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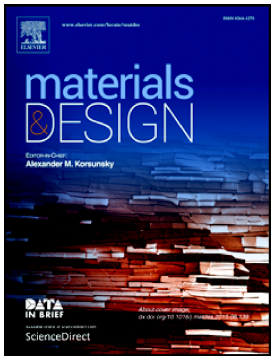

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Finite element simulation of scratch on polypropylene panels

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Abstract:

Scratch simulation of polymeric materials has been a challenging task. It requires a material constitutive model that is capable of representing the complicated material response at large strains, and also a modelling method that can comprehensively resolve several physics, i.e., tribology, material deformation and damage, indenter statics and dynamics. This paper discussed the use of two finite element simulation approaches: (i) Abaqus/Explicit Arbitrary Lagrangian-Eulerian (ALE) adaptive meshing and (ii) the Coupled Eulerian-Lagrangian (CEL), in modelling scratches of talc-filled polypropylene using an elastic-plastic with isotropic hardening material model and a hyperelastic-viscoelastic model. The models were evaluated with scratch experiments and a very good agreement between the simulations and experiments was found. Various technical challenges in modeling scratch of polymeric materials were discussed and solved during the development of both successful methods and their merits and drawbacks were also discussed in detail.

Keywords: scratch, polypropylene, polymer, finite element, experimental verification

1. Introduction

Polypropylene (PP) and PP composites filled with various additives, such as talc, minerals and glasses, have been used as automotive interior components due to their resistance to corrosion, easy to form, light weight, low water absorption, good weatherability and low cost. However, the surface of PP compounds can be easily damaged by mechanical forces, causing scratch and mar during the manufacturing processes and consumer use, which limits their application in such field. It is essential to understand the scratch mechanism of PP compound panel surfaces for improving the material scratch/mar resistance [1].

The scratch/mar of thermoplastic materials is a complicated mechanical process, where surface interaction takes place between the object (indenter) and the materials [2]. Delving into the mechanism of the scratch/mar of the polymers requires a comprehensive treatment of

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