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Effects of different shocked paths on fatigue property of 7050-T7451 aluminum alloy during two-sided laser shock processing

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ABSTRACT

The tensile samples manufactured by 7050 aluminum (Al) alloy were treated by different shocked paths during two-sided laser shock processing (LSP), and the samples were divided into two groups according to these different paths. The first group was treated by two paths, while the second group was treated by four paths. The fatigue tests were performed on a servo-hydraulic material testing machine system by using the stepped loading method named Locati. The fracture morphology was observed by scanning electron microscopy (SEM). Experimental results showed that the fatigue lives of the second group increased compared to those of the first group. The effects of different shocked paths on fracture morphology during two-sided LSP were discussed. Furthermore, the enhancement mechanism of different shocked paths on fatigue crack initiation and growth two-sided LSP was also addressed during.

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1. Introduction

With the development of high power laser, the laser surface modification of engineering materials attracts a wide attention, which causes rapid growth of laser application fields [1]. Among them, the laser shock processing (LSP) is a new surface modification technology with the development of the laser which generates high power density and short pulsed laser beam since the late 1970s [2]. The high magnitude stress wave generated by the interaction between the high-power, short pulsed lasers and the metal materials can improve the mechanical properties of the metal materials effectively, especially the anti-fatigue fracture properties of the metal materials [3–5].

7050-T7451 aluminum (Al) alloy is a super-high strength alloy, and its yield strength approaches tensile strength. In addition, its weight is light, so it is widely used in aerospace and automotive industries [6–8]. But the failure usually occurs in practical use, and the main failure modes are fatigue, corrosion and wear [9–11], which happens on the material surface. Thus its surface structure and property will influence the integrative performances directly, which limits its wide applications [12]. Many researches have been devoted to the modification of the Al alloy, such as shot peening [13], cold rolling [14], and LSP [15]. LSP, as one of the effective technologies to improve the surface mechanical properties of Al alloy, has been intensively studied by many researchers [16]. For example, Luong and Hill [17] investigated the effects of LSP and shot peening on the high cycle fatigue (HCF) performance of 7050-T7451 Al alloy. The results showed that LSP induced a layer of compressive residual stress more than three times deeper than that of the shot peening. Zhang and Yu [2] found the fatigue life of the laser shocked 2024-T62 Al alloy samples was two times greater than that of the un-shocked samples. Rubio-González et al. [3] observed that the fatigue crack growth with LSP was reduced compared to that without LSP. However, most of the above researches have mainly focused on the comparison of fatigue life between the LSP and other technologies, or differences between the samples treated with LSP and without LSP, few researches have been paid attention to the effects of different shocked paths on the fatigue properties during two-sided LSP.

With the above background in mind, the objective of this paper was to compare the fatigue lives of 7050-T7451 Al alloy with different shocked paths by using the stepped loading method during two-sided LSP. Specifically, the scanning electron microscopy (SEM) analyses on the microstructures in different regions with different shocked paths during two-sided LSP were carried out. Furthermore, the enhancement mechanism of the fatigue crack initiation and growth was also investigated and discussed.





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