STRUCTURALLY-PHASE COMPOSITION OF THE WELD METAL AT MMA STEEL 12CRNITI18-10

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Abstract. The paper presents the results of studies improve efficiency of manual arc welding of austenitic steels. It is in arc welding of austenite steels the use of inverter power supply furthers obtaining more fine-grained structure of added metal and thermal impact zone, shortens thermal impact zone; that improves corrosion resistance of joint weld.

Keywords: MMA, an inverter power source, microstructure, microhardness.

Introduction

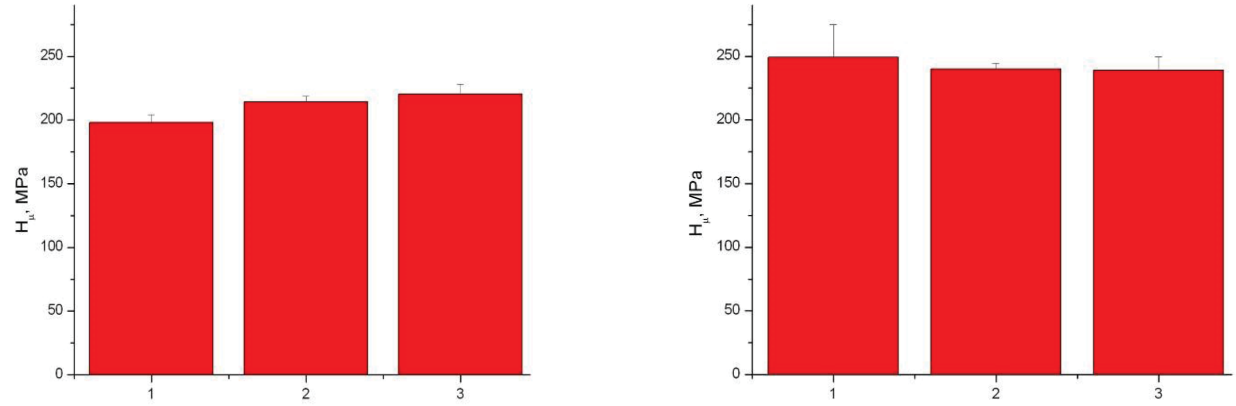
One of the main functional qualities of chromium-nickel austenite steels is their high chemical stability both in salt aqueous solutions, and alkali and acidic mediums in the wide range of temperatures. Having both sufficient strength and extraordinarily high plasticity these steels are a unique constructional material, applied in different branches of industry and national economy. The majority of products made of austenite steels are manufactured with the use of arc welding. Regarding the standards of strength, plasticity, lack of cracks and pores chromium-nickel austenite steels are welded with no restrictions. However, special maintenance conditions of constructions specify additional requirements for corrosion resistance of joint welds, and that is a nontrivial issue [1, 2]. Corrosive attack is known to arise in added metal from electrochemical heterogeneity caused by non-homogeneity of structure and chemical composition [3], or in thermal impact zone also as a result of structural non-homogeneity and non-equilibrium of stress state [4]. An attempt to improve corrosion resistance of welds is made mainly by affecting the state of added metal. It is welded with basic-coated electrodes and those containing more austenite-making elements of nickel and manganese [4]. Formation of delta ferrites is prevented; the latter are principally subject to corrosive attack [5]. With the same purpose added metal is modified by rare-earth metals, for example, yttrium [6-8]. Finally, nano-powders are injected into a weld pool in order to grind the structure of added metal and make its state more equilibrium [9, 10, 11]. All these methods neither exert significant influence on the state of thermal impact zone nor change its corrosion resistance. Alternation, introduced in heat input into the joint weld, is practically the only method to change the state of thermal impact zone. Nowadays, application of inverter power supply capable to reduce heat input into a joint weld is seemed to be a promising technology [11], thermal impact zone gets shorter and corrosive attacks along this zone are not so probable. This paper is aimed at comparative research into joint welds made by manual arc welding provided that diode and inverter power supplies are used.

Materials, research procedures and results

3 mm thick sheets of hot-rolled stainless 12X18H9T steel were used as research material. The sheets were welded in a butt joint (joint C7 according to GOST 5264-80) by manual arc welding with 08Х20Н9Г2Б – type ЦЛ 11 electrodes, (d = 3 mm). Two different power supplies were used for welding: diode rectifier WD-306 and inverter Nebula-315, welding current of both supplies was I = 70…80 A.

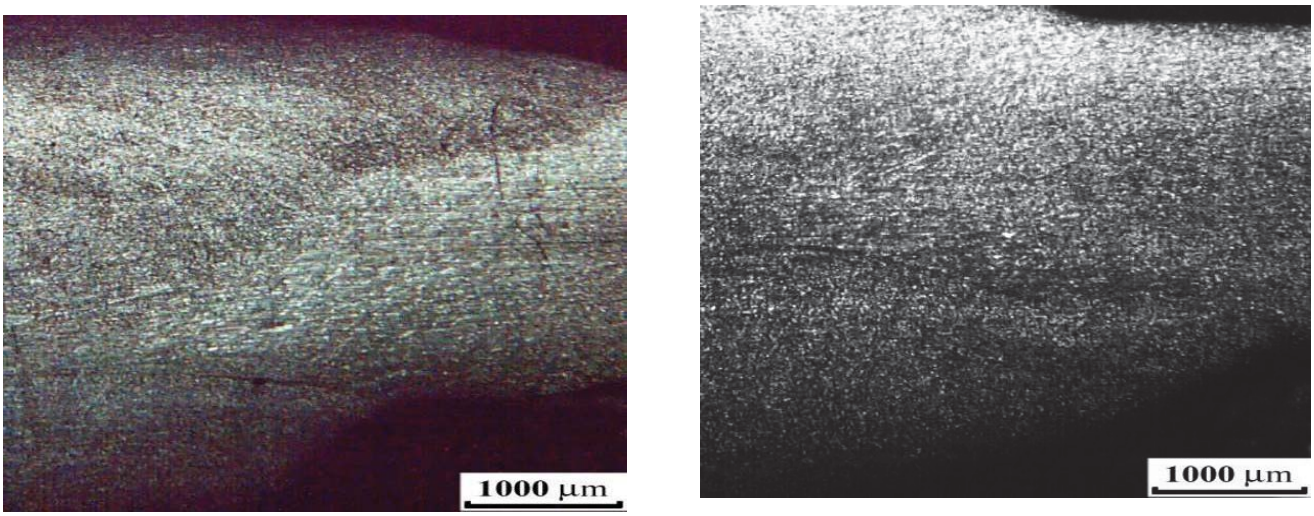
The method of optical metallography was applied to sections made of welded samples to carry out macro- and micro structural research. Microscope Neophot-21 and digital camera Genius VileaCam were used. The sections were made by mechanical finishing, diamond paste АСМ 10/7 НВЛ mechanical polishing and chemical etching in nitrohydrochloric acid (40% HCl + 40% HNO_3 + 10%C_2H_5OH). Microhardness in added metal, in thermal impact zone and in base metal was measured on the same sections. Microhardness testing instrument DURAMIN 5 was used; it can determine the microhardness according to Vickers method while the load is 50 g and holding period lasts 10 s.

It has been found out that microhardness is minimal in added metal of joint weld made with power supply diode rectifier. Microhardness increases gradually while passing thermal impact zone towards base metal. Although microhardness doesn't differ much in the mentioned zones, it is of statistical importance. Microhardness zonation is different in joint weld made with inverter supply Inverter. Here hardness is maximal in added metal. However, the difference in microhardness of all zones is statistically unimportant, that is, a full-strength weld is made. We emphasize that microhardness of base metal in both joint welds isn't also statistically relevant, as expected. On the contrary, thermal impact zone and added metal of joint weld made with inverter supply have much higher microhardness than those of joint weld made with diode rectifier. Noted regularities correlate with structural state of joint welds under investigation.



a) b)

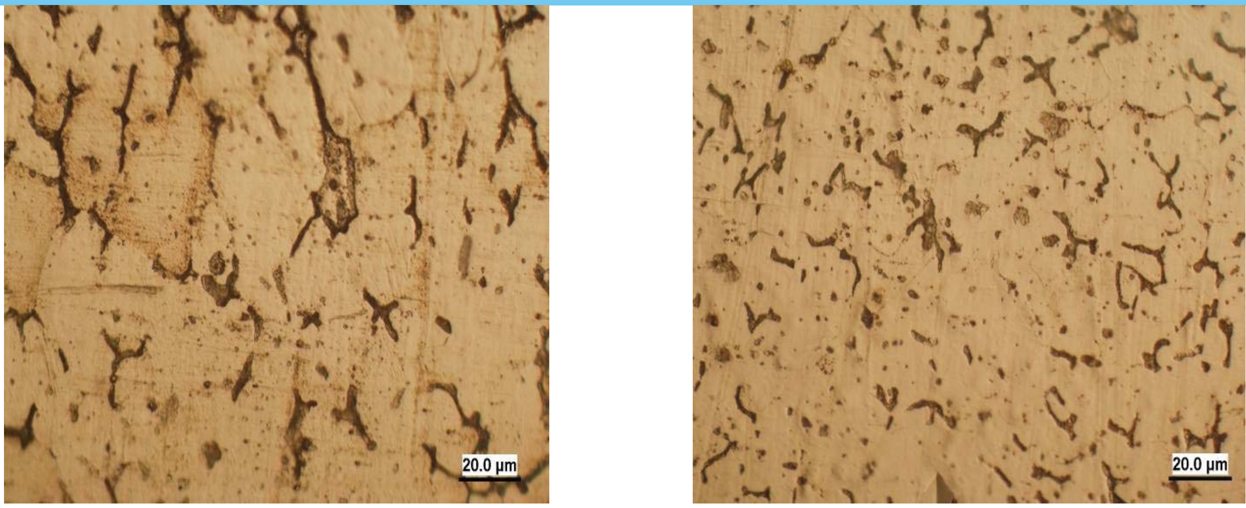
Fig. 1 Microhardness of joint welds:
a) – diode rectifier, b) – inverter, 1 – added metal,
2 – thermal impact zone, 3 – base metal



a) b)

Fig. 2 The general view of joint welds: a) – diode rectifier, b) – Inverter

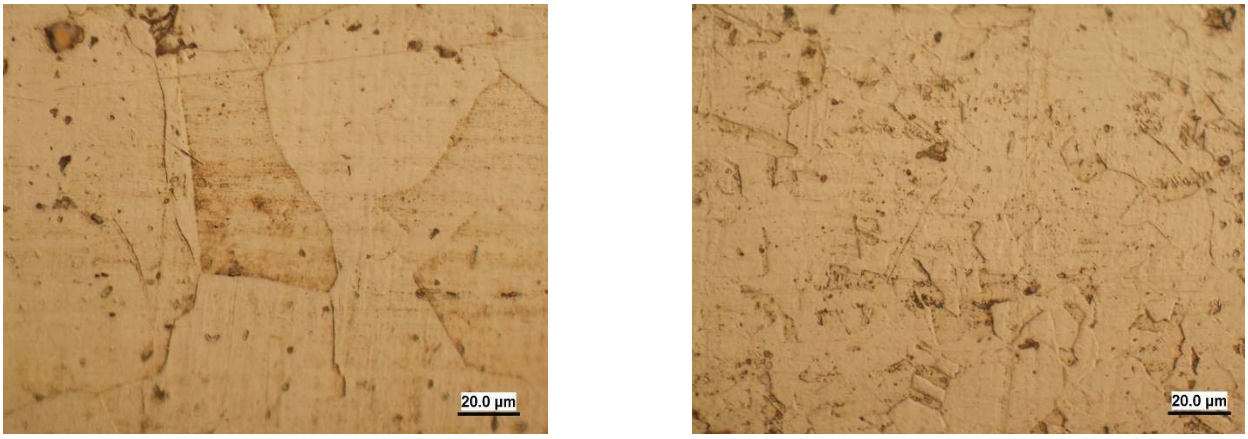
Fig.2 shows that macroviews (zooming ´ 40) of joint welds, made with different power supplies, don’t differ much. There are no welding defects, added metal has a considerably highly dispersed dendrite structure, and thermal impact zone smoothly moves to base metal.



a) b)

Fig. 3 Microstructure of added metal: a) – diode rectifier,
b) – Inverter

However, the microstructure of joint welds in these zones is essentially different (fig.3, fig.4). Added metal has inhomogeneous structure if diode rectifier is used. Dendrites have various lengths; they are well-developed. They are ≈ 2 micron wide. Metal has grain structure in inter-dendrite zones, which is typical for chromium-nickel austenite with average dimension ≈ 20 micron. Added metal has more homogenous structure if inverter supply is used. Dendrites are not so long in average, their width is smaller (≈ 2 micron). Inter-dendrite zone is bigger. Grain structure is more distinct, an average grain is half as small and totals ≈ 12 micron.



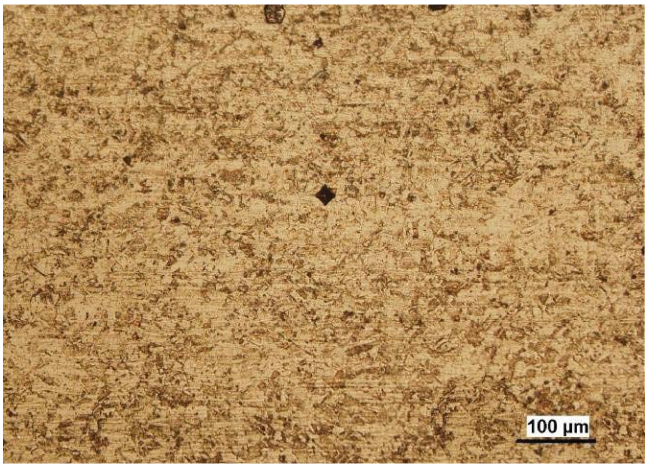
a) b)

Fig. 4 Microstructure of thermal impact zone: a) – diode rectifier,
b) – Inverter

Thermal impact zone has a polyhedral grain structure in both cases, which is typical for chromium-nickel austenite (fig.4). Average grain is much bigger than in added metal, especially in the samples made with diode rectifier, where it is 54 micron. Some grains contain twins. Average grain is smaller ≈ 30 micron in thermal impact zone of joint weld made with inverter supply, whereas the possibility of grains to have twins is higher.

As expected, the structure of base metal is similar in both samples (fig.5). The difference in average dimension 20 micron and 17 micron is within the limits of statistical uncertainty.

a)



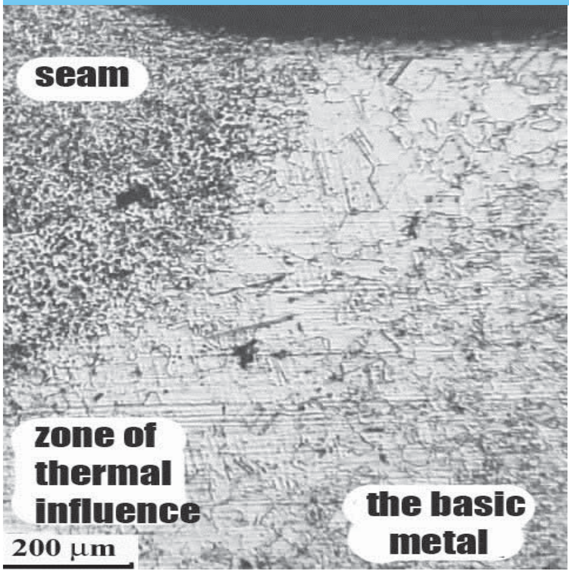
b)

Fig. 5 Microstructure of base metal: a) – diode rectifier,
b) – Inverter

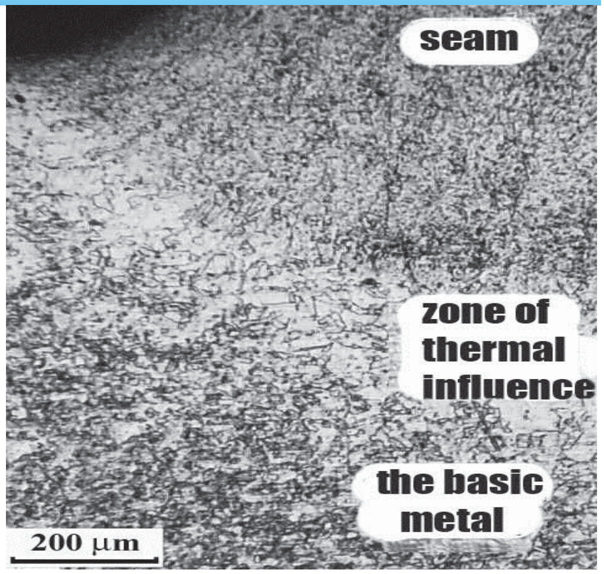
As mentioned above, thermal impact zone smoothly moves to base metal in both joint welds under consideration. The least possible width of thermal impact zone 75 micron is registered in joint made with inverter supply (fig.6b), and the biggest one 3000 micron – in joint made with diode rectifier (fig.6a).

Conclusion

In arc welding of austenite steels the use of inverter power supply furthers obtaining more fine-grained structure of added metal and thermal impact zone, shortens thermal impact zone; that improves corrosion resistance of joint weld.



a)



b)

Fig. 6 Minimal width of thermal impact zone in joint: a – diode rectifier; b – inverter power supply

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