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(54) A method for producing composite zones in castings

Verfahren zur Herstellung von Verbundzonen in Gussteilen

Procédé de production de zones composites dans des pièces coulées

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The file contains technical information submitted after the application was filed and not included in this specification

EP 2 650 064 B1

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Description

[0001] The present invention relates to a process of manufacturing composite zones in iron alloy-based castings, designed for structural components resistant to abrasive wear.

[0002] Iron alloys with increased hardness represent the largest group of materials used in the manufacture of structural components resistant to abrasive wear. Among these materials, the most commonly used are cast steels: mainly martensitic, and austenitic with manganese and chromium, and to a lesser extent cast irons: white martensitic cast iron, as well as chromium cast irons. Among the materials resistant to abrasive wear, a separate group form composite materials reinforced with hard ceramic phases such as nitrides, carbides, borides or oxides. One of the methods to obtain hard ceramic phases is the SHS method (*self-propagating high-temperature synthesis*) disclosed, inter alia, in the publication by A.G. Merzhanov, Journal of Materials Processing Technology, Vol. 56, year of edition 1996, pages 222-241, which enables a synthesis of these phases from reactants of the atomic ratio corresponding to the stoichiometry of a given compound. An example of the use of this method for the fabrication of cast in situ composites is the technology of SHSB (*self-propagating high-temperature synthesis in bath*), in which the initiation of the reaction occurs at the instant of placing the packets with reactants in a crucible of the furnace holding liquid alloy. At that instant, the ceramic particles are formed as a result of violent exothermic reaction initiated by heat collected from the liquid metal. Next, as a result of the effect of eddy currents raised by the induction furnace, a vigorous stirring of the said ceramic particles occurs. As a result of this process, the ceramic particles are dispersed in the entire volume of the liquid alloy. This method has been disclosed, inter alia, in the Polish patent specification No. 190 605A1.

[0003] Polish patent specification No. 167197B1 discloses a method for manufacturing by the casting route a layered material, wherein the said method is characterised in that, that on the bottom of the mould cavity, or on a "scaffold" in the mould cavity, a ceramic component in the form of granular electrocorundum layer is introduced, said ceramic component being next poured with cast aluminium alloy.

[0004] In the publication by E. Frasz, E. Olejnik et al, Archives of Foundry Engineering, Vol.10, year of edition 2010, pages 39-42, the authors disclosed, that in the region of reaction layer, the crystals show an oval and coagulated shape, while at the layer-casting interface cuboids were observed. In the experiment a commercial titanium powder of 99.98% purity and 44 μ m granulation was mixed with a graphite powder of purity 99.99% and 30 μ m granulation, and next compacted at the bottom of the previously prepared mould.

[0005] Moreover, patent specification CN 1868635A discloses a method for obtaining a composite material

based on steel, locally reinforced with TiC particles, which are synthesized from the compacted mixture of powders of Al, C, and Ti-Fe at high temperature in a foundry mould.

5 **[0006]** American patent specification US5,509,555 describes a method for producing articles, including composites, by reactive infiltration of a porous proform. A dense composite can be formed when a silicon-aluminium alloy at temperature range from about 900°C up to 10 1800°C is contacted with the carbon proform. Because some of porous carbon proform is reacted with silicon, the composite beside silicon-aluminium alloy includes also a ceramic phase - silicon carbide.

15 **[0007]** US Patent Application US20110226882 discloses a composite impactor for crushers. The composite impactor has a reinforcement microstructure concentrated with globular particles of titanium carbide. The reinforcement was accomplished by placing granules, containing a mixture of powders of titanium and carbon, in a metal container, which is then placed in the mould at the location where the impactor is expected to be reinforced.

20 **[0008]** From American patent specification No. US 7,935,431B2 is known a cast metal wear part comprising at least two portions. The first portion includes exclusively 25 a cast iron, and the second portion is a conglomerate, where the cast portion has been reinforced with an agglomerated particles infused into. The conglomerate structure is formed in situ reaction between two or more powdered raw materials, which have been formed into a shape and placed into a mould prior pouring a cast alloy. 30 Parts created in this way, feature high impact resistance, above 10MPa \sqrt{m} , and for the conglomerate with the cast iron therein Vickers hardness above 1000Hv₂₀ was achieved.

35 **[0009]** As for majority of heavy duty tools the surface wear resistance is of paramount importance any improvement, which increases the wear resistance is important.

[0010] According to the invention, this problem is 40 solved by application of extremely high pressure, equal to 500MPa, during the process of compaction and shaping of inserts, which are next glued to the walls of the foundry mould. The inserts are composed with powdered reactants of SHS synthesis, and are prepared by mixing 45 a titanium powder having a purity of 99.98% and a particle size of 40 μ m with a graphite powder having a purity of 99.99% and a particle size of 40 μ m, and were the atomic ratio of 1:1 is maintained.

[0011] Hard and abrasive wear-resistant ceramic 50 phases of the MeC type (where Me - Ti, Nb, Mo, Zr, W, V, Ta) are formed in situ by reaction that takes place between them, placed on the walls and / or on the bottom of a mould or die, reactants and liquid alloy poured into the said mould or die. The introduced components are 55 undergoing the reaction of SHS (self propagating high-temperature synthesis), as a result of which, in the liquid alloy, carbides are locally generated, to form, after the casting crystallisation process, a composite zone. The

method guarantees the creation of areas reinforced with ceramic phases in strictly determined places of the casting. The process of the creation of an area resistant to abrasive wear occurs simultaneously with the process conferring to the cast detail its ultimate, final shape.

[0012] An important advantage of the method according to the present invention is the possibility of transforming the selected area of casting into a composite, wherein the reinforcement is accomplished by *in situ* synthesis of a high-melting point, hard ceramic phase of the MeC type. Within the area of the foundry mould cavity or die cavity, where the shaped inserts are arranged, after the process of crystallisation and solidification of the casting, a composite containing carbides is produced, the matrix of the locally produced composite being an iron-based cast alloy, while the reinforcing phase is composed of carbides.

Example.

[0013] A mixture of reactants for the TiC carbide synthesis was prepared by mixing titanium powder having a purity of 99.98% and a particle size of 40 μm and graphite powder having a purity of 99.99% and a particle size of 40 μm . The powders were combined together while maintaining the atomic ratio of 1:1 and were stirred for 6 h in the absence of oxygen. Thus prepared mixture was divided into batches and subjected to compaction in a die under a pressure of 500 MPa. Compacted shaped inserts of dimensions 5 x 10 x 45 mm were obtained, and then the shaped inserts were glued to the walls of a mould made of bentonite sand mixture. Then the cast alloy corresponding with its composition to the composition of a ferritic nodular graphite cast iron grade according to EN-GJS-350-22-LT (PN-EN-1563) was prepared, and was next poured into a mould. The surface of the shaped insert contacting the hot liquid metal initiates the exothermic reaction of synthesis (SHS) of the reinforcing phase, as a result of which a composite area reinforced with TiC carbides is formed in the casting.

Claims

1. A method for producing composite zones in castings, where prior filling a foundry mould with an iron based cast alloy, on walls and / or on bottom of the foundry mould, shaped inserts are placed, which after filling the foundry mould with the iron based cast alloy undergo a reaction of self propagating high-temperature synthesis (SHS), and which previously are prepared by mixing a titanium powder having a purity of 99.98% and a particle size of 40 μm with a graphite powder having a purity of 99.99% and a particle size of 40 μm , and where the atomic ratio of 1:1 is maintained, is **characterised in that**, the powdered reactants of SHS synthesis are subjected to compaction and shaping under pressure of 500MPa, and subsequently glued to the walls of the foundry mould

made of bentonite sand mixture.

Patentansprüche

1. Ein Verfahren zur Herstellung von Verbundzonen in Abgüssen, bei denen vor dem Füllen einer Gussform mit einer Gusslegierung auf Eisenbasis auf Wänden und / oder auf der Unterseite der Gussform geformte Einsätze angeordnet sind, die nach dem Füllen der Gussform mit der Gusslegierung auf Eisenbasis einer Reaktion selbstausbreitender Hochtemperatursynthese (SHS) unterzogen werden. Diese werden zuvor durch Mischen eines Titanpulvers mit einem Reinheitsgrad von 99,98% und einer Teilchengröße von 40 μm mit einem Graphitpulver mit einem Reinheitsgrad von 99,99% und einer Teilchengröße von 40 μm vorbereitet, wo das Atomverhältnis von 1:1 beibehalten wird, und kennzeichnen sich dadurch aus, dass die pulverförmigen Reaktanten der SHS-Synthese einer Verdichtung und Formgebung unter einem Druck von 500 MPa unterzogen und anschließend an die Wände der Gussform aus Bentonitsandmischung geklebt werden.

Revendications

1. Procédé pour la production de zones composites dans des pièces moulées, où avant de remplir un moule de fonderie avec un alliage moulé à base de fer, sont placés sur les parois et / ou sur le fond de celui-ci des inserts façonnés qui, après le remplissage du moule de fonderie avec l'alliage à base de fer, subissent une réaction de synthèse à haute température auto-propagée (SHS) et qui sont préalablement préparés en mélangeant une poudre de titane de pureté 99,98% et une granulométrie de 40 μm avec une poudre de graphite de pureté 99,99% et une granulométrie de 40 μm , et où le rapport atomique de 1: 1 est maintenu, procédé qui se **caractérise par le fait que** les réactifs en poudre de la synthèse SHS sont soumis à un compactage et à une mise en forme par une pression de 500 MPa, et par conséquence se collent aux paroi du moule de fonderie constitué d'un mélange de sable à bentonite.

REFERENCES CITED IN THE DESCRIPTION

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