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STRESS ESTIMATES FOR PARTICLE DAMAGE IN FE-TIB2 METAL MATRIX COMPOSITES FROM EXPERIMENTAL DATA AND SIMULATION

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Abstract - Experimental data regarding microstructural damage evolution in Fe-TiB_2 composites are examined in order to estimating the fracture stress of the TiB_2 particles in relation to their size distribution. At first, an a priori "on/off" particle breaking mode is introduced in a numerical modelling based on nonlinear homogenization methods, considering a three (matrix plus undamaged and damaged particles) phase assemblage. Specific effects on the stress estimates in the particles and on the damage evolution, due to particle shape and elasticity anisotropy, to matrix grain size and hardening, as well as to the loading mode, are examined in comparison with a reference estimate from a fully isotropic description of the undamaged material. The firstly assumed "on/off" brutal particle damage description is shown to overestimate both the damage-induced porosity in the material and the matrix hardening. Both are then adjusted with the available data using a much lower and gradual decrease of the TiB_2 particle stiffness from the undamaged state. From these adjustments, estimates of the size-related particle fracture stresses are obtained. Particle fracturing occurs with limited and gradual stiffness loss of the composite, consistently with a quite good bonding of the TiB_2 particles with the surrounding ferrite matrix.

Keyword – Metal matrix composites, plasticity, TiB_2, damage analysis, damage modelling.

1. Introduction

Metal-matrix composites (MMC) with particle reinforcement are very attractive materials for an increasing number of applications and can be highly challenging for modelling