

Virtual DMA performed on heterogeneous microstructures with FFT- spectral solver: Application to an amorphous glassy system

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Following the routes opened by the resort to spectral solvers applied on real composite microstructures to analyse the homogenization problem in elasticity, we extended a FFT approach implemented in the CRAFT solver [1] to viscoelastic materials, thus realizing a virtual Dynamical Mechanical Analysis (DMA) computational tool. Virtual experiments can be applied on heterogeneous microstructures so as to deliver the whole behaviour of the complex moduli over unlimited range of frequencies. DMA performs then a frequency analysis of the transfer function of the material (modulus, relaxation, compliance... quantities) with classical determination of storage and loss components (real and imaginary parts) [2]. It offers a full frequency characterization of the material constitutive law which can be applied afterwards in all cases of temporal excitations. CRAFT code and its central Lippmann-Schwinger equation are then solved in complex variables.

An example will be given in the case of a multidomain microstructure supposed to describe a glassy system or an amorphous polymer [3]. The idea is to consider a glassy system as a collection of clusters having each their own relaxation time. A distribution of times is considered and random assignation of these times to the voxels of the microstructure allows idealization of a system with heterogeneous dynamics. We will show first that the FFT-solver approach offers a very efficient virtual DMA tool, allowing 3D simulations and we will secondly illustrate the progress that can be made in material science with virtual DMA thanks to the concept of transfer function as a key path to discriminate between effective models.

References

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