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Optimization of gaseous nitriding of carbon iron-based alloy based on fatigue resistance modelling

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Abstract

Gaseous nitriding of steels is a well-established thermochemical surface treatments that increases the fatigue resistance of treated parts. The present work proposes a modelling of the fatigue life as a function of the applied stress. It takes into account the hardness and compressive residual stresses that developed during nitriding. The model is suitable to help optimizing nitriding parameters by reverse modelling.

Keywords: steel, multiaxial fatigue, residual stresses, hardness, numerical modelling

1. Introduction

Fatigue resistance and mechanical capacity of engine components are of vital importance for aerospace and automotive industries. Surface engineering is then used to advantages in order to improve superficial properties, such as hardness and compressive residual stress [1, 2, 3]. Among surface treatments, thermochemical surface treatments of steel, such as nitriding, proved their efficiency against the fatigue phenomenon [4, 5].

Gaseous nitriding is based on the diffusion of nitrogen atoms through the treated surface. It involves the precipitation of nanoscale alloying element nitrides MN (M = Cr, V) that provides an increase of hardness and the generation of compressive residual stresses [2]. For a given steel composition, nitriding parameters (time, temperature, nitriding potential) and mechanical properties can