UDC 621.74.002.6:669.131.7

Improving the Service Properties of Cast Iron Rolls by Modifying the Melts with Rare-Earth Metals

L.K. Ivanova, E.V. Kolotilo, Ya.S. Maimur, D.V. Mukha

National Metallurgical Academy of Ukraine

Processing roll melts by complex modifiers based on rare-earth metals as a result of changes in the microstructure and mechanical properties of cast iron enhanced the service properties of mill rolls.

Keywords: CASTING, MILL ROLL, CAST IRON, MODIFICATION, PROPERTY

Introduction

Increase of production and improvement of casting manufacture of high-strength cast iron is one of the most important areas of a comprehensive program of scientific and technological progress of foundry in Ukraine for the long-term perspective. Substantial reserves of improving the quality of castings lie in the possibility of the active and intentional formation of their structure and properties by processing the melts in the liquid state with efficiently selected additives. Review of national and foreign scientific and technical and patent literature has shown that there are still no universal modifier and method of modification, satisfying the conditions of production of cast rolls; that issues of structurization and crystallization of modified roll cast iron remain controversial and need further studies for the concretization the compositions of modifiers and modifying technology for specific industrial applications.

More than sixty years researches on the influence of individual rare-earth metals and complex modifiers on their basis on the structure and properties of the sheet rolls have been conducted in NMetAU [1-3]. At the same time features and regularities of structurization of the working layer and the core of chilled sheet rolls in cast iron under the influence of complex modifiers in the technical literature are not properly highlighted.

Results and Discussion

In order to produce rolls with high service properties, additional studies of the structurization peculiarities of modified with complex modifiers based on rare-earth metals roll cast iron are required.

The influence of cerium, yttrium, lanthanum, samarium, gadolinium, dysprosium and complex modifiers on their basis on the structure of white rollcast iron is studied. Metallographic analysis was performed on an optical microscope Neophot-21 at magnifications of 100-500. The sections were studied before and after nital etching.

The results of comparative studies on the structure of cast iron rolls, modified with Mg and complex modifiers based on rare-earth metals showed that the in case of a close chemical composition in the structure of the working layer of the test rolls graphite was absent, while in cast iron rolls modified with magnesium, its number was 0.5-2.5% at depths of 10 and 20 mm from the working surface. Furthermore, the structure of the metallic matrix of complex modified cast iron was characterized by greater dispersivity of the components.

Modifying effect of increasing amounts of modifiers in white cast irons is manifested in the suppression of the crystallization of honeycomb ledeburite, increasing of microhardness of the matrix and cementite, in the transformation of a part of austenite into martensite. The residual of modifiers optimal for the modification of cast iron rolls are determined. The efficiency of the use of gadolinium and dysprosium as components of complex modifiers for modifying cast iron rolls is shown and the composition of a complex modifier is optimized.

Modification of iron melts with a complex

modifier made it possible to reduce 2.5-6 times, depending on the cooling rate, the amount of nonmetallic inclusions in the working layer of rolls while decreasing their average size.

Comparative tests of mechanical properties of cast iron rolls modified with a complex modifier and modified with magnesium showed that the strength properties of the material at a depth of 10-160 mm of the body of rolls modified with a complex modifier were 15-20% higher than in the test cast iron rolls modified with magnesium.

The effect of cooling rate in the range 0.04-2.5°/sec from 950°C on the structurization of complex modified white roll cast iron was also studied. Over the entire investigated range of cooling rates cast iron austenite underwent the eutectoid transformation developed with the formation of pearlite with different dispersivity. The studies of the influence of cooling rate on properties of cast irons (hardness, elastic modulus and wear resistance) showed improvement of the properties in 5-23% with increasing cooling rate in the critical temperature range. Heat treatment modes of rolls from complex modified cast irons were developed.

An experimental batch of rolls was cast in industrial conditions using a complex modifier. During the rolls operation improvement of durability by 20-35% compared to the mass production rolls cast with spherical graphite was achieved.

Conclusions

1. A technology for processing roll melts with complex modifiers based on rare-earth metals was developed.

2. As a result of changes in microstructure and mechanical properties of cast iron melt treatment enhanced the service properties of the rolls.

References

1. Belai G.E. Issledovanie vliyaniya modifitsirovaniya na kristallizatsiyu chuguna, strukturu i svoistva listoprokatnykh valkov: avtoref. dis. kand. tekhn. nauk: spets. 05.16.04 “Lityeinoe proizvodstvo”, G.E. Belai, Dnepropetrovsk, 1967, 23 p.*

2. Kolotilo E.V. Issledovanie i usovershenstvovanie protsessov proizvodstva listoprokatnykh valkov iz modifitsirovannykh chugunov: avtoref. dis. kand. tekhn. nauk: spets. 05.16.04 “Lityeinoe proizvodstvo”, Ye.V. Kolotilo, K., 1977, 21 p.*

3. Ivanova L.Kh. Teoretichni osnovy ta praktychni metody oderzhannya lytykh prokatnykh valkiv iz kompleksnomodyfikovanykh chavuniv: avtoref. dis doktora tekhn. nauk: spets. 05.16.04 “Lyvarne vyrobnytstvo”, L.Kh. Ivanova, Dnipropetrovsk, 2008, 35 p.**

* Published in Russian
**Published in Ukrainian

Received October 6, 2011

Повышение служебных свойств чугунных валков модифицированием расплавов редкоземельными металлами

Иванова Л.Х., Колотило Е.В., Маймур Я.С., Муха Д.В.

Обработка валковых расплавов комплексными модификаторами на основе редкоземельных металлов в результате изменения микроструктуры и механических свойств чугунов способствовала повышению служебных свойств прокатных валков.