Materials Science Forum Vols. 561-565 (2007) pp 2485-2488
online at http://www.scientific.net

Online available since 2007/Oct/02

Investigation on Fatigue Crack Growth Behaviour in S45C Steel by Water Cavitation Peening with Aeration

B. Han[1, a], D. Y. Ju[2, b] and T. Nemoto[3, c]

[1]Graduate School of Saitama Institute of Technology, Fusaiji 1690, Fukaya, 369-0293, Saitama, Japan

[2]Department of Material Science and Engineering, Saitama Institute of Technology, Fusaiji 1690, Fukaya, 369-0293, Saitama, Japan

[3]Department of Gerontechnology, National Centre for Geriatrics and Gerontology, Japan

[a]q6002fea@sit.ac.jp, [b]dyju@sit.ac.jp, [c]nemo@nils.go.jp

Keywords: Water cavitation peening, Residual stress, Crack growth rate

Abstract. Water cavitation peening (WCP) with aeration is a recent promising method in the surface enhancement technique, which can induce compressive residual stress in the near surface of mechanical components by the bubble collapse on the surface of components in the similar way as conventional shot peening. In this paper, the effect of WCP on fatigue crack growth behavior was investigated in single-edge-notched flat tensile specimens of S45C steel. The notched specimens were treated by WCP, and the compressive residual stress distributions in the near surface layer were measured by X-ray diffraction method. The tension-tension ($R = S_{min}/S_{max} = 0.1$, $f = 10$ Hz) fatigue tests were conducted. A Shimadzu servo-hydraulic fatigue test machine with in-situ observation by JSM-5410LV scanning microscope was used for all testing. Compared with those without WCP treatment, WCP can induce the residual compressive stress in the near surface layer, and delay the fatigue crack initiation, and decrease the rate of fatigue crack growth.

Introduction

Improvement of fatigue performance of mechanical components has been achieved by shot peening, however, the shot peening process have several limitations, such as increased roughness, higher cost and difficulty in process setup. Water cavitation peening [1] (WCP) or cavitation shotless peening (CSP) [2] is a potential surface enhancement technique, which has a high-speed submerged water jet pressurized by a plunger pump. When the high pressure water is jetted through a jet nozzle to the metallic component, the uniform big bubble cloud can be generated, and the bubble collapse on the surface of the component will produce impact effect just as shot peening. In particular, WCP have some advantages, such as the optimal treatment capability to the complicated and narrow surface [3, 4], the shotless effect on the material surface [5], no thermal effect on the material surface, the isotropic process capability [6], clean, inexpensive and nontoxic. Several recent investigations have revealed that cavitation technology can be utilized for enhancing the fatigue strength of mechanical components by introducing residual stress in the surface of metallic components in a similar way as conventional shot peening [7, 8, 9]. However, the degree of fatigue improvement by the process is