Savez inženjera metalurgije Jugoslavije
SIMJ

UDC:621.762.3:669.1.011=20
Originalni naučni rad

PROPERTIES AND STRUCTURAL CHARACTERISTICS POWDER SINTERED MATERIALS ON THE BASIS OF IRON

SVOJSTVA I STRUKTURNE KARAKTERISTIKE SINTEROVANIH PRAŠKASTIH MATERIJALA NA BAZI ŽELEZA

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Received: 5. 5. 2002.
Accepted: 18. 06. 2002.

ABSTRACT

The paper is devoted on comparative to research of properties of powder composite materials on the basis of the iron, containing of a shaving waste products of cast-iron received at different conditions. Simultaneously it is investigated structural characteristics to the same materials. It is established, that mechanical and antifriction properties of the material received by pressing without application of technological greasing, almost twice exceeds similar properties of the material received by pressing in usual conditions. Is established, that the pressing in "sweating" matrix essentially improve physic-mechanical and antifriction properties sintered iron-cast iron materials. Pressing in "sweating" matrix and exception from composite technological greasing provided effective drainage of air from a compression mould at pressing, so, high density and durability of a material. It is established, that of sinter composite material "iron-cast iron-brass" consists from α–iron. Solid solutions such as Fe-Cu-Zn-S, Fe-Cu-S simultaneously are found out. The microstructure consists from pearlite. At all cases in structure of materials is present structural - free cementite.

Key words: Antifriction, powder, cast iron, sinter

1. INTRODUCTION

Iron and steel sintered components are widely used in the automotive industry, office and household machines, tools, pumps, shock absorbers, camshaft belt pulleys, etc. [1, 2]. One of the most prominent features of pressed and sintered of pressed and sintered powder materials parts is their porosity. It is well known that the presence of pores exerts a strong influence on many properties of sintered materials [3]. Another problem is the dimensional change during sintering, so that more intense sintering results in better properties without significant changes in the total porosity [4].

Powder metallurgy is a method capable for producing new alloys which cannot be made conventionally [5, 6].

Macro heterogeneous composite materials are good prospects for applications as friction pairs. Macroheterogeneous casted composite materials were developed primary for use in severe working conditions such as heavy loads, elevated temperatures, dusty environment, etc., and to replace bronze and other antifriction plain bearing materials. Due to the production technology; secondary non-ferrous alloys and even scrap can be used to produce macro heterogeneous casted composite materials. These materials are nearly suitable for all friction parts and are unaffected by dust, sand, and water. The structure of macro heterogeneous casted composite materials consists of a matrix with uniformly distributed reinforcing particles (e.g., iron based alloys).This feature allows for a reduction in the consumption of non ferrous alloys up to 70 %. Depending on the working conditions (sliding velocities, specific pressure, etc.) different compositions of macro heterogeneous casted composite materials can be produced. The application of casting technology provides cost reduction of plain bearings up to 40 % depending on the size and design of parts compared to bronze ones. Moreover, in some cases an abnormally low friction coefficient can be achieved and as a result a wearless condition can be obtained. It is obvious that the service life and performance of bearing materials depend on the processes occurring in the contact area of the friction pairs. So in, order to develop new bearing materials an predict their performance one must have information about the materials behaviour in the contact area [7].

The degree of the reaction is determined by the chemical composition and structure of phases as well as by the phase distribution and morphology, the interaction between the phases and their interaction with other components in the friction contacts region. The wear resistance and friction coefficient are determined by the ability of the structural elements to keep their stability through energy dissipation or through reconstruction (without destruction) into a state which is more preferable for the type of friction. So, determining the relationship between the initial structure an the surface layers structure under friction , and establishing the regularities in the appearance of different phases and elements, and their ability to resist wear, are very important steps in the theory and practise of tribology [7].

To the last progress in the field of waste-handling shaving of constructional steels by methods of a powder metallurgy are referred: technology of waste-handling shaving of ball-bearing steel, designed SPO SII „Traktorselkhozmash " (Russia) and technology of waste-handling of shaving of a low alloyed steel SAE, designed corporation "Ford Motor" (USA).

The modern production of many mechanisms and machines shows high requirements to reliability of sites, continuously working during duration of time. Many details of these sites work in difficult conditions of friction and deterioration, influence of high pressure and aggressive medium at high speeds of movement. These conditions is put forward on the foreground necessity of investigation of materials capable to resist to such influences on an extent enough of the large service life of machines [8].

It is known, that to add of a cast iron powder in charge on the basis of iron, allow synthesize at sintering alloyed powder material with high durable and satisfactory physic-mechanical properties [9].

It is necessary to note, that powder metallurgy enables to receive composite materials of system metal - nonmetal with the big distinction after the form and the size of powder particles [10, 11].

From this point of view analysis of antifriction and mechanical properties iron-cast iron powdered sintering of compositions introduces the special concern.

2. MATERIALS AND METHOD OF APPLICATIONS OF CONDUCTING OF EXPERIMENTS

At studies were used the following materials:

- The sprayed retrieved ferrous dust (flow state 30 seconds; bulk weight 2,5 g/sm^3; dispersion ability ≤200 mkm);
- The sprayed brass powder with following chemical components in mass. %: Cu 60,5-63,5; Fe 0,15; Pb 0,08; Zn - remaining;
- Powder from special cast iron with interdendritic dot graphite, which is obtained from powder – waste of production by grinding in spherical grinding mill;
- Powder of talk;
- Powder of technical sulfur.

The shaving of special cast iron with interdendritic dot graphite contains following elements in mass. %: C 2,0-3,0; Si 2,5-3,8; Mn 0,4-0,9; P 0,1-0,3; S 0,05-0,1. The mixture conducted in the Y-figurative mixer during the 1 hour.

Charge pressed on specialized HPM-100S press for a powder metallurgy under pressure 400-1000 MPa in a press form with a "sweating" matrix [8]. For the choosing of an optimum regime of pressing, for the receiving of deriving porous plane bearings with indispensable physics-mechanical characteristics, stress of pressing was measured in ranges 100-250 MPa, and speed of pressing was established by the hand lever of an input resonator with scale from 0,1-0,45 m/sec. Depth of a matrix of -22 mms, mass of a shot of charge -16,6 g, control high of pressing -14,6 mms.

The calibrating of plane bearings was carried out after caking on the same press, on which one they were pressed, but with usage of the calibrating instrument. As against pressing in a mold tool, in the calibrating instrument were used a matrix from wolfram - cobalt hard alloy. During this processes possibility of scores in a matrix and puncheons was eliminated at calibration of bearing boxs in a case of formation of structural - free sementite on boundaries of grains of metal. The speed of calibrating was constant - 0,25 m/sec, as variations on their properties does not render.

Obtained pressings - prismatic samples by the sizes 55 x 10 x 10 mm sintered in conveyer board "KOYO LINDBERG" at speed of a ribbon way 3,5 m/sec and temperatures 800-1200^{0}C with isothermal endurance in a zone of caking 1 hour in endothermic gas sphere. Temperature in a zone of a preheating of board (575 ^{0}C) was permanently controlled by the a chromel - alumel thermoelectric couple, and in a zone of caking - in two points by platinum – platinorodium thermoelectric couples. In cooling zone of board temperature automatically stabilized in a given regime by temperature sensors in three points on cooling temperature of water: 60, 40, 20 ^{0}C accordingly.

The tribotechnical performances is sample studied on the friction machine SMTS-2. The tribotechnical investigations of powdered materials in laboratory conditions are one of main stage of their operability for operation in clusters of friction. During the such materials testing in laboratory conditions the different schemas of friction is use, which for geometry of friction contact can be separated two groups: with constant and variable nominal contact area. The most abundant schema is the friction of disk - carrier socket, which one basically will be realised on the standard machine SMTS-2. In many cases realization of the schema the disk - carrier socket on standard machines at high pressures is hampered, as it is required, that the pressure in a contact zone should do not exceed yield limit of sample material. For a solution of this problem and express valuation of antifriction properties of materials, the extension of technical feasibilities of friction machines the new gadget to the machine SMTS-2 is designed by us [12]. The given gadget, from one side ensures free and smoothly varying of installing of carrier sockets under pressure, from other side - allows at enough large moment of frictions to create counteraction present moment and to hold a carrier socket. In result is reached even dense sticking of friction surfaces of samples.

Density and porosity of baking samples obtained by a hydrostatic method. Oil imbued impregnated samples was obtained by a method of weighing baking, impregnated oil and after its skim. To carried out of investigations used a Soxhlet apparatus and analytical balance.

A breaking strength on a tension and a bending fatigue strength defined by machine P-10 on appropriate a technique.

The metallographic analysis was conducted on a "LICHTMIKROSKOP" (Institute of Metallurgy, Technical University of Aachen). For determination of a microstructure of bearing boxs special samples were carved on a milling machine. A microstructure of a surface of the bearing box investigated on the whole sample. Etching of samples were conducted in 4 % HNO_3 solution.

3. RESULTS

It is known, that powder materials have low mechanical properties and wear resistance. Decrease of the porosity making 7-20 % up to a minimum or creation without porosity a material, also does not allow essentially to raise wear resistance at dry friction. As pore in structure of a material in a small amount they, not reducing mechanical properties of a material, during friction play a role of an air pillow and absorb products of deterioration. We shall note, that pressing in "sweating" matrix and exception from composite technological greasing provided effective drainage of air from a compression mould at pre-ssing, so, high density and durability of a material.

The carried out investigations have shown, that, the best antifriction properties are observed at a material containing, in mass percent: 54,5 cast iron; 10 brass powders, 1,5 powder of talc and 0,5 powder of sulfur. Antifriction properties of samples received in the press-form with using of "sweating" matrix represent the certain interest. Common porosity of these samples makes 7-9 %, which is much lower than for received in the sample press-form [13].

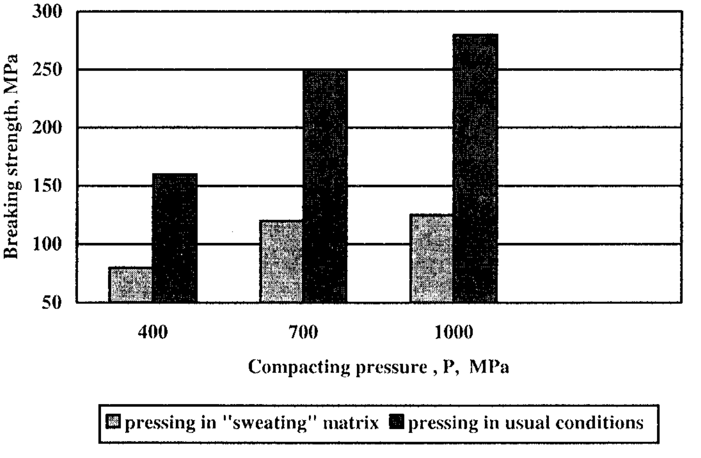

Fig. 1 - Dependence of a breaking strength from compacting pressure of „iron - cast iron-brass" powder composite material at temperature of sintering T=1150°C

On fig. 1-2 are submitted dependence of some properties of the materials received from composite, containing zinc stearate and not containing it. Pressing without application zinc stearate was carried out in a compression mould with "sweating" matrix. Application of pressing without introduction of technological greasing promotes increase of mechanical and ant frictional properties of a powder composite material "iron–cast iron-brass". Achievement of high durability at a stretching of the given material in case of pressing in "sweating" matrix speaks improvement of quality of merging of metal particles at sintering. Presence of technological greasing interferes with drainage of gases from a compression mould, deterioration compactibility composite and reduces quality of merging of particles owing to its sublimations at sintering. Durability at a stretching of materials raises 1,3-1,5 times (in comparison with similar materials, pressing in usual conditions). The given composition received by pressing in "sweating" to a matrix, is observed increase durability at a bend in 1,2-1,4 times in comparison with the same a material made traditional pressing (fig. 2). Simultaneously pressing composite in "sweating" matrix, not without application of technological greasing, considerably allows to lower porosity (up to 7 %). And it allows to raise mechanical and antifriction properties of a material.

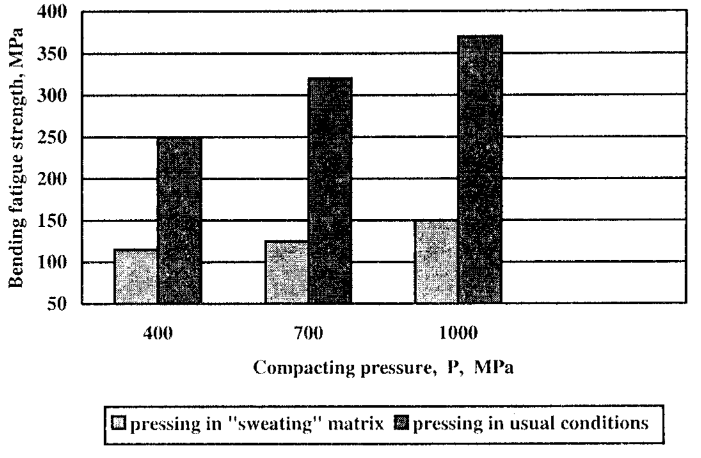

Fig. 2 - Dependence of a bending fatigue strength from compacting pressure of „iron- cast iron-brass" powder composite material at temperature of sintering T=1150°C

In conditions of dry friction at loading 2 MPa coefficient of friction of an alloy containing 30 mass. % of cast iron, much more, than alloy containing 40 mass. % of cast iron, that is concerned to the more contents in it inclusions of graphite. With increase of loading coefficient of friction of both alloys grows. Apparently, thus during friction in the high degree the firm inclusions - cementite, oxides take part, and the inclusions of graphite are gradually superseded from a zone of friction in interstice. At the next increase of loading coefficient of friction begins to be reduced, that is caused by their intensive deterioration [13].

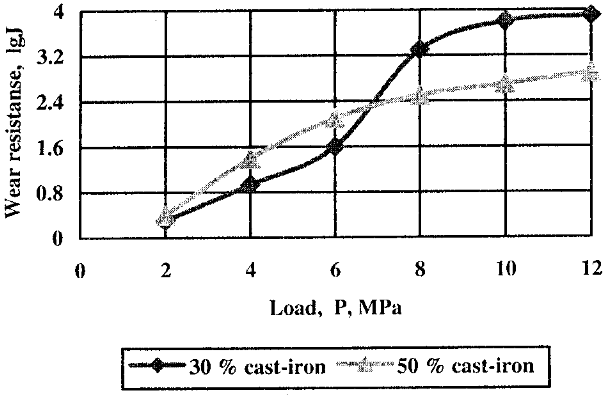

Fig. 3 - Dependence of intensity of wear resistance from maintenance and sizes of loading of „iron- cast iron-brass" powder composite material of cast-iron

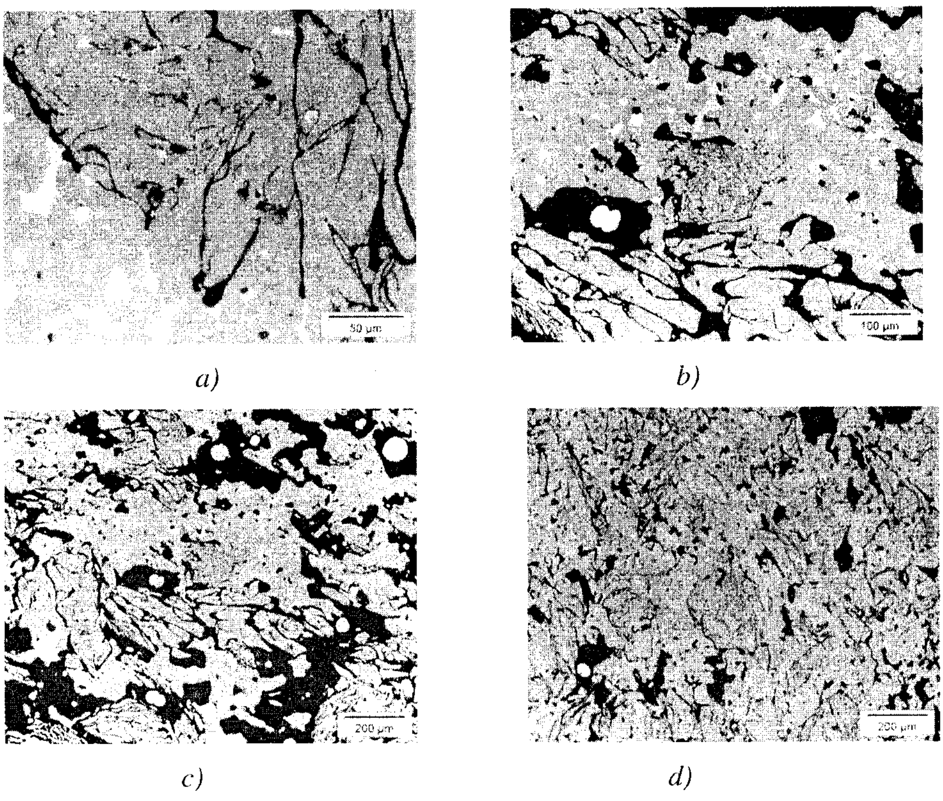

Fig. 4 - Microstructure „iron-cast iron-brass" compositions: temperature of sintering T=1150°C, duration of sintering 2 hours

On fig. 3 it is shown, that at loading 2 MPa of its value is not high. With increase of loading of deterioration begins to be increased. Its increase is strongly expressed in materials with the contents of cast iron 30 mass. %, in which structure has high inclusion of cementite. Obviously, at increase of loading last are painted and there is an intensive deterioration of a material. A material containing 50 mass.% of cast iron, wears is moderate, and its intensive deterioration is not observed down to loading 12 MPa, that is explained by feature of its microstructure consisting from pearlite and set of inclusions of graphite. Such structure, apparently, alongside with high strength of a matrix, provides to a material good enough durable at dry friction, due to presence of these inclusions.

In fig. 4 microstructures of sinter compositions "iron-cast iron-brass" are submitted at temperature 1150°C. The microstructure consists from pearlite, dark (presumably these nonmetallic inclusions) and light inclusions. At all cases in structure of materials is present structural - free cementite. It is established, that of sinter composite material "iron-cast iron-brass" consists from α– iron. Solid solutions such as Fe-Cu-Zn-S, Fe-Cu-S simultaneously are found out.

4. CONCLUSIONS

1. Thus, comparing properties of a powder composite material such as the "iron-cast iron-brass", received by pressing in usual conditions and in "sweating" matrix, it is possible to conclude, that mechanical and antifriction properties of the material received by pressing without application of technological greasing, almost in 1,5-2 times exceeds similar properties of the material received by pressing in usual conditions.
2. Is established, that pressing in "sweating" matrix and exception from composite technological greasing provided effective drainage of air from a compression mould at pressing, so, high density and durability of a material.
3. It is established, that of sinter composite material "iron-cast iron-brass" consists from α– iron. Solid solutions such as Fe-Cu-Zn-S, Fe-Cu-S simultaneously are found out. The microstructure consists from pearlite. At all cases in structure of materials is present structural - free cementite.

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