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Comparative study of the effects of surface mechanical attrition treatment and conventional shot peening on low cycle fatigue of a 316L stainless steel

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Abstract:

In this work, the effects of surface mechanical attrition treatment (SMAT) and conventional shot peening (CSP) are comparatively studied on the surface characteristics and low cycle fatigue (LCF) properties of a 316L stainless steel. For this purpose, surface topography, residual stress and work hardening are evaluated on the treated samples. Both CSP and SMAT are performed with the same Almen intensity and the same coverage. Total strain controlled LCF tests are carried out in order to compare the effects of these two techniques on the fatigue properties of the studied steel. The results show that the samples treated by SMAT and CSP exhibit similar trends of cyclic stress amplitude evolution, and higher mechanical strength than the untreated samples. However, the samples treated by CSP manifest higher fatigue life under low strain amplitude (±0.5%), but lower fatigue life under high strain amplitude (±1.25%), compared to the SMATed samples. The fatigue life results are discussed based on the analysis of different characteristics including surface topography, microstructure, residual stress and its relaxation, as well as fracture surfaces.

Keywords: SMAT; Conventional shot peening; 316L steel; Low cycle fatigue; Damage mechanism.

1. Introduction

The in-service resistance of mechanical components is of primary importance due to increased demand for security and economic issues. To improve the performance and consequently the service life of mechanical components, one of the approaches is to alter their surface by means of mechanical surface treatment. Mechanical surface treatment techniques have been widely used to improve fatigue resistance of engineering parts. These techniques including for example shot peening [1–3], deep rolling [4,5], are based on contact loading