Prediction of meso-scale mechanical properties of poly-silicon materials

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The miniature sizes of micro–electro–mechanical systems (MEMS) as well as the nature of their manufacturing processes, such as etching, material layer deposition, or embossing, are responsible for the existence of a scatter in the final dimensions, material properties ... of manufactured micro–sensors. This scatter is potentially threatening the behavior and reliability of samples from a batch fabrication process, motivating the development of non-deterministic computational approaches to predict the MEMS properties.

In this work we extract the meso-scale properties of the poly-silicon material under the form of a probabilistic distribution.

To this end, Statistical Volume Elements (SVE) of the micro-structure are generated under the form of a Voronoï tessellation with a random orientation for each silicon grain. Hence, a Monte-Carlo procedure combined with a homogenization technique allows a distribution of the material tensor at the meso-scale to be estimated[1]. As the finite element method is used to discretize the SVE and to solve the micro-scale boundary value problem, the homogenization technique used to extract the material tensor relies on the computational homogenization theory[2].

In a future work, we will investigate, in the context of MEMS vibrometers, the propagation to the macro–scale of the meso-scale distribution of the homogenized elasticity tensor, with the final aim of predicting the uncertainty on their resonance frequencies.

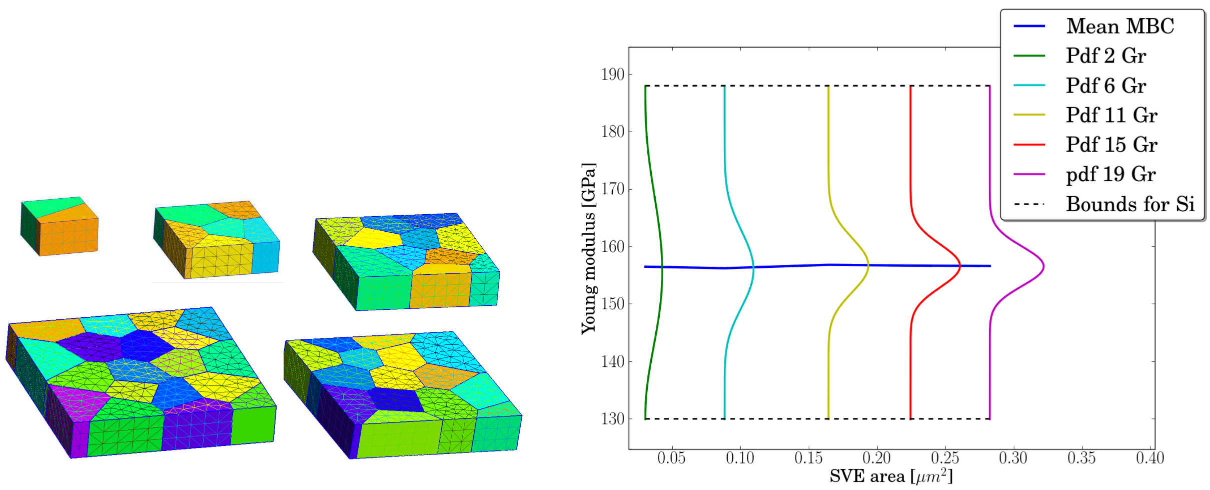

Figure 1: Extraction of the meso-scale properties (a) Different SVEs (b) Extracted Young modulus distributions.

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