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Constitutive modelling of ductile damage matrix reinforced by platelets-like particles with imperfect interfaces: Application to graphene polymer nanocomposite materials

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Abstract

In this paper, the mechanical response of composites consisting of ductile matrix reinforced by platelets-like particles is derived with imperfect interfaces. Due to its flexibility to study imperfect interfaces with limited number of model parameters, the linear spring model LSM is considered. Moreover, the interfacial contribution to the strain concentration tensor within each material phase and inside the average strain filed is described by a modified Mori-Tanaka scheme. The material nonlinearity is established by the J_2 plasticity and Lemaitre-Chaboche damage model. A generalised mid-point rule is used to solve rate equations yielding to anisotropic consistent (algorithmic) tangent operators. To avoid spurious macroscopic stress-strain response, an isotropisation procedure is adopted during the computation of a modified Eshelby's tensor. Numerical results are performed on graphene platelets GPL-reinforced polymer PA6 composite. They confirm the possibility to achieve high stiffness with low values of GPL aspect ratio. The accumulated plastic strain and the damage variable within the matrix are influenced by the GPL volume fraction which is also involved in the softening of the overall response when imperfection is considered at the interface.

Keywords: Interface, Graphene platelets, Ductile damage, Algorithmic tangent operators, Micromechanics

1. Introduction

Platelets-like particles represent a type of ellipsoidal oblate inclusions that are characterised by a very small thickness compared to both others semi-axis dimensions. Platelets-like particles become attractive with the development of nanocomposites such as the graphene platelets GPL based polymer composites. It is reported [1] substantial property enhancements at much lower

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