8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

RATE DEPENDENT FAILURE OF HIERARCHICAL NANO-COMPOSITES

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Key words: Hierarchical composites, Dynamic failure, Length-scale effects, Computational microstructural mechanics

ABSTRACT

Nature tends to design inhomogeneous microstructures, using growth mechanisms to develop the levels of hierarchy while retaining very fine length scale control. Such well-designed natural microstructures are shown to be extremely efficient (strong and ductile) from a structural viewpoint [1]. Motivated by this concept, we define *hierarchical* composites as heterogeneous materials that comprise two or more constituent phases where at least one phase is itself a composite at a finer scale [2]. Recent advances in nanostructured materials have provided new impetus for developing super-strong composite materials, exploiting the interplay between the deformation mechanisms active at multiple length scales [2, 3].

Our current work focuses on using continuum approaches in modelling the rate-dependent mechanical response of artificial hierarchical composites. The primary objective here is to investigate the microstructure-property relationship with reference to failure in such composites. To this end, we *construct* model microstructures with multiple phases that include elastic/elasto-plastic inclusions embedded within an elasto-plastic matrix, and perform explicit finite element analyses. The effect of interfacial interaction between the individual constituents is also accounted for through cohesive models. These relatively simple (compared to actual microstructures) microstructural models provide guidelines regarding the synergistic and/ or competing processes in dynamic failure. We then present rate-dependent explicit analyses of the actual microstructures for a novel *trimodal* Al-alloy particulate composite that exhibits impressive strength and a rate-dependent failure response [4].

References

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