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Experimental investigation of explosive welding of Ni_3Al - based alloy

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Abstract – In this paper joining of fine-crystalline plates of Ni_3Al (Zr, B) based alloy with aluminum alloy, steel and another Ni_3Al (fig.1a-b) alloy by explosive welding was investigated. The examinations of the joints in various configurations included e.g. amount of plates and materials conditions were conducted. No symptoms of joined materials cracking were observed, and for some of joints very good formability was confirmed by cold rolling. Additionally, the multilayered material consisting eight Ni_3Al plates was obtained (fig.1c).

The implementation of advanced technologies is often limited by the lack of suitable structural materials that can fulfil the working conditions. Due to their special properties, intermetallic alloys (e.g., Ni_3Al) may have potential applications in this area. Intermetallic Ni_3Al–based alloys are a group of advanced materials with outstanding physical and chemical properties (such as high catalytic activity and structural stability in corrosive environments), which make them possible candidates for many high-tech applications [1,2].

Earlier studies of Ni_3Al–based alloys welding mainly focused on the method using tungsten inert gas, electron beams and laser welding were conducted. It was reported that the Ni_3Al–based alloys after above welding processes crack predominantly in the heat-affected zone and that the solidification cracks are in the fusion zone [2-3].

The main objective of present work is to investigate the possibility of joining by explosive welding, without cracks. Nearly single-phase Ni_3Al based intermetallic alloy plates with zirconium boron additions were examined. The investigated material (with thickness approx. 0,9-0,4mm) was obtained by cold-rolling up to 60% cold work and further one-hour annealing at temperature range 400-1200^{O}C [3]. High pressures (up to several tens of GPa) and high velocities (up to several kilometres per second) of the explosive-welded components were obtained in a parallelepiped configuration of loading, with ammonal as the blasting material. The cross-sections of explosive welded joints shows an irregular line of the joint, with small undulations and hooks of different amplitudes and periodicities. No symptoms of cracking in joined materials were observed. Good quality of joints was confirmed by e.g.: water quenching (for Ni_3Al – steel type of joint) and severe cold rolling up to 60% of cold work (for Ni_3Al-Ni_3Al type of joint). After treatments conducted any cracks of the joints were observed.

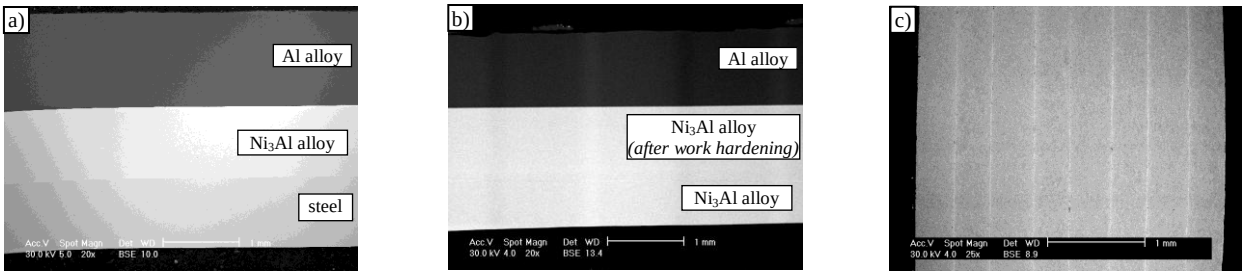

Figure 1: SEM images of examples of composition obtained by explosive welding: a) Al alloy-Ni_3Al based alloy-steel, b) Al alloy- Ni_3Al based alloy after work hardening- Ni_3Al based alloy, c) multilayer from eight Ni_3Al based alloy plates.

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