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Abstract

Depending on the process parameters and mechanical properties of the joint materials, explosive welding can cause localized changes in the structure of the joint and induce defects such as microcracks, melted pools or hard intermetallic phases in the close vicinity of the interface. Therefore, the aim of the thesis was to investigate the influence of the bonding zone of layerwise heterostructured metal composites manufactured in the process of explosive welding on the fatigue life.

Extensive fatigue testing under cyclic tension or tension and compression was conducted as an experimental basis for the analysis. Moreover, optical microscopy for interval testing and *in situ* monitoring via visual system were employed for the identification of crack initiation sites. Digital image correlation implementation allowed to reveal heterogeneous strain distribution in particular layers of the composites. Based on full-field strain evolution analysis multidirectional strain measurements were made and damage mechanisms were identified. As a result, it was possible to depict hysteresis loops as a true stress – strain relationship. Metallographic testing provided data to characterize geometry of the interfacial wave. Strain hardening was determined by microhardness distribution at the vicinity of the interface.

Interfacial wave height and strain amplitude were chosen as a main factors influencing fatigue life of steel-based composites with refractory outer layer. Gaussian process was applied to depict relation between the given parameters. The analysis of partial dependency has shown a linear relationship between wave height and fatigue life. It was estimated that the increase of 100 μm results in reduction of fatigue life by 36%. Results of fatigue life were also compared with the design curve being a requirement for fatigue performance stated by American Society of Mechanical Engineers (ASME). It was concluded that the use of high strength steel as base material does not necessarily improve fatigue performance of the composite.

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