

Welded Layers Microstructure Modification on the Basis of Powder Wire Cr10B4 with addition of Al, Mg

Andriy Voitovych, Roman Mykhalskyi,
Roman Vlach

Department of Welding, Hardware Diagnosis
and Restoration, Lviv Polytechnic National University,
UKRAINE, Lviv, S. Bandery street 12,
E-mail: andrsibox@gmail.com

Abstract – The welded layers formed of powder wires PW Cr10B4, PW Cr10B4Al2, PW Cr10B4AlMg were investigated in the course of work. It was defined that Al, Mg applications influence the microstructure grinding and rounding carboboride inclusions. Abrasive wear resistance of the weld materials under the condition of outwearing by a fixed abrasive, unfixed abrasive, as well as shock load, was detected. It was determined that wear resistance of the welded layers with PW Cr10B4AlMg at shock load was 3.5 time higher than that of other weld materials. Degradation mechanism of the welded layers PW Cr10B4AlMg is malleable.

Key words – welded layers, microstructure modification, powder wire, wear-resistance, surface.

I. Introduction

The details that work on the condition of abrasive particle presence undergo outwearing [1]. Powder materials of the system Fe–Cr–B–C are widely used for outworn surface recovery [2]. The phase composition of the microstructure of the system Fe–Cr–B–C consists of: Fe/Cr carbides with hardness to 900 HV, as well as carboborides with hardness to 1300 HV and an eutectic matrix with hardness to 700 HV [3]. The welded layers of Fe–Cr–B–C material continue working several times longer on the condition of abrasive outwearing. A disadvantage of the wear-resistant material is dendritic axes that condition fracturing at shock load. The microstructure loses its capacity to resist outwearing and destroys fast because of microfissure creation [5]. The attempts of graphite rounding in high-strength cast irons are known. Mg₂Si modifier that influences graphite flakes well was used in the course of work [6]. But this modifier is hardly accessible and expensive, that is why the aim of this work is to study the influence of aluminium-magnesium powder PAM – (Al 60%, Mg 40%) and aluminium powder PA (Al 99.99) on the microstructure of the welded layers of powder wire PW Cr10B4.

II. Experiment method

Welding was conducted in the flux OCS 45M, with the automatic head ABS, powder wires PW Cr10B4, PW Cr10B4Al2, PW Cr10B4AlMg (Table 1), PW diameter is 1.6 mm, clad material is steel 1008, filling rate is 18%.

TABLE 1

PW BURDEN COMPOSITION

PW	Chemical elements, %				
	Cr	B	Mg	Al	Fe
Cr10B4	10	4	-	-	The rest
Cr10B4Al2	10	4	-	2	The rest
Cr10B4AlMg	10	4	1	1	The rest

For welded layers formation DC welding generator ПСО 500 was used. Welding current is 160–180 A, voltage is 28–30 V. Welding wire delivery rate is V_{wire} 142 m/h, welding rate is V_{weld} 13 m/h. The microstructure of the welded layers was examined on a transverse microsection using the electronic microscope EVO 40 XVP. Hardness measurement was made with a microhardness tester IIIMT-3, charge weight 200g.

Welded layers wear-resistance was investigated under different outwearing conditions. Abrasive outwearing with an unfixed abrasive was estimated according to GOST 23.208-79. Dry quartz sand with particle size 200...1000 μm was constantly delivered to the area of contact of the wiper and sample. Wiper turning speed was 25 (m/s), and strength of its pressing to the sample was 2.4 (kN). For estimation of outwearing with a fixed abrasive an abrasive wheel CM-2 on a ceramic bond was used. Line friction velocity was 0,4 (m/s), load in the area of line load was 1.5 (kN).

Shock outwearing was estimated according to striking force 12 KJ with a ball $\varnothing 25$ mm made of steel IIIX 15 that was falling onto the surface with frequency 40 s⁻¹. Experiment duration was 3600 s. Sample weight loss was determined electronically with accuracy to 2×10^{-4} .

III. Result discussing

The microstructure of the welded layers PW Cr10B4 (Fig. 1 a) consists of dendritic axes, sizes reach from 10 to 15 μm in width and from 100 to 700 μm in length. Heat-resistant element content there constitutes Cr to 13 mass%. We can assume that these are carboborides FeCrB. Welded layers matrix contains ferrum Fe to 93 mass% and low-alloyed Cr is on the level to 3 mass%.

It was detected that additional alloyage with the powder PA, PAM PW burden influenced the microstructure. The microstructure of the welded layers of PW Cr10B4AlMg (Fig. 1 б) is altered in comparison with the microstructure of the welded layers mentioned above. A prolonged nature of the dendritic axes is changed into a roundish one, refinement takes place, the sizes of the inclusions decrease and become from 10 to 5 μm in length and width.

It is conditioned by decrease of welding puddle temperature, with respect to exothermic reaction. But it leads to dissolution of Cr in average spectrum 3.1-5.3 mass% in two of the welded layers. A disadvantage of microstructure of the welded layers formed of PW Cr10B4Al2 is a high porosity.

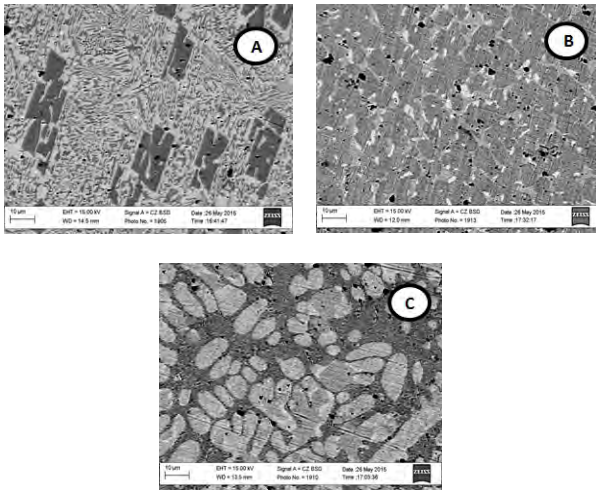


Fig. 1. Microstructure of welded layers:
a- welded layers of PW Cr10B4, b- welded layers of PW Cr10B4Al2, c-welded layers of PW Cr10B4AlMg

It was detected that the welded layers of PW Cr10B4AlMg had finely divided phases with a complex chemical composition Fe(Cr Mn)Si; they are marked with black inclusions.

Small hardness of the welded layers of PW Cr10B4 is on the level of 650 HV. In the other welded layers of PW Cr10B4Al2 small hardness increases to 780 HV. But it decreases to 700 HV in the welded layers PW Cr10B4AlMg.

Wear-resistance of the welded layers (Table 2) under the condition of outwearing with a fixed abrasive is the smallest in the welded layers of PW Cr10B4Al2, loss weight constitutes 0.31g. It was defined that wear-resistance of the welded layers of PW Cr10B4AlMg is 1.5 times higher than that of PW Cr10B4.

TABLE 2

WEAR-RESISTANCE OF THE WELDED LAYERS

Material	PWCr10B4	PWCr10B4Al2	PWCr10B4AlMg
With a fixed abrasive	0.05	0.31	0.032
With an unfixed abrasive	0.02	0.01	0.02
Shock outwearing	0.0094	0.0048	0.0025

But under the condition of outwearing with an unfixed abrasive wear-resistance of the welded layers of PW Cr10B4Al2 is the highest, weight loss is 0.01g. The other welded layers PW Cr10B4, PW Cr10B4AlMg have equal weight loss 0.02g. At shock load weight loss is the lowest in the welded layers of PW Cr10B4AlMg – 0,0025g, this wear-resistance is 3.5 times higher in comparison with the welded layers PW Cr10B4.

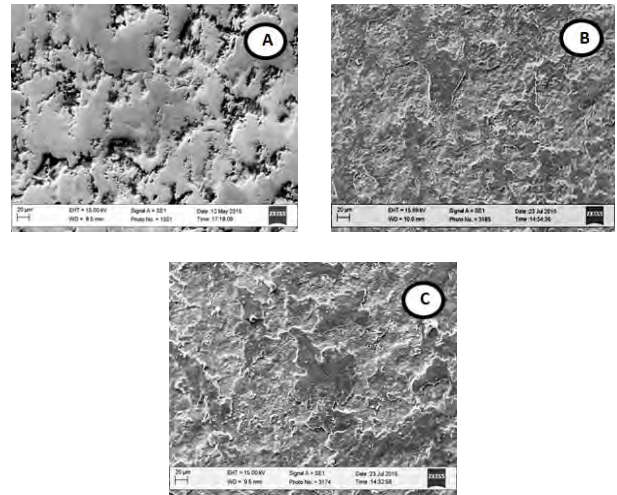


Fig. 2. Surface morphology after shock outwearing:
a-welded layers of PWCr10B4, b-welded layers of PWCr10B4Al2, c-welded layers of PWCr10B4AlMg

The welded layers of PW Cr10B4 destroy in a brittle way, since hard carboboride inclusions fringe out and crumb. It is also confirmed with the highest weight loss 0.0094g. The other welded layers of the wires PW Cr10B4Al2, PW Cr10B4AlMg, destroy in a malleable way.

Conclusion

1. The microstructure of the welded layers of powder wires PW Cr10B4, PW Cr10B4Al2, PW Cr10B4AlMg in the flux OCI 45 was investigated. It was detected that additional alloyage with powder PA, PAM PW burden influences the microstructure grinding and rounding dendritic axes.

2. Wear-resistance of the welded layers of PW Cr10B4AlMg is 1.5 times higher on the conditions of outwearing with an unfixed abrasive and 3.5 times higher at shock load outwearing.

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