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EXPERIMENTAL RESEARCH OF SINTERED POROUS MATERIALS OF BRONZE POWDERS

I.VIDA-SIMITI, N. JUMATE, T. BOLOG, G. BATIN

Technical University of Cluj-Napoca,
e-mail: ivida@personal.ro

ABSTRACT

Porous sample were fabricated by sintering of bronze (Cu Sn10) with different particle size range. The paper investigates the influence of the particle size distribution, temperature and sintering time on the structural characteristics (porosity, pore size, dimensional changes) of the porous parts studied. A porous structure with small-sized pores and a uniform distribution of the pore sizes is obtained in conditions of a narrow range of particle size distribution, small size of the powder particles and optimal sintering parameters.

KEYWORDS: porous materials, sintering materials, bronze powders.

1.Introduction

Porous elements obtained by Powder Metallurgy methods are used with excellent results as filters, flame arresters, noise suppressors, distributors of gases in fluids, electrochemical catalyzers etc.

A uniform porous structure with small sized pores ensures the main conditions required for these applications.

Structural parameters (porosity and size of pores) are influenced by the following technological processing parameters: the powder size range, compacting pressure, sintering temperature, sintering time [1,2,3,5,6,7]. A previous paper [8] studied the influence of the compacting pressure on the porous structure parameters of permeable sintered materials from 316 L stainless steel powder.

This study provides new comparative results regarding the influence of powder size ranges of free bronze sintered powder on the permeable porous structure in conditions of changing the sintering time .

2.Experimental method

Porous samples in the shape of disc tablets, 25 mm diameter and approximately 2 mm thickness, were made by sintering from free bronze powder poured into a matrix. The powder size ranges and thesintering time were the technological parameters that were changed in order to study their influence on the main structural characteristics.

Sintering was performed in a vacuum oven ($5*10^{-5}$ torr) at a relatively low temperature of 750^0C in order to ensure the intercommunicating characteristic of the pores and to avoid their closure in case of intensive sintering conditions.

The powder size ranges obtained by sifting and selected for the samples were: -40 µm; (+40 - 63) µm; (+63 - 80) µm; (+80 - 100) µm; (+100 - 125) µm; (+125 -160) µm.

During sintering the samples were maintained for 30, 45 and 60 minutes.

The porous structure was examined by a scanning electron microscpe (JEOL 5600 LV) and microphotos were obtained. The porosity of the samples with regular geometric shape was determined by calculation, based on their weight and calculated volume.

3.Results and discussion

Experimental sintering tests were performed at 850^0C, according to prescriptions found in literature [6]. It was found that the powder samples of high powder size ranges were melted and underwent marked contractions (fig.1).

Using the temperature of 750^0C, sintering was performed for 30, 45 and 60 minutes. It was found that at sintering time s of more than 45 min. the powder size ranges (100 - 125 µm; 125 -160 µm) were highly contracted (fig.2).

This may be explained by the fact that with vacuum sintering the heat transfer is mainly by thermic radiation. Due to the high porosity of the free powder having a powder size between 100 - 125 µm and 125 -160 µm, the "absorbant black body" phenomenon occurs.

A certain part of the thermic radiation is absorbed by the sample material, a part is reflected by the sample surface and another part penetrates into the pore cavity where heat accumulates, leading to the local temperature increase. The diffusion process at the level of the sintered bridges is enhanced. The increase of the temperature by 20^{0}C practically doubles the diffusion coefficient and triggers the transfer of material around the bridges between particles. Consequently, the effect of local temperature increase following the heat transmission by radiation leads to intensified sintering, reduction of porosity and increase of contractions.

Fig. 1. *Bronze powder samples sintered at 850^{0}C*

Fig. 2. *Bronze powder samples sintered at 750^{0}C*

This accounts for the high contraction in the powder samples with powder size s between 100 – 160 µm.

Figure 3 graphically presents the influence of the sintering time on the total contraction of samples for all the powder size rangees studied at a constant sintering temperature (750^{0}C). High contractions may be noted with powder size rangees (+100 - 125) µm; (+125 -160) µm.

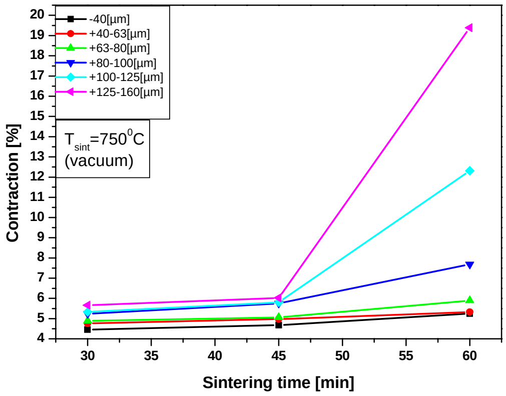

Fig. 3. *The influence of sintering time and powder size on the contraction*

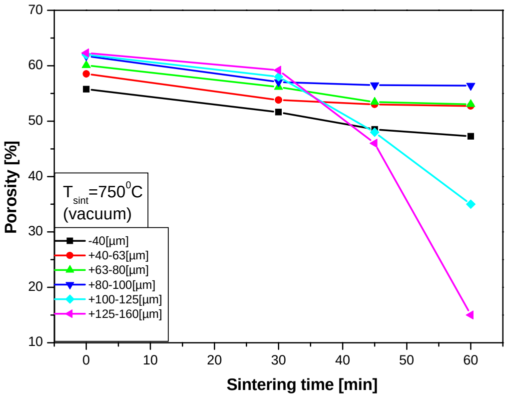

Fig. 4. *The influence of sintering time and powder size on the porosity*

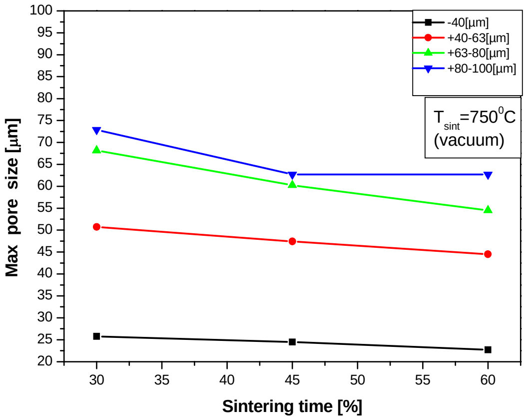

Fig. 5. *The influence of sintering time and powder size on the maximal pore size*

A more marked reduction of the porosity in the -40 µm powder size range (fig. 4) may be accounted for by the initially higher degree of packing of the small particles. The same findings are expressed by figs. 5 and 6, which show the variation of the size of the largest pore and the average pore size respectively in relation to the sintering time . The pore size undergoes small, even insignificant changes when sintering time increases. The mechanism of material transfer around the inter-particle bridges during sintering is not very intense. Consequently the pore size does not decrease too much with sintering time.

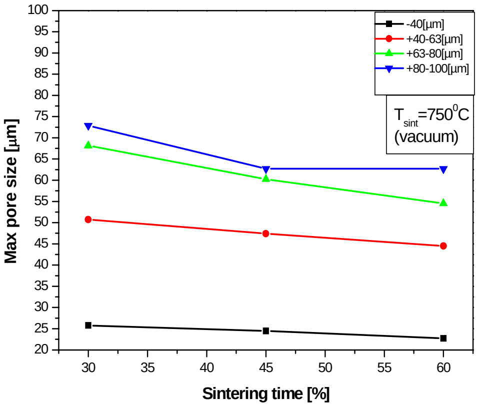

Fig. 6. *The influence of the sintering times and powder powder size on the average pore size*

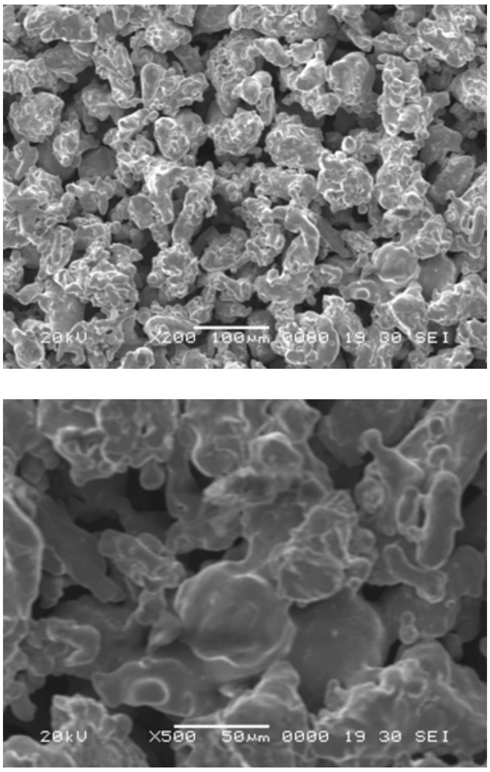

Fig. 7. *SEM image (x 500) of the bronze porous structure (45 mon.)*

The SEM images (fig.7) of the porous structures evidence the fact that the pore size and the inter-particle bridges reduction are not significantly changed. However, it may be noticed that the particle surface is smooth, following the material transport into the superficial layer by sintering. The surface defects and the roughness disappear following the sintering mechanisms.

Fig. 7 shows the image of the porous structure of the sample made of +63 – 80 µm granulometric powder sintered for 45 minutes.

The images evidence the inter-particle bridges formed after sintering only in the small areas of initial contacts between the free powder particles.

The narrow powder size ranges, formation by free spreading into the mold as well as the relatively low sintering temperature (750^{0}C) ensures a uniform porous structure with intercommunicating pores, favourable to fluid flow and filtration.

Conclusions

The sintering time has a marked influence on the porous structure parameters (porosity, pore size) in the case of the samples sintered from free bronze powder with (-100 – +160) µm.powder size .

Thesintering time does not influence the porous structure parameters (porosity, pore size) significantly in the samples obtained from free powder with (-40 – 100) µm powder size .

By sintering the powder particle surface becomes smooth, due to the transport of substance into the superficial layer of the material.

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