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Constitutive modeling of a thermal aging behavior due to cyclic mechanical loadings with a multiphysics approach

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Filled rubbers submitted to high-cycle fatigue exhibit a complex evolution of their physical properties. Obviously this evolution is highly depend on the material formulation, on the loading, and on environmental conditions. For large deformations at ambient temperature, damage is the most frequently observed phenomena. For moderate strain or specific thermal conditions, a chemo-physical evolution can be observed before a significant apparition of damage. In this case, physical properties evolve and the material response can become stiffer upon the number of mechanical cycles. We propose to model this kind of phenomenon with a multiphysics approach. We take into account chemical reactions in a continuum media submitted to finite strain and self heating.

Chemical reactions are described with internal variables that represent the chemical conversions of reactants [1]. The application of the fundamental thermodynamics principles and specific choice of thermodynamic potentials allow us to qualitatively describe a chemo-physical evolution in a filled rubber submitted to complex thermo-mechanical loadings. The choice of a consistent chemical thermodynamic potential is discussed. Some representative examples are show as applications.

References

[1] N'Guyen, T.A., Lejeunes, S., Eyheramendy, D., Boukamel, A., Mech. of Mat., 95 (2016).