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Multi-scale mechanics of smart material systems and structures

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During the last few decades, active composites have been in the focus of intense technological and fundamental researches from industry and academia, respectively. Besides, the wide use of passive composites in transport vehicles and infrastructures led to their functionalisation for their monitoring and control. Good candidates for related sensing, actuation or transduction functions are the so-called smart materials, such as piezoelectric materials, shape memory alloys or polymers, electro- or magneto-strictive materials, electro- or magneto-rheological fluids and electro-active polymers. With the help of integrated control algorithms and processing devices, passive material systems and structures become *smart*; therefore, due to their multi-physical and multi-disciplinary nature, their multi-scale modelling and simulation are still not yet fully mastered. Hence, in order to reach *robust designs* of these advanced smart material systems and structures, special fundamental and applied research efforts are still required in order to reach: (i) materials multi-physical effective properties complete and reliable data sets; (ii) efficient *multi-scale* models and *local/global* solutions; (iii) mastering *integrity* and *reliability* critical issues for wider and safer applications.

This focused issue of *Acta Mechanica* presents six *revised*, from ten *peer-reviewed*, manuscripts that were *extended* after their selection from the twelve contributions presented in two sessions at the Mini-Symposium MS27 on *Multi-scale Mechanics of Smart Material Systems and Structures*, co-organised by the present guest editors during the 8th *European Solid Mechanics Conference* held at Graz (Austria) on 9–13 July 2012. These six papers focused on one or more of the above mentioned research issues of *Multi-scale Mechanics of Smart Material Systems and Structures*; in particular, Micro-mechanics-based numerical homogenisations of *magneto-electro-rheological* particle and *piezoelectric* fibre reinforced polymer composite material systems, *local* (section)-*global* (structural) analytical models and solutions for the piezoelectric d₁₅ shear-induced torsion actuation and sensing problems, *multi-scale fatigue life* analyses of polymer encapsulated piezoceramic transducers, and behaviour and response nonlinearities analyses for healthy and *cracked* piezoelectric transducers at room or *cryogenic* temperatures. It is hoped that this focused issue contributes to the progress of this topic state-of-the-art and serves the research needs of the *Acta Mechanica* readers.

As a closure, we would like to thank the authors, for their high quality contributions; the reviewers, for their constructive expertises; and the Editor-in-Chief, Professor Hans Irschik, for letting us the entire freedom of this issue management and his editorial administration team for the great help in managing anonymously the managing guest editor's co-authored contributions.

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