6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

VISCOELASTIC BEHAVIOUR OF HETEROGENEOUS MATERIALS STUDIED THANKS TO AN EXTENSION OF CRAFT SOFTWARE IN HARMONIC REGIME.

Julien Boisse[1], Stéphane André[1] and Laurent Farge[1]

[1] Laboratoire des Energies et de Mécanique Théorique et Appliquée
LEMTA - UMR CNRS 7563, Université de Lorraine, 2, avenue de la Forêt de Haye,
Vandoeuvre-lès-Nancy, F-54500, France,
E-mail julien.boisse@univ-lorraine.fr *https://lemta.univ-lorraine.fr/*

Key Words: *Viscoelasticity, Homogenization, CRAFT, Spectral method.*

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. The idea is to propose a virtual Dynamical Mechanical Analysis experiment applied on heterogeneous microstructures. DMA performs a frequency analysis of the transfer function of the material by applying a sinusoidal harmonic steady-state regime. The transfer function (modulus, relaxation, compliance... quantities) is complex with classical 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.

Examples will be given of various microstructures made of two individual viscoelastic constituents assumed to behave according to a standard 3-parameter Voigt rheological model (spring connected in series with a Voigt unit [2]). As already shown [3], the key resulting effect on the homogenized effective material is the appearance of an additional fading memory term i.e. of a transfer function with broadened spectrum of relaxation times. Following this fact and connections established with fractional rheological models, we will show that a very efficient effective model can describe the mesoscopic behaviour of a great variety of microstructures.

REFERENCES

[1] H. Moulinec, P. Suquet, A numerical method for computing the overall response of nonlinear composites with complex microstructure, *Comput. Methods Appl. Mech. Engrg.*, 157, 69-94, 1998.

[2] N.W. Tschoegl, *The Phenomenological Theory of Linear Viscoelastic Behavior, An Introduction*, Springer Verlag, 1989.

[3] R. Brenner, P. Suquet, Overall response of viscoelastic composites and polycrystals: exact asymptotic relations and approximate estimates. *Int. J. Sol. Struct.*, 50(10), 1824-1838, 2013.

[4] S. Andre, Y. Meshaka, C.Cunat, Rheological constitutive equation of solids: a link between models based on irreversible thermodynamics and on fractional order derivative equations, Rheologica Acta, 42, 500-515.