 financed by the National Science Centre, Poland. Numerical analyses: PLGRID facilities - ICM UW Warsaw, CI TASK in Gdańsk, CYFRONET, Kraków and LUMI in Kajaani (Finland). References: [1] Postek, E. and Sadowski, T. Distributed microcracking process of WC/Co cermet under dynamic impulse compressive loading. Compos. Struct. (2018) 194: 494-508. [2] Postek, E. and Sadowski, T. Qualitative comparison of dynamic compressive pressure load and impact of WC/Co composite. Int. J. Refract. Hard. Met. (2018) 77: 68-81. [3] Postek, E., Sadowski, T. and Bieniaś, J. Simulation of impact and fragmentation of SiC skeleton, Phys. Letters (2021) 24:578-587.

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abst. 1115
DANTE
Wednesday
September 4
11h30

Application of bone healing simulation technique to the design of orthoses/prostheses made of flexible fibrous composites

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It is well known that mechanical stimulation directly affects and controls cell and tissue development in the fractured bones in terms of mechano-regulation theories which correlate mechanical stimuli and bone healing. There are many different types of mechano-regulation algorithms which use different types of mechanical stimuli such as principal strain, fluid velocity, deviatoric strains and so on. External load types and prostheses type may change mechanical condition at the fracture site especially in calluses