Sintered brass from mechanical Cu-Zn powder mixtures

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ABSTRACT. The conditions in which the sintering of the brasses from mechanical Cu-Zn powder mixtures, without the evaporation of Zn is possible, are presented. The 80Cu-20Zn elaborated brasses of 78...88% compactnesses have been studied by REM. The different reciprocal diffusion of the two components at the beginning of sintering are revealed.

INTRODUCTION

It is difficult to obtain sintered brass parts from mechanical Cu-Zn powder mixtures [1] due to the great vaporizing tendency of zinc at the sintering. Very few data are available in the literature [2] that points out the elaboration of sintered brasses in this way. Starting from these considerations we have studied the possibilities of obtaining some brasses from mechanical powders mixtures. One of our reasons was an evident lower cost of such materials, of up to 20-25%, as well as their multiple applications.

EXPERIMENTAL PROCEDURE

There have been used the powders given in Table 1.

Technological characteristics of the powders used					
Powder	Type	Grain size, μm			Specific surface, cm^2/g
		+63	63-45	-45	
Cu	Dendritic	-	>98		1100-1250
	Spheric	≤ 5	20-30	Balance	325
Zn	Irregular	≤ 5	30-40	Balance	

They have been initially submitted to a reduction in hydrogen atmosphere.

Some prepared mixtures with a composition of 80% wt.Cu and 20% wt.Zn have been homogenized for 30 minutes in a homogenizer of a rotary inclined cylinder type.

The compaction of the samples has been performed under pressures of 312 MPa and 625 MPa, respectively.

The compacted samples have been sintered in a tubular furnace at the temperature of $650 \pm 20^\circ\text{C}$, for 2,5; 15 and 40 minutes in an atmosphere of high purity Argon (a 0,8 bar pressure) and in the presence of carbon (i.e. a special graphite boat). In these sintering conditions, established as adequate, oxidation i.e. any loss of zinc, was completely prevented. After sintering, the maximum determined weight losses were under 0,06%.

RESULTS AND DISCUSSIONS

Thus, there have been obtained sintered brasses having final compactnesses of 78...88%, depending on the compactness after pressing and the type of copper powder.

They are characterized by:

i) The reduction of compactness (the increase of porosity) after sintering, as compared to the pressed state (Table 2), is due to the swelling of samples.

Table 2

Some properties of elaborated brasses

Powder mixture, %	Pressing		Sintering		Compactness reduction, $-\Delta C, \%$
	p, MPa	$C_p, \%$	$t, \text{min.}$	$C_s, \%$	
80Cu _{den} ⁺ +20Zn	625	94,3	2,5	88,7	5,6
			40	87,9	6,4
80Cu _{sph} ⁺ +20Zn	312	86,5	2,5	78,8	7,7
			40	77,7	8,8
	625	94,0	2,5	83,9	10,1
			40	82,5	11,5

It is more evident in the case of the materials elaborated on the basis of copper spheric powder. The greater the compacting pressure and the longer the sintering duration the more the compactness reduces. This phenomenon may be explained, on one hand, by the effect of wedge of the expansion of the liquid phase (zinc) on copper grains. The less the porosity of the pressed (available for this phase) the more accentuated the phenomenon. On the other hand, by solving zinc in copper a α -solid solution is formed, having a specific volume greater than that of the copper. However, this inconvenience of swelling may be technologically removed by a double pressing.

ii) The metallographic study (REM) of the elaborated brasses enables the elemental analysis, i.e. quantitative determinations of the components concentration in sintered materials. In the microstructure there has been observed only the α -solid solution, which was inhomogeneous mainly in the short duration sintered samples. After 2,5 minutes sintering the concentration of the elements in the different structure zones varies between 65...90% for copper and 35...10% for zinc.

Such a short sintering duration has pointed out the incipient different distribution of the two components, i.e. a different reciprocal diffusion. Rather surprisingly, at the beginning of sintering process, copper reacts with zinc more strongly than inversely, exhibiting a more homogeneous distribution, as it may be observed in Figure 1.

a.

b.

Figure 1. Zinc diffusion in copper (a) and copper diffusion in zinc (b) after 2,5 min sintering.

The fact zinc diffuses more slowly in copper is supported by the lower value of the diffusion coefficient, namely $10^{-14} \text{ cm}^2/\text{s}$ against that of copper in zinc which is about $10^{-9} \text{ cm}^2/\text{s}$ (at 420°C) [3].

iii) α - solid solution is more homogeneous in the case of samples sintered of copper dendritic powder than in the case of the spheric one (Figure 2).

a.

b.

c.

Figure 2. Unetched microstructure of 80Cu - 20Zn brass sintered from copper dendritic powder for 2,5 min (a) and from copper spherical powder for 2,5 min (b) and 40 min (c), respectively.

That fact may be explained by the specific surface that differs substantially between the two types of powders. Simultaneously with an increase in the sintering time the homogeneity of α - solid solution becomes substantially greater, too. That is fully agrees with a constant diminish in the compactness on behalf of a volume increase of the sintered samples.

CONCLUSIONS

For a corresponding sintering of such brasses it is sufficient a sintering time of approximately 40-45 minutes.

So, there may be stated that the question that caused these investigations, i.e. the possibility of elaborating sintered brasses out of mechanical Cu - Zn powder mixtures is answered affirmatively only if the other sintering conditions are ensured.

The necessity of such materials which are evidently cheaper than the brasses made out of prealloyed powders is obvious and will be continuously increasing.

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