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INVESTIGATION OF JOINING ZINC-COATED STEEL SHEETS BY LASER WELDING FOR AUTOMOTIVE INDUSTRY

With the constantly growing volume of automobile production, the manufaturers are trying to reduce their consumption due to ever-increasing fuel prices. One way to save fuel is to reduce car mass. Weight can be reduced by application of hight-strenght steel grades (AHSS), respectivly combination of composites and sandwich materials. Currently the number of used progressive hight- strenght steels (AHSS) is rising becouse they allow to reduce the weight of the vehicle and also fuel consumption, guaranteeing high passive crew safety especially at the points of deformation zones where they can absorb large amount of the impact power and also ensure stiffness of the bodywork. The group of AHSS materials includes dual phase steels (DP), transformed induced plasticity (TRIP), multi-phase steels (CP) and martenzitic steel (M). Charasteristic values are the slope values Re > 300 Mpa and hight tensile strenght Rm > 600Mpa. Highly percetible are especially TRIP steels witch are usually alloyed with C, Al, Mn, S, Si, P, B, Cr + Mo, Nb + Ti. Increased Al content causes an increase in C in residual austenite. Like Si, Al is also insoluble in cementite, wich couse it slowing formation and at the same time increasing the rate of the bainitic transformation. In addition to these progressive types of steels that are able to reduce the weight of cars but they are still dominant for the production deep steel [1-4].

Selected types of steels were used to evaluate the bodywork and their components in the automotive industry. Samples made from HSLA steel double sided galvanized steel sheet were 0.79 mm thick and marked as A. Samples marked as B were made from double-hot galvanized steel plate DP 600 with thickness of 0.8 mm. Test samples made with galvanized steel sheet of TRIP thickness 0.78 mm were marked as C. Chemical composition evaluated by spectral analysis on the device Belec compact port of steel is in Table 1.

Table 1. Chemical composition of analysed samples (wt. %) (P < 0.002, S < 0.002)

	C	Mn	Si	Cr	V	Mo	Al	Cu	Nb	Ti	W	Fe
A	0.005	0.408	0.127	0.031	0.006	0.007	0.033	0.015	0.035	0.033	0.037	rest
B	0.110	1.964	0.277	0.204	0.011	-	0.031	0.018	0.020	-	0.005	rest
C	0.086	1.488	0.184	0.040	0.012	0.022	2.245	0.020	0.022	0.007	-	rest

Laser welding was realised in First Welding Institute Bratislava on CO_2 laser (AF8P) with max. power 8 kW and wave lenght 10,6μm. Quality of welded joint made by laser was judged with help of : - visual inspection of the welds according to EN ISO 17637, - weld joint test in the transverse direction according to STN EN ISO 4136, - micro-hardness evaluation of welded joints on Vickers cross-sectional metallographic cuts according to EN ISO 9015-2 at load 981,0 Nm^{-1}. Macroscopic and microscopic analysis using the light microscope Olympus SZ 61 and Olympus GX 71 was performed on metallographic cuts according to EN ISO 17639.

Welding quality analysis by visual inspection has not demonstrated the presence of external surface defects such as pores, craks, flowing root, but the difference was recorded as thickness between the base material and the joint site that is documented on macrostuctures. Based on results of the destructive tests for the individual evaluation methods it is possible to counclude that the maximum values of load capacity were C samples where the following average values Re = 448 MPa and Rm = 764 MPa were measured with the values declared by manufacturer. The measured microhardness values correspond to the chemical composition of the investigated materials and the observed structures. The maximum value of microhardness was shown to be C. The average value of the microhardness of the base material was 242 HV0.1, the mean value of 369 HV0.1 was measured in HAZ and the maximum value of 498 HV0.1 was measured in welding metal. The macroscopic analysis of the metallographic cuttings confirmed the results of the visual inspection of the weld joints. The surface of the welded metal made by the laser had a distinctive drawing in a well-readable direction of welding. Structural analysis was performed using light microscopy on transverse cuts. The macrostructure of the welding joint of the sample C of the TRIP steel sheet is shown in Figure 1. The laser welding has a characteristic drawing with a legible dihedral angle of the crystalline crystals. Weld metal is slightly overlaid. Macroscopic analysis did not show the presence of internal defects (cavities, pores). These occur fairly often in the center of welding lenses at resistance spot welding for this type of material. The area of welding as well as HAZ is narrow. The basic material has a fine-grained structure with an average grain size of G9 EN ISO 643. The TRIP steel microstructure (Figures 2) is multiphase composed of polyhedral ferrite, martensite, bainite and residual austenite. Laser welding is a suitable way of welding body panels of various material combinations such as DP and TRIP, BH (Bake Hardening) and DP, IF (Interstitial Free) and TRIP, and the like.

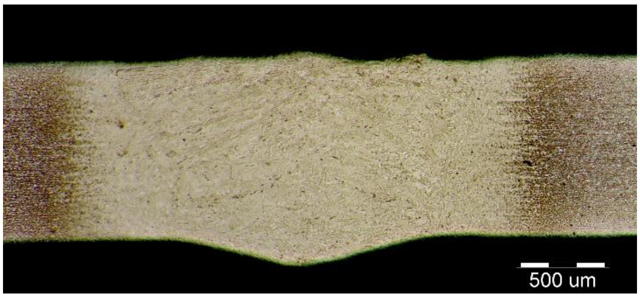

Fig. 1 Macrostructure of sample C

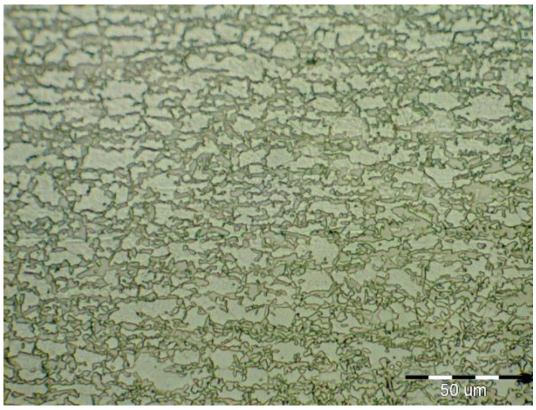

Fig. 2 Fine-grained multi-phase microstructure of base material sample C

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Reference

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