Deep rolling effect on fatigue behavior of austenitic stainless steels

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DEEP ROLLING EFFECT ON FATIGUE BEHAVIOR OF AUSTENITIC STAINLESS STEELS

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Abstract

In the present study, the effect of deep rolling on the fatigue behavior of two austenitic stainless steels susceptible to strain hardening (AISI 304 and AISI 316) was investigated. The effect of the force and the deformation velocity, on the surface hardening and the final roughness produced by deep rolling treatment, were analyzed using a device built for this purpose. The microstructure of the materials was characterized by optical microscopy, the fracture surfaces were characterized using scanning electron microscopy, the residual stresses and microstructural changes produced by the deep rolling method were characterized by X-ray diffraction. Results show that the deep rolling produces increases in hardness, volume fraction of martensite and compressive residual stresses that increase the fatigue strength of both steels. Also, it was observed that at high cycle fatigue, the AISI 304 stainless steel presents a better fatigue response after deep rolling treatment than the AISI 316. This behavior is associated with a higher resistance to fatigue crack nucleation and growth rate due to metallurgical effects, such as deformation twins and a greater increase in the volume fraction of martensite.

Keywords: deep rolling, austenitic stainless steel, fatigue strength, AISI 304, AISI 316

1. Introduction

Several mechanical elements used in industrial applications are subjected to cyclic loads, which can cause fatigue damage and reduce its service life [1-3]. In conventional manufacturing processes, heat treatments, thermochemical treatments and some surface coatings are employed to increase the fatigue strength, and prolong the fatigue life of mechanical elements [4-6]. However, there are other alternatives to increasing the fatigue strength of these elements. One of the alternatives includes