Veränderung der Netzwerkdichte und -struktur durch Alterung

ein Beschreibungsmodell zur Vorhersage der Langzeiteigenschaften von Gummi

Manfred Achenbach

Rubbers applied in various components (like seals) usually suffer from changes in their mechanical properties caused by changes in their constitutive elements (chain segments) by chemical means over time, commonly known as ageing.

Rubber can age through two mechanisms: (i) the diffusion of fluid molecules and (ii) the chemical reaction of dissolved species with atoms in the constitutive chain molecules. Changes in the amounts of any or all species present can result in changes in how the rubber material responds to mechanical loads.

The overall goal of the presented model is to predict the effects of ageing on component performance. The application of the FE Method to molecular diffusion and chemical reaction is relatively straight forward, as the equations which describe the ageing processes in rubbers are analogous to the equations describing heat conduction in solids. We can take therefore advantage of past experience in solving heat transfer problems by the FE Method and apply that knowledge to the solution of the equation governing the diffusion and chemical reaction processes in rubbers. However, the analogy between heat conduction and mass transport is not complete, as certain differences exist between the governing equations of these two problem classes, as will become apparent in the presented paper.

To simulate aging properly one needs in addition a new feature, which is not described in ordinary hyperelasticity modelling. That feature considers the change in the number of effective chain segments on the reversibility of the free energy of the body. Within this paper we present an appropriate extension of ordinary hyperelasticity to consider for aging rubber bodies.