Phenomenological Modeling of Porous Shape Memory Alloys

G.Ozerim*, Z. Moumni† and G.Anlas+

*ENSTA ParisTech
Chemin de la Hunière, 91120 Palaiseau, France
*Bogazici University
Bebek Mah., 34342, Besiktas/Istanbul, Turkey
e-mail: ozerim.gulcan@ensta-paristech.fr

† ENSTA ParisTech
Chemin de la Hunière, 91120 Palaiseau, France
Email: ziad.moumni@ensta-paristech.fr

+ Bogazici University
Bebek Mah., 34342, Besiktas/Istanbul, Turkey
e-mail: anlas@boun.edu.tr

ABSTRACT

Shape memory alloys (SMAs) are a group of smart materials having a capability to sustain and recover a significant amount of deformation. Among different alloys, the NiTi is the most widely used SMA. Similar to the dense NiTi, porous NiTi is an attractive material, especially for biomedical applications. In addition to its shape memory characteristics, porous NiTi has some additional benefits, superior to classical metallic foams (e.g., Ti or stainless steel), such as low density, high specific surface area and high permeability which make them a good candidate for implant applications.

In this study, the aim is to develop a macro-scale phenomenological model to describe the thermo-mechanical behavior of porous NiTi SMA. The original ZM (Zaki-Moumni) model for dense SMAs within the framework of generalized standard materials with internal constraints is modified including the porosity as an additional internal variable. The constitutive equation obtained is then used to simulate the pseudoelastic response of porous NiTi SMA. In addition to phase transformation, the evolution of porosity is also observed. 1D version of the analytic model is programmed in Matlab, and the numerical results are compared to the experimental results in the literature to validate the model.

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