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Investigation of physical-mechanical and welding-technological properties of electrodes for wear-resistant surfacing

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ABSTRACT: This article describes the investigation of physical-mechanical and welding-technological properties of electrodes for wear-resistant surfacing

KEY WORDS: manual arc surfacing, electrode, physical-mechanical properties, welding-technological properties, microstructure, wear resistance

I. INTRODUCTION

At the present stage, manual arc surfacing has a wide field of application, effective in terms of technical and economic indicators: the possibility of applying a metal layer of a sufficiently large thickness, maneuverability and simplicity, transportability and prevalence by power sources, applicability in combination with other methods of surface treatment, the possibility of using for many metals and alloys, the possibility of obtaining the most diverse composition of the deposited metal, the cost-effectiveness of surfacing of parts with uneven wear.

Every year, the demand of Uzbekistan for surfacing electrodes, widely used in the repair production of metallurgy, mechanical engineering, and the oil and gas industry, is increasing. The main manufacturers of welding electrodes in Uzbekistan JV LLC Tashkent Pipe Plant, JSC Uzmetkombinat, PO Navoi Mechanical Plant SE NMMC do not produce electrodes for wear-resistant surfacing.

II. LITERATURE SURVEY

Leading scientists of the world, in particular the Italian researchers R. Rissone, G. Gausen, carried out numerous studies to study the formation of a drop of metal and slag during manual arc surfacing with covered electrodes. [1].

Researcher from Sweden O. Kelberg studied the formation of the weld surface, the separability of the slag crust, the possibility of surfacing in different spatial positions, etc. [2]

Scientists from Russia and Ukraine G.L. Petrov, G.K. Tatur, K.V. Lyubavsky, B.E. Paton, V.V. Podgaetsky, I.K. Pokhodnya studied droplet formation upon melting of the rod and electrode coating and the interaction of the formed phases with each other and with the gas. [3]

Uzbek scientists M.A. Abralov, R.U. Abdurakhmanov, N.S. Dunyashin, R.M. Saidov, Z.D. Ermatov, V.L. Halperin investigated the processes of interaction of phases occurring at various stages of heating and melting of the electrode, which determine their final composition in manual arc welding of low-carbon and low-alloy steels. [4]

Despite the achieved scientific results in the field of creating and developing the composition of the coating of surfacing electrodes, there are many unsolved problems: Models and methods for predicting the composition of the deposited metal of the weld during manual arc surfacing have not been sufficiently studied. To solve the above problems, it is necessary to carry out studies that made it possible to evaluate the results of surfacing processes occurring in the solid phase, drop

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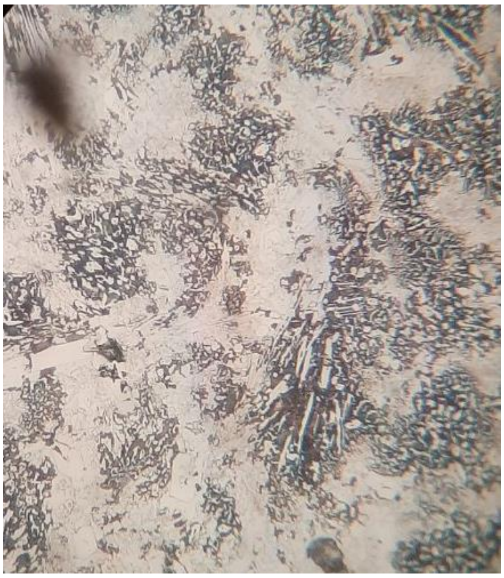
and metal bath, to determine the average and partial transition coefficients of elements and to identify their relationship with the characteristics of surfacing electrodes. [5-6].

III. METODOLOGY

The properties of the following electrodes were investigated:
No. 1 - T590 (Russian Federation),
No. 2 - wt. %: graphite battle - 8-10, marble (Sovuk bulak) - 10-12; quartz sand (Kulantayskoe) - 3-5; pegmatite (Ketmenchinsky) - 5-7, fluorite - 3-5, silicon carbide - 8-10; ferrosilicomanganese (Uzmetkombinat) - 8-10, ferrochrome - 26-30; ferrotitanium - 8-10, starch (rice) -1-3;
No. 3 - wt. %: graphite battle - 8-10, marble (Tomchiata) - 8-10; quartz sand (Yakkabag) - 5-6; pegmatite (Ketmenchinsky) - 4-6, fluorite - 2-4, silicon carbide - 8-10; ferrosilicomanganese - 8-10 (Uzmetkombinat), ferrochrome - 28-30; ferrotitanium - 9-11, starch (rice) -2-4;
No. 4 - wt. %: graphite battle - 8-10%, marble (Gazgan) - 6-8; quartz sand (Kermeninskoe) - 5-6; pegmatite (Ketmenchinsky) - 4-6; ferrosilicomanganese (Uzmetkombinat JSC) - 8-10, silicon carbide - 8-10; ferrosilicomanganese (Uzmetkombinat) - 8-10, ferrochrome - 26-28; ferrotitanium - 8-10, starch (rice) -1-3;
For the manufacture of welded samples, 09G2S steel was used. Before surfacing, the electrodes were calcined at a temperature of 250-280 ° C.
The microstructure of the deposited metal at a magnification of x200 is shown in Fig. 1.



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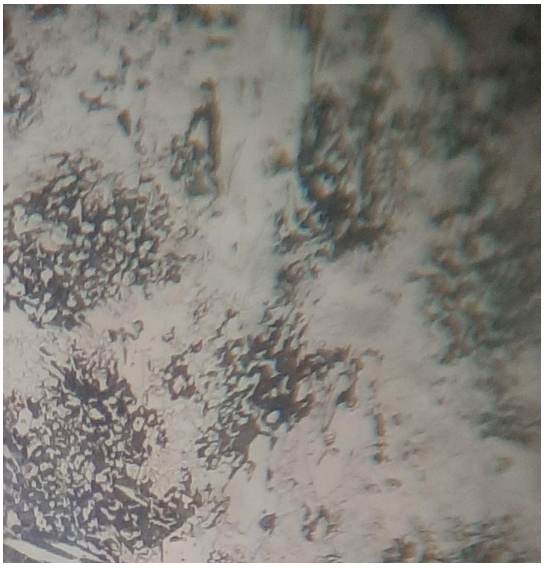

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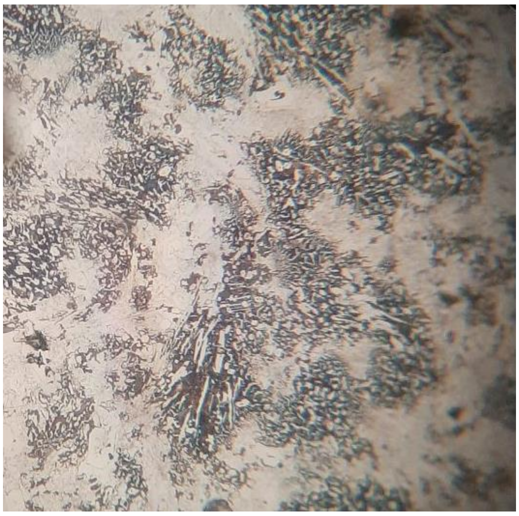

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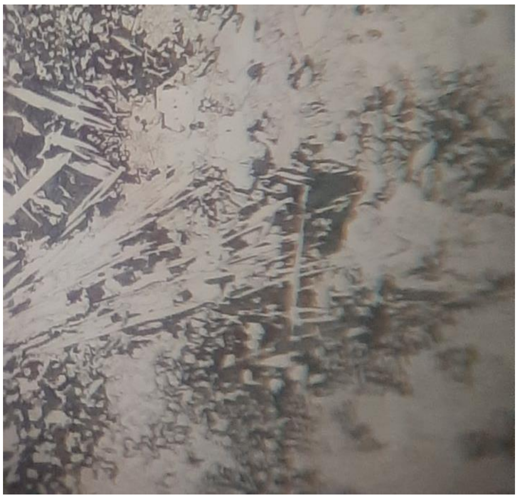

No.4

Fig. 1. The microstructure of the deposited at a magnification of x500, made using electrodes No. 1-5

Microstructure of the deposited metal using an electrode (Fig. 2-3) No. 2 - hypereutectic cast iron with various carbides: a-primary (coarse) cementite; b - chromium carbides; c - joint iron carbides with chromium; d - ledeburite

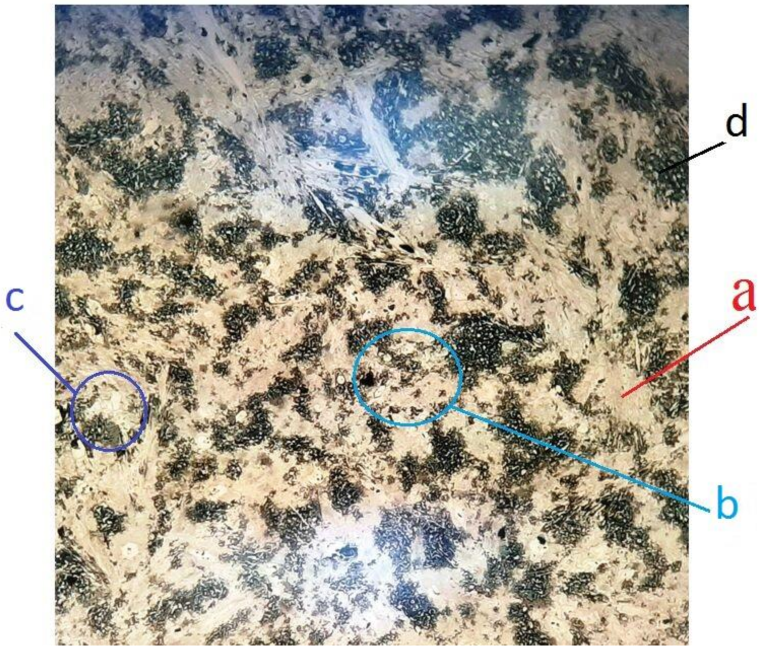

Fig. 2. Microstructure of the deposited metal - hypereutectic cast iron with various carbides, x200:
a - primary (coarse) cementite; b - chromium carbides; c - joint iron carbides with chromium; d - ledeburite

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Fig. 3. Microstructure of deposited metal, x600:
a - primary (coarse) cementite; b - chromium carbides

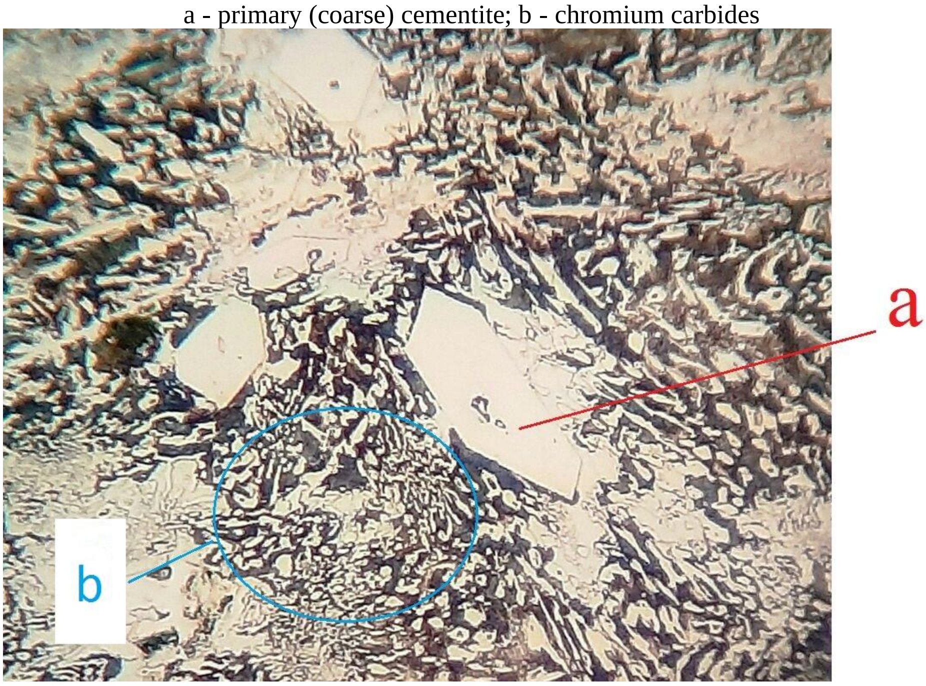

Fig. 4. Microstructure of deposited metal, x1000:
a - chromium carbides; b - ledeburite

The hardness of the deposited surface using electrode # 2 is 57-61 HRC. It was found that the microhardness of cementite is 6-8 GPa, chromium carbide 10-13 GPa, combined iron carbide with chromium - 8-10 GPa, ledeburite 5-6 GPa (Fig. 5-6).

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Fig. 5. Measurement of microhardness of primary cementite

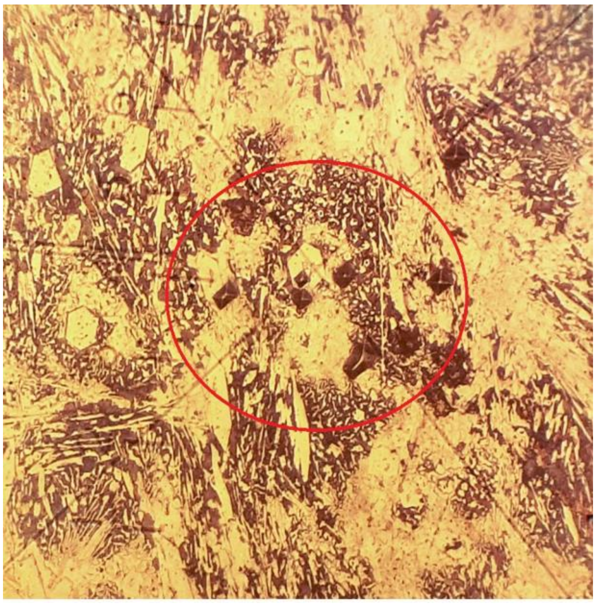

Fig : 6. Measurement of chromium carbide microhardness

It was found that the stability of arc burning during welding with the T590 electrode and the developed electrodes No. 2-4 is high - calmly, evenly burning arc without vibration. The slag crust is separated after welding with electrodes No. 2-4 without additional mechanical impact

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Table 1. Comparative analysis of welding and technological properties of electrodes

Electrodes	No. 1	No. 2	No. 3	No. 4
Position	bottom	bottom	bottom	bottom
Arc striking	good (8)	good (10)	good (9)	good (10)
Arc stability	good (10)	good (10)	good (8)	good (9)
Arc re-ignition	good (9)	good (10)	good (10)	good (8)
Slag crust shape	smooth glossy crust, pores on internal surface	surface smooth, fine scaly	surface smooth, fine scaly	smooth surface, fine scaly
Slag crust color	dark gray with blue tint	dark gray with blue tint	dark gray with blue tint	dark gray with blue tint
Slag crust separability	good (8)	good (9)	good (8)	good (10)
Splashing	the average (7)	insignificant (9)	Insignificant (9)	insignificant (9)

The developed composition of the slag base of modern import-substituting surfacing electrodes increases the wear resistance of the deposited metal under conditions of abrasion by abrasive materials by 13-15%. (Table 2)

Table 2. Results of testing for wear resistance of the deposited metal, performed with electrodes No. 1-No. 4

Electrode No.	Износ, мг				Average amount of wear, mg	Hardness, HRC
	No. 1	No. 2	No. 3	No. 4		
No.1	9,07	9,16	9,12	9,19	9,14	57-61
No.2	7,69	7,85	7,72	7,93	7,78	61-63
No.3	7,89	7,96	7,94	8,02	7,95	61-63
No.4	8,53	8,86	8,94	8,56	8,70	59-62

The results of the studies performed were the necessary basis for the development and implementation of the technology for the preparation of electrode coatings from local raw materials for wear-resistant surfacing JV LLC "Tashkent Pipe Plant named after V.L. Halperin "

IV.CONCLUSION

Developed electrodes for wear-resistant surfacing containing the following components, wt.%: Graphite battle - 8-10, marble (Sovuk bulak) - 10-12; quartz sand (Kulantayskoe) - 3-5; pegmatite (Ketmenchinsky) - 5-7, fluorite - 3-5, silicon carbide - 8-10; ferrosilicomanganese (Uzmetkombinat) - 8-10, ferrochrome - 26-30; ferrotitanium - 8-10, starch (rice) -1-3, provide: - surfacing in the lower and inclined positions by direct current of reverse polarity. Deposition ratio 9.3 g / A • h; - electrode consumption per 1 kg of weld metal - 1.3 -1.5 kg; - surfacing of parts operating under conditions of predominantly abrasive wear with moderate impact loads. - typical hardness of weld metal is 57-61 HRC.

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