Self-heating and fatigue of additively manufactured NiTi

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ABSTRACT

NiTi as a shape memory alloy (SMA) benefits from unique functional properties, such as superelasticity (SE) and shape memory effect (SME) and could be a great candidate for different applications. However, due to the high reactivity, high hardness, and ductility, the conventional fabrication of NiTi is a challenging task, and therefore, the conventionally fabricated NiTi is only available in simple geometries [1]. Using additive manufacturing techniques to produce NiTi is a promising solution to this problem. Although additive manufacturing provides a flexibility in fabrication of complex geometries, this process might affect properties of the material such as mechanical fatigue life.

The traditional methods for fatigue characterization are extremely time consuming and costly. Therefore, the self-heating test, as an alternative fatigue characterization method, is used. This method is based on the assessment of the material temperature variations occurred upon cyclic loading at various stress amplitudes. The results obtained from this method have been validated for a wide range of metallic materials.

This study is focused on the self-heating response and the fatigue properties of SE and SME additively manufactured NiTi alloys. More precisely, this work aims at understanding the fatigue behavior of additively manufactured NiTi via self-heating method. Benefiting from this robust and fast method, effects of additive manufacturing parameters on fatigue properties can be efficiently studied. The obtained results provide us to make a contribution towards determining the relation between the results obtained from self-heating tests and those obtained from classical fatigue ones.

Furthermore, for better comprehension, a two-scale model describing the probabilistic apparition of inelastic inclusions in an elastic matrix is developed based on a SMA behavior model [2,3]. It permits to reproduce self-heating results and then, by choosing an adapted fatigue criterion, is able to predict fatigue properties of the samples.

REFERENCES

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