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Structural reinforcement and failure analysis in composite nanofibers of graphene oxide and gelatin

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ABSTRACT

In this work we study the mechanical properties and failure mechanism of nanocomposites of graphene oxide sheets embedded in polymeric systems, namely films and electro-spun nanofibers. In this last system, contrary to conventional bulk composites, the size of the nano-reinforcement (GO sheets) is comparable to the size of the nanofibers to be reinforced (≈ 200 nm). As polymeric matrix we use gelatin. We demonstrate that the high chemical affinity of the two materials hinders the renaturation of gelatin into collagen and causes a nearly ideal mixing in the GO–gelatin composite. Adding just 1% of GO (wt of GO with respect to gelatin) we obtain an increase of Young's modulus >50% and an increase of fracture stress >60%. We use numerical simulations to study the failure mechanism of the fibers. Calculations well agree with experimental data and show that, even if cracks start at GO sheet edges due to stress concentrations, crack propagation is hindered by the nonlinear behaviour of the matrix. Moreover, the presence of the GO sheets in continuous gelatin films improves the material stability to phosphate buffer solutions from 2 days to 2 weeks, making it a better material than gelatin for applications in biological environments.

1. Introduction

Nanofiller/polymer composites find a wide range of applications, thanks to the ability of the nanofiller to improve the mechanical, chemical, thermal and optical properties of the matrix [1,2].

Among nano-fillers, the newest and most studied class of materials is that of so-called 2-dimensional materials, such as

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