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ABSTRACT. *In this paper we analyze growth of small cracks initiated from microscopic notches and loaded near the growth threshold under different stress ratios. The results of in-situ optical measurements during high cycle fatigue testing show that small cracks initiate and grow quickly after which there is a long period of slow growth until the large crack growth threshold is reached. The crack growth rate data from different loading ratios indicates that the positive portion of the stress amplitude or the maximum stress intensity factor can be used to compare crack growth rates. The test data also shows that increasing only the compressive stress portion of the loading will cause an arrested small crack to grow again.*

INTRODUCTION

The designer of machines or mechanical components that experience numerous loading cycles needs to understand the material response to the loads and possible defects or cracks that can grow or initiate fatigue cracks. This has given rise to many studies about small fatigue cracks and unique phenomena that occur in their initiation and growth. The effect of the compressive portion of the fatigue cycle on the behavior of small cracks is important for many industrial components that, for example, use various surface hardening treatments to improve their fatigue strength or endurance. Many of these fatigue improving treatments cause high compressive stresses on the component surface. This can prevent fatigue, but if not used properly, cause failure for example in axels and gears where incorrect surface hardening can warp the component or cause cracks to initiate and grow.

The general focus of most small crack growth research has been in the range of tension - tension loading ($R > 0$) or symmetric loading at $R = -1$. Several researchers have studied also the initiation and arrest of small cracks from notches under fully compressive loading [1-5]. An interesting question is the amount of crack closure in small cracks because the original studies done on crack closure by Elber were performed on large cracks in soft metals [6-7]. More recently Silva studied the effect of compressive loading on crack growth. One of the main focuses of his research was the inability to explain some of the effects of compression on the crack growth in fatigue by crack closure [8]. The research showed that there is a significant effect of compressive loading on the crack growth and this varies from material to material. It was concluded