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Influence of particles-matrix interphase on stress distribution in particulate composite with polymer matrix

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Abstract

In this paper fracture behaviour of particulate composite ($CaCO_3$ – PP) is studied. Attention is focused mainly to the influence of interphase between particles and matrix on stress distribution and on micro-crack propagation in composite matrix. The composite was modeled as three-phase continuum and numerically simulated on a microscopic scale using the finite element program ANSYS. Simplified two-dimensional model is used for estimation of hypothetical micro-cracks path prediction. The influence of interphase properties on fracture toughness for particle reinforced polymer composite is discussed.

Keywords: particulate composite, crack propagation, interphase, $CaCO_3$ – PP composite

1. Introduction

Polymeric particulate composites are frequently used in engineering applications. The properties of the particles themselves (size, shape, material properties) can have a significant effect on the global behaviour of the composite. The addition of rigid particles to a polymer matrix usually has an embrittling effect on the composite. Most studies on modification of thermoplastic composites with rigid mineral fillers report a significant decrease in fracture toughness compared with the neat polymer [4]. The presence of particles significantly influences the cure reaction, resulting in the formation of the third phase known as the interphase, which possesses property distinct from those of the matrix and the particles. In the studied case the size of the interphase is between 20 and 50 nanometres. The interphase has a microscopic scale and controls the adhesion between particles and matrix. Thus it essentially contributes to the ability of the matrix to transfer macro-load and plays a deciding role in the evaluation of the driving force of micro-cracks [1].
Rigid particles as toughness must fulfill certain requirements: the particles have to be of small size (less then 5 μm), the aspect ratio should be close to 1 to avoid high stress concentration, the particles must debond prior to the yield strain of matrix in order to change the stress state of the matrix and the particles should be dispersed homogeneously in the matrix [3].

The main goal of the present paper is to estimate the influence of interphase on micro-crack propagation in the particulate composite. In the contribution the particle-filled polymer composite is modelled as three-phase continuum represented by infinite matrix with homogeneously dispersed identical coated stiff spherical particles. The studied composite corresponds to calcium carbonate (CaCO3) filled polypropylene.

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