FATIGUE BEHAVIOUR OF NANOSTRUCTURED SURFACES OBTAINED BY SHOT PEENING*

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Abstract

An unconventional method of shot peening aimed to generate a nanograined layer over the surface of specimens has been applied by means of the standard air blast equipment but using peening parameters essentially different from typical ones. Surface nanocrystallization is verified and affirmed through various experimental procedures and different methods have been applied to characterize the nanostructured layer. A detailed numerical model of this severe shot peening is also developed and validated with experimental data. Rotating bending fatigue tests are performed to evaluate the effects of the nanocrystallized layer on fatigue strength for smooth and notched specimens. First series results are available and the other fatigue tests are still in progress.

Keywords surface nanocrystallization; severe shot peening; fatigue; experimental test; numerical simulation.

1. Introduction

Majority of failures such as fatigue fracture, fretting fatigue, wear and corrosion, are very sensitive to the structure and properties of the surface material and in most cases originate from the exterior layers of the work piece. Therefore it would be considerably effective to apply an approach to enhance material properties on the surface of the part.

A variety of processes have been proposed to produce nanocrystal surfaces among which alternative methods of shot peening (SP) have received considerable attention due to relative simplicity and applicability for different classes of materials. SP is a popular mechanical surface treatment generally aimed at creation of compressive residual stresses close to the surface and work hardening of the surface layer. These effects are very useful to totally prevent or greatly delay the part failure (Almen and Black, 1963; Marsh, 1993; Schulze, 2006).

Recent researches have successfully demonstrated that particular SP processes which are different from conventional air blast shot peening (ABSP), not only in the needed technological facilities but also for the mechanics of the treatment, have been aimed at achieving ultrafine grained materials on the surface of treated parts (Bagheri and Guagliano, 2009). However, these processes are not so popular from an applicative point of view, since they require dedicated facilities and do not allow adequate production rates. On the other hand it would be convenient to adapt conventional SP to obtain ultrafine or nanostructured surface, since its flexibility makes it possible to be used for components of almost any shape in commercial scale.