Features of laser welding of sandwich composite metal-polymer materials

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•Abstract

Laser welding of metal-polymer sandwich composite material samples made of 0.48 mm thick DPK 30/50+ZE dual-phase steel and 0.3 mm thick polypropylene-polyethylene foil as core material was carried out. A ROFIN StarWeld Manual Performance Nd:YAG laser with a wavelength of 1.06 µm was used for the two-sided butt welding of composite sandwich panels. The structure of the central polypropylene-polyethylene layer remained practically unchanged under the selected laser welding parameters. By redistributing power density and beam energy using diffractive freeform optical elements it is possible to improve the quality of the welded joint. In this case the occurrence and effect of possible residual deformations and stresses must be investigated..

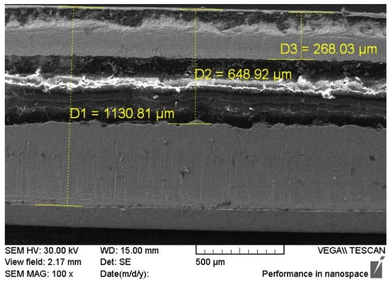


Figure 1. Initial state of the sample edges, x100.

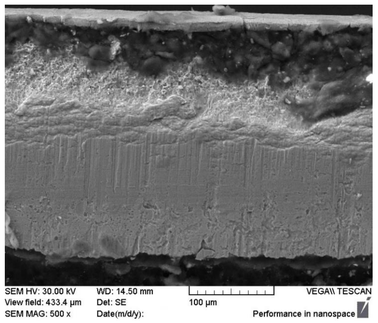


Figure 2. Upper edge of the sample after cutting with scissors, x500.

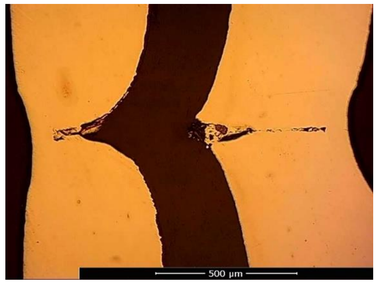
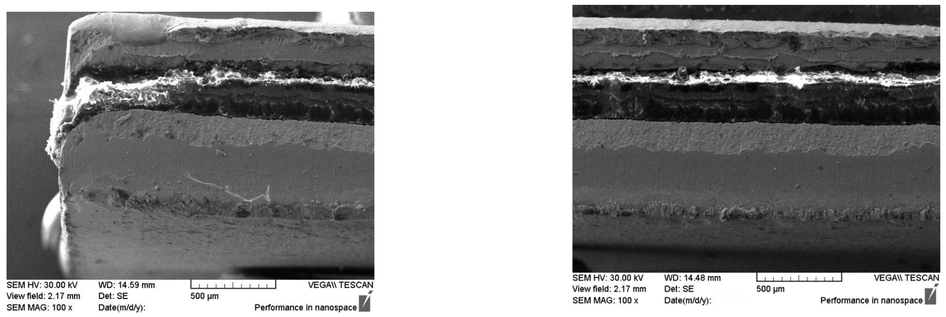


Figure 3. Cross-section of the area of two-sided welding of edges in the initial state.



a b

Figure 4. Fracture condition of the upper edge of the sample at the beginning (a) and in the central part (b) of the weld.

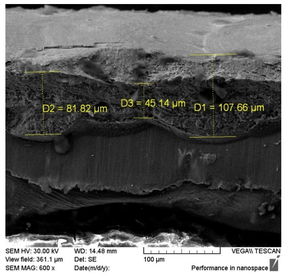
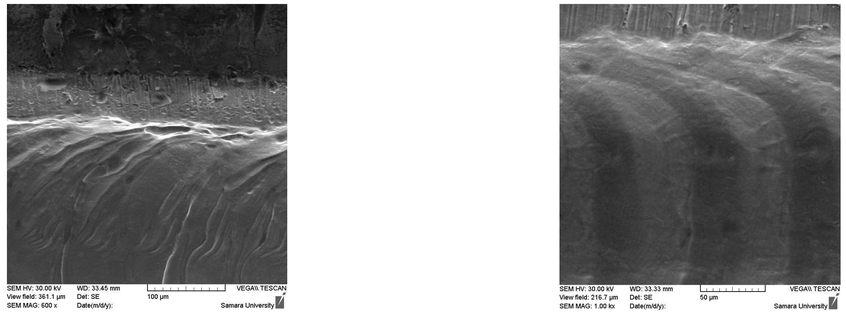


Figure 5. Fragment of the central part of the joint.



a b

Figure 6. Top view of the welded joints obtained after welding the composite three-layer specimens alternately on both sides: x600 (a); x1000 (b).

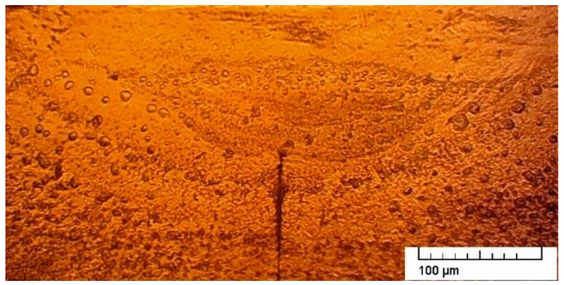


Figure 7. Macrosection of the welded joint in the upper layer of the composite specimen, which represents the microsection of the weld area.

•Conclusion

The two-sided butt laser welding of three-layered metal-polymer sandwich composite samples made of DPK 30/50+ZE dual-phase steel and a polypropylene-polyethylene film was carried out. A ROFIN StarWeld Manual Performance Nd:YAG laser with a wavelength of 1.06 µm was used to weld the composite sandwich panels. It was determined that the two-sided metal-polymer-metal butt welding of composite sandwich panels without significant degradation of the central polymer layer is feasible under the following parameters: pulse energy 5 J, pulse duration 3.5 ms and pulse repetition rate 4.8 Hz.

The use of pulsed laser welding with a predefined spatial distribution of power density and energy makes it possible to obtain a welded joint with a cross-sectional area several times larger than that produced using a concentrated heat source. The small cross-sectional area of the weld is retained, which is a characteristic feature of laser welded joints, defining their main advantage - the possibility of obtaining welds, which are limited in width with minimal deformation of products.

By redistributing the power and energy density of the beam, it is possible to improve the quality of the welded joint. By shaping the laser energy, diffractive freeform optical elements offer the possibility to achieve a predefined power density and energy profile in the focal plane. In this case, the occurrence and effect of possible residual deformations and stresses must be investigated.