

Effects of loading conditions on the fatigue failure characteristics in a polycarbonate

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Abstract. In this study, fatigue properties and crack growth characteristics of a polycarbonate (PC) were examined during cyclic loading at various mean stress (σ_{amp}) and stress amplitude (σ_{mean}) conditions. Different S vs. N and da/dN vs. ΔK relations were obtained depending on the loading condition. The higher fatigue strength and the higher resistance of crack growth are seen for the PC samples cyclically loaded at the higher mean stress and lower stress amplitude due to the low crack driving force. Non-linear $S - N$ relationship was detected in the examination of the fatigue properties with changing the mean stress. This is attributed to the different crack growth rate (longer fatigue life): the sample loaded at the high mean stress with lower stress amplitude. Even if the higher stress amplitude, the low fatigue properties are obtained for the sample loaded at the higher mean stress. This was due to the accumulated strain energy to the sample, where severe plastic deformation occurs instead of crack growth (plasticity-induced crack closure). Shear bands and discontinuous crack growth band (DGB) are observed clearly on the fracture surfaces of the sample cyclically loaded at the high stress amplitude, where the lower the σ_{mean} , the narrower the shear band and DGB. On the other hand, final fracture occurred instantly immediately after the short crack growth occurs in the PC sample loaded at the high mean with the low σ_{amp} , i.e., tear fracture, in which the shear bands and DGB are not seen clearly.

Keywords: polycarbonate; loading condition; fatigue strength; crack growth rate; failure characteristic

1. Introduction

Many engineering components made of polycarbonate (PC) have been employed dramatically in automotive and aerospace industries due to excellent transparency, high mechanical properties, high heatproof property and excellent flameproof property. Because failure in the components of the related polymer occurs, investigation of the mechanical properties would be important. The deformation characteristics in polycarbonate were studied by Krongauz *et al.* (2009), where the kinetics for the de-coloration reaction of photochromic spiropyran dissolved in the polymer are considered. Moreover, many researchers have examined the fatigue and crack growth characteristics until now. Fundamental experimental approaches have been carried out by Radon *et al.* (1976). In their conclusions, a linear relationship between crack length and cyclic number was

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