
Internal variables and statistics of the viscous strain field in linear viscoelastic particulate composites

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Abstract

Here we consider a composite material made of an inclusion phase dispersed in a matrix. For moderate fractions of the volume fraction of inclusions and non-ageing linear viscoelastic behaviour of the phases, the correspondence principle associated with the Hashin-Shtrikman model are used to estimate the Laplace transforms of the effective creep and relaxation functions of the composite as well as the phase averages of the stress field. In the isotropic case and if the relaxation functions of the phases display a discrete spectrum (Maxwell model here), exact expressions of the macroscopic behaviour (macroscopic free and effective energies) as well as the time evolutions of the averages and fluctuations per phase of the stress field have been established from a finite number of macroscopic internal variables (see (1)). To elucidate the general link between these macroscopic internal variables and the microscopic field of internal variables (viscous strain), the correspondence principle is used to express the Laplace transform of the viscous strain field as a function of the macroscopic loading. In the isotropic case and for Maxwellian phases, the results mentioned above can be used to express the phase averages of the viscous field as a function of the poles associated with the microstructure and those of the phase relaxation functions. This yields general relations between the macroscopic internal variables and the phase-averaged viscous strain field.

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