Porous Materials Based on Nickel and Aluminum

L.V. Dubinina [1,a], V.U. Lopatin [2,b], V.K. Narva [3,c], V.A. Shugaev [4,d], Tein Vin [5,e]

[1,2,3,4,5] Department of Rare Metals and Powder Metallurgy, Moscow Institute Steel and Allows (Technological University), 4 Leninskii prospekt, Moscow, Russia,119049
[a]Dubinina@misis.ru, [b] airguner@misis.ru, [d] shsasha@mail.ru, [e]kohtein@yandex.ru

Abstract

Investigation of influence the morphology of initial powder particles, application pore-formers for sintering of nickel powders and application of flux for sintering of aluminum was made. Using different methods was prepared material with size of porous in wide range size of pores (1-500 μm). Using the flux for gravity sintering of aluminum in air atmosphere was manufactured porous material with porosity about 45%..

Keywords : interconnected porosity sintering nickel aluminum pore-former

1. Introduction

Per the last decade the rough development was receiv ed with materials with high percent interconnected poro sity, which properties, appreciably, are determined by p ores shape, porous sizes and pore size distribution. The regulation of distribution of porosity and pore size is extremely actual, especially for high porous (more then 50%) and microstructural (pore size 1-2 μm) materials [1].

The possibility of a solution of this task behind the following paths have been installed:

- the morphology of initial powder particles
- uses of the modified components
- application pore-formers
- application of fluxes and brazing materials

2. Experimental and Results

At analysis of influence morphology of particles the carbonyl and electrolytic nickel have been used. Pore size and porosity varied as depending on technological conditions of sintering (pressure of a molding, temperature, time of sintering), and from a relation of miscellaneous sorts of a nickel powders. Was established that increase of a long of carbonyl nickel pressability of mixtures is aggravated. For samples sintered at temperature 450 during 0,5 hours from beforehand annealed in hydrogen of a powder consisting of 70 % carbonyl and 30 % did not vary on the size. At porosity 55-58 % the pore size was equal 1-1,3 microns, the coefficient of transparency was equal 2,3-2,4 10^{-14} $м^2$.

Of the modifying component the powder of alum inumin an amount 3-10 % was used. The choice of aluminum was grounded on possibility of formation $NiAl_3$, NiAl, Ni_3Al and formation of diffusive porosity during sintering. The use of mixtures containing 10 % of aluminum has allowed increase porosity up to 55-60 % bothat using of carbonyl nickel, and of mixtures with electrolytic nickel too. Pore size was about 0.8-1μm, coefficient of transparency 5,8-7,6 10-14 $м^2$, hardness 11-30 kg/mm^2.

Of the modifying component the powder of aluminum in an amount 3-10 % was used. The choice of aluminum was grounded on possibility of formation NiAl3, NiAl, Ni3Al and formation of diffusive porosity during sintering. The use of mixtures containing 10 % of aluminum has allowed increase porosity up to 55 -60 % both at using of carbonyl nickel, and of mixtures with electrolytic nickel too. Pore size was about 0.8-1 m, coefficient of transparency 5,8-7,6 10-14 м2, hardness 11-30 kg/mm2.

The way of deriving high porous of cellular materials because of powder of nickel or iron (1-4 μm) with removable pore-former on classical technique of a powder metallurgy was made [2].

The ways of regulation of the size and distribution ofpores are offered by a selection of particular fractions (distribution of sizes of pore-formers) and perfecting of technique of manufacture of samples. Like the removable pore-formers were used soda and sodium hydrocarbonate (500-100 μm). The adding of the components ona stage of blending metallic, ensuring sticking,

of a powder on particles pore-former is offered, therefore is gained mixture and the random distribution of pores inpre-form is ensured [**Fig.1**]. Behavior of these connec-tions at heat allow to carry out nonisothermal sintering and first isothermal endurance without formation of a fluid phase, that ensures forming a metal skeleton with given allocation of pores on the size

and on size of pore-form. The removal of pore-former is out during thesecond isothermal endurance by its fusion in a filling from Al_2O_3. Porous size was determinate by size of pore-former.

In last 10-15 years the interest to execution of porous aluminum has amplified. Porous aluminum apply to manufacture of filters for clearing gases and liquids, heat-insulating panels

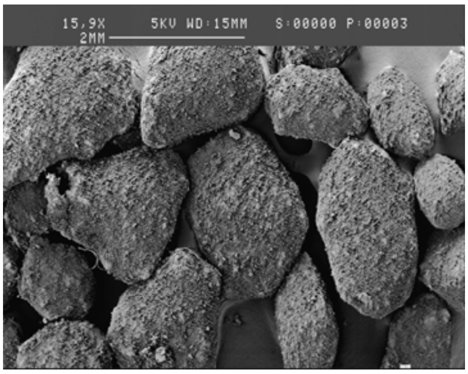

Fig. 1. Particles sodium hydrocarbonate covered by nickel powder.

and cages, damping parts of the automobile, flame arresters. For manufacture of porous aluminum with enclosed and apparent porosity will utilize two base methods foaming of melted aluminum by foaming agents (hydrides of metals) or passage of pressure gases again through a melt of aluminum. The oversights of these methods is the impossibility of making of regular structures (metal - porous) and impossibility of regulation of pore size and particular relation between enclosed and apparent porosity. By unique method allowing to create such structures is the powder metallurgy. But, there are difficulties at sintering aluminum, bound with presence of a high-melting oxide film on surface. Now there is only one method allowing conducts sintering aluminum this sintering in high vacuum during several clocks.

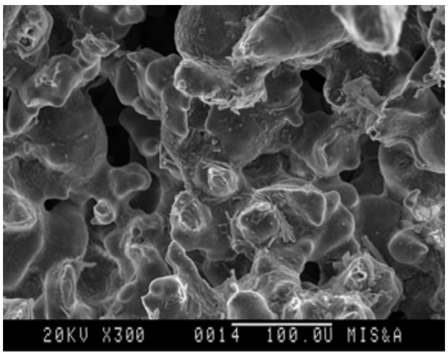

Fig. 2. Sintered aluminium particles.

The method of manufactory of porous aluminum by sintering of powder with using of the flux $KAlF_4$ and silumin, in simple furnaces on air for short time terms was d e s i g n e d . The parameters influencing on porosity of aluminum (about 45%) and mechanical properties of material was installed.

Using the methods of powder metallurgy was obtained the material with low density (1.5-1.7 g/sm^3), porous size from 10 up to 70 μm, low thermal conductivity and with porous distribution [**Fig. 2**]. Relationship between size of metal powder, size of flux, size silumin and porosity and its influence on properties was investigated.

3. Summary

Using metal powder molding and sintering available to obtain materials with interconnected porosity with small size of porous by changing form and ratio different type powder.

Application removable pore-formers for sintering admit to manufactured porous material with interconnected porosity with porous size obtained by size of pore-former.

By application flux and components with melting temperature low then melting temperature of base component is available to sinter porous aluminum by gravity sintering on air.

4. References

1. V.Narva. Production of high-porous parts from nickel powder. 12-th International Baltic Conference, Tallinn, pp.15-19 (2003).
2. V.Lopatin, L.Dubynina. Preparation of macrohomogeneous mixtures of metallic powders with salt poreformer during its great-scale volume content Nonferrous metallurgy transaction, 2004, v.3, pp. 85-88