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Computational homogenization of the debonding of rigid-particle reinforced elastomers: considering interphases

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ABSTRACT

When a particle inclusion is embedded in a polymer matrix, the polymer tends to adsorb on the surface of the inclusion. The effect of this may result in an interphasial zone between the particle and the polymer often referred to as “bound” rubber. The extent and composition of this zone depends on a number of factors, including the surface area and surface treatment of the particle, as well as the level of mixing and age of the composite [1]. Studies on the failure of particle reinforced polymers have indicated that, at large strains, cracks/debonding (occurring at the microscale) can have a significant influence on the macroscopic response of these composites [1–3]. There has been much work done on the debonding process of particle reinforced composite materials under small deformations, but in recent years the interest in finite deformation debonding has increased. In this study we present a fully three-dimensional model, using cohesive zone elements to account for the nonlinear debonding process between the particles and the interphase, to simulate the behavior of these composites under finite deformations. The nonlinear relation used for the cohesive model is the consistent, potential-based PPR model [4]. Our numerical model uses the concept of reduced volume elements with periodic boundary conditions to represent isotropic materials.

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