Phase-field simulation of self-healing AlMg alloy

H. Sepúlveda[1,a], S. Fetni[1], J. Delahaye[2], J. Gheysen[3], S. De Raedemacker[4], J. Villanova[5], L. Duchêne[1], A. Simar[4,b], A. M. Habraken[1,c]

[1] University of Liège, UEE Research Unit, MSM division, allée de la Découverte, 9 B52/3, B 4000 Liège, Belgium
[2]University of Liège, Place du 20-Août, 7, B 4000, Liège, Belgium
[3]Laboratory of Mechanical Metallurgy, École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzertland
[4]Institute of Mechanics, Materials and Civil Engineering (iMMC), Université catholique de Louvain, B-1348 Louvain-la-Neuve, Belgium
[5]ESRF – The European Synchrotron, Grenoble 38043, France

[a] H.sepulveda@doct.uliege.be, [b]Aude.simar@uclouvain.be, [c] Anne.habraken@uliege.be

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Abstract:
The AlMg alloys are widely used in different transportation industries due to their excellent strength-to-weight ratio [1]. In these industries, the components must withstand overloads and a high number of loading cycles [2], which, over time, can generate damage in the materials and in the worst-case failure [3]. To increase the lifetime of these parts, one innovative solution is to use self-healing materials.
There exist different types of self-healing methods, one of them is the diffusion self-healing mechanism. In this mechanism, the alloy microstructure is composed of a healing agent in solid solution [4]. After damage, a healing heat treatment triggers the diffusion of this healing agent towards the voids and heals the material.
An in-situ Diffusion Healing Heat Treatment at 400 °C was applied to heal a damaged AlMg alloy at the European Synchrotron Radiation Facility (ESRF) [5], where nano-holotomographies (nano-CT) of the damaged and healed microstructure evidenced the healing capacity of the alloy by diffusion mechanism with a voxel size of 35 nm. A diffusion phase-field model based on Kim-Kim-Suzuki [6] was applied to predict the microstructure evolution of the material during this healing heat treatment. The results obtained with the phase-field model are compared with the experimental measurements to corroborate their accuracy.

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