Fatigue modification of TA15 titanium alloy weldments by an ultrasonic impact treatment

Gao, Yukui; Zhong, Zheng; Zhang, Xiaodan; Wang, Yuhui

Published in:
Proceedings of the Risø International Symposium on Materials Science

Publication date:
2014

Citation (APA):
FATIGUE MODIFICATION OF TA15 TITANIUM ALLOY WELDMENTS BY AN ULTRASONIC IMPACT TREATMENT

Yukui Gao*, Zheng Zhong*, Xiaodan Zhang** and Yuhui Wang***

*School of Aerospace Engineering and Applied Mechanics, Tongji University, No. 100 of Zhangwu Road. Shanghai 200092, China

**Department of Wind Energy, Risø campus, Technical University of Denmark, DK-4000 Roskilde, Denmark

***National Engineering Research Center for Equipment and Technology of Cold Strip Rolling, Yanshan University, Qinhuangdao 066004, China

ABSTRACT

The welded components of TA15 titanium alloy were ultrasonically impact treated. The fatigue lives were investigated under the same test conditions. The fatigue strength was determined by stair-step method and the residual stresses were analyzed by an X-ray diffraction stress tester. The results show that the fatigue properties of TA15 titanium alloy welded components are sensitive to the surface treatment and ultrasonic impacting can prolong the fatigue lives. The effect of fatigue strength improvement mainly depends on compressive residual stresses and grain refinement.

1. INTRODUCTION

Welding is a main jointing method of different metallic components and the fatigue property is a critical issue of the application of welded components. Many surface enhancement processes such as shot peening (Ali, An, Rodopoulos, Brown, O’hara, Levers and Gardiner, 2007), laser peening (Hatamleh 2009), and water jet peening (Tonshoff, Kroos and Marzenell, 1997), were employed to increase the fatigue properties of welded components, and recently ultrasonic impacted peening has been developed and used by aircraft manufacturers (Liu, Wang, Deng, Xia, Huo, Wang and Gong, 2014). Compared with the conventional shot peening which is widely employed in industry, ultrasonic impacting uses the head of a ball to impact the critical local positions of welded components, as shown in Fig. 1. The objective of this work is to investigate the residual stress field induced by the ultrasonic impacting with the focus on its effect on the fatigue performance of welded components.
Fatigue modification of TA15 titanium alloy weldments

4. CONCLUSIONS

The welded components of TA15 titanium alloy were ultrasonically impact treated with the characterization of microstructure, the measurement of surface residual stress, fatigue properties and the observation of the fracture surface. The following conclusions can be drawn.

(1) Welding induces tensile residual stresses, while ultrasonic impacting can introduce compressive residual stresses in the surface layer.

(2) An ultrasonic impact treatment increases the fatigue life with an enhancement factor of 1.73 under 500MPa.

(3) An ultrasonic impact treatment increases the fatigue strength from 321MPa to 361MPa by 12.4%.

(4) Fatigue cracks initiate at the surfaces for the welded specimens, while for ultrasonic impact treated samples, most of the cracks initiate at the defects beneath the surface.

ACKNOWLEDGEMENTS

Y.G. and Z.Z. acknowledge the support from the National Natural Science Foundation of China (11372226), the Open Project Program of National Engineering Research Center for Equipment and Technology of Cold Strip Rolling (NECSR-201306) and the National Basic Research Program of China (2010CB833105). X.Z. gratefully acknowledge the support from the Danish National Research Foundation (Grant No. DNRF86-5) and the National Natural Science Foundation of China (Grant No. 51261130091) to the Danish – Chinese Center for Nanometals.

REFERENCES


