14th World Congress on Computational Mechanics (WCCM XIV)
8th European Congress on Computational Methods in Applied Science and Engineering (ECCOMAS 2020)
July 19- 24, 2020, Paris, France

UNCERTAINTY QUANTIFICATION AND PROPAGATION IN HETEROGENEOUS MATERIALS

TRACK NUMBER 800

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Key words: Heterogeneous Materials, Uncertainty, Multi-scale Mechanics, Homogenization, Uncertain Computational Models.

ABSTRACT

Over the last few decades, uncertainty quantification and propagation in heterogeneous media, such as composite materials, has gained huge attention in the scientific community. Indeed, several uncertainties affect the performance of such materials at all scales due to the heterogeneous nature, the complex manufacturing processes, the inherent dispersion of the constituents and other factors. Uncertainties may also arise due to operational and environmental factors as well as to damages and defects during the service life.

It is now widely recognized that observed uncertainties in the behaviour of a physical system at any scale can be ascribed to fluctuations at finer scales. The integration of multi-scale modeling with uncertainty quantification is therefore critical for the analysis and design of heterogeneous materials [1]. For this reason, the linking of micromechanical characteristics with the random variation of material properties at the macroscale has been widely investigated during the last years [2].

Most of the studies concerning the uncertainty quantification in heterogeneous materials rely on well-established probabilistic methods. Recently, increasing attention has been devoted to non-probabilistic approaches, such as interval models, convex models or fuzzy sets (see e.g., [3]). These approaches are useful when available experimental data are insufficient to provide a reliable probabilistic characterization of the uncertain properties.

Both probabilistic and non-probabilistic uncertainty analysis of heterogeneous materials poses severe computational and modeling challenges, due to the high dimensionality of uncertainty and the intricate relations among different scales. Sensitivity analysis and surrogate models [4], as well as advanced sampling techniques, are commonly adopted to enhance computational efficiency in view of industry-oriented applications.

This minisymposium aims at collecting the most recent theoretical and computational developments in the field of uncertainty quantification and propagation in heterogeneous materials. Contributions concerning advanced techniques and innovative applications in the framework of both probabilistic and non-probabilistic approaches are invited.

Topics of interest include but are not limited to:

- Microstructure simulation
- Homogenization techniques
- Computational methods for multi-scale modelling and analysis
- Surrogate models
- Reduced order models
- Sensitivity analysis
- Advanced Monte Carlo simulation techniques
- Identification of effective material properties
- Modeling of spatially varying uncertain properties
- Reliability analysis.

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