CHARACTERISTIC OF PLASTIC DEFORMATION OF SINTERED MATERIALS

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ABSTRACT: *Micromechanisms of fracturing working at the origin of fractures of metallic materials are related to the development of the plastic deformation at both microscopical and macroscopical levels respectively.*

KEYWORD: Sintered materials, microinhomogenity, plastic deformationa.

1.INTRODUCTION

In several papers we have analysed microinhomogeneity of plastic deformation in relation to the properties, size, morphology and distribution of coexisting phases using single and multiphase metallic materials.

The plastic deformation precedes and accompanies the origin of such fractures. Micromechanisms of the plastic deformation of sintered materials are modified mainly by the presence of pores and the above described particle connections when one compares them with classical metals.

Microinhomogeneity of plastic deformation has been classified among the most important specific features of plastic deformation of the sintered materials.

We have found out, using the method of statistical evaluation of micronetwork deformation, that we are able to determine so called "microinhomogeneity index". This index determines the magnitude of the deviations of local deformations in microvolumes from the mean magnitude of plastic deformation, which have been found out macroscopically.

We have proved that barrier effects, accumulation of dislocations, specific micromechanisms of the origin and propagation of cracks affecting morphology of the fracture surfaces are related to the microinhomogeneity of plastic deformation. Energy of the fracture surfaces is also affected [1, 2, 4, 5]. Similar, but more intensively developed effects have been manifested in the matrix of the PM materials. Main attention has been paid to the microinhomogeneity of plastic deformation due to porosity and presence of particle connections. This was based on knowledge of relations of the total porosity P_T and plain porosity P_x to macroplastic characteristics of sintered Fe, namely the effect of porosity on values of ductility, values of reduction of area as well as metallographical observations of the concentration of slip strips in microdomains of pores.

2. EXPERIMENTAL RESEARCH

The following knowledge follows from the carried out studies:

a) Isolated particle connections - necks prevail in the structure of sintered iron pressings with spherical particles and porosities of approximately 12-15% and higher. Their sizes and quality cause, when compared with the maximum cross section of powder particles, that the stresses and the plastic deformation are dominantly concentrated in them. In other words, the connections - necks are not able to transfer the deformation flow to inside of particles of metallic powders.

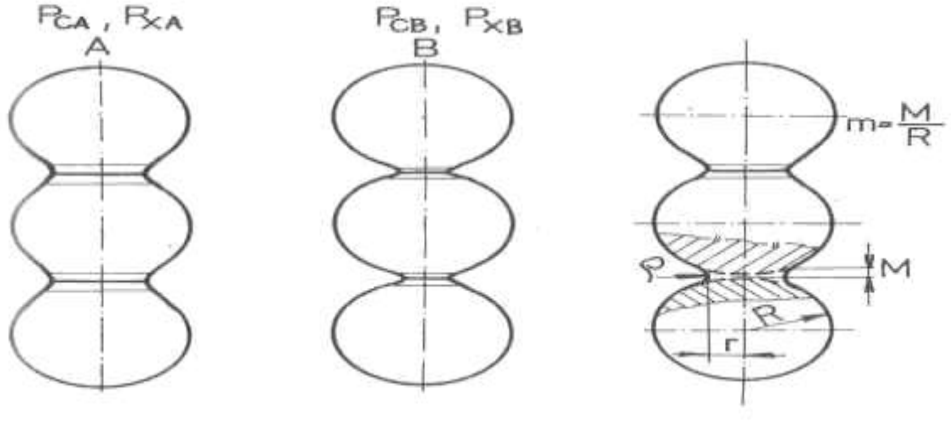
b) The particle connections are developed in such an extent at approximately 6% porosity P_c and a smaller that powder particles participate in macroplastic deformations of sintered bodies practically in their entire volume. Isolated pores work in the matrix only as microconcentrators of stresses.

c) Certain portions of the volume of spherical powders also participate in various extents in plastic deformation along with the necks - connections at porosities P_c from 6 to 12-15%. The larger the porosity, the smaller the volume of activated powder particles, which are participated in plastic deformation [1, 3].

Application and evaluation of the deformation by a micronet with parameter of 0.05 mm applied on the surface of a thin section of etched structure of sintered powders has led to the following knowledge.

This index determines the magnitude of the deviations of local deformations in microvolumes from the mean magnitude of plastic deformation, which have been found out macroscopically.

The distinct inhomogeneity of plastic deformation of sintered porous Fe on the basis of spherical particles with the total porosity P_c of approximately 8.5% is caused by localized deformation from particle connections - necks and with the related opening of pores. It has been manifested by local shiftings of the micronets. For forged state with the residual porosity of approximately 1%, the microinhomogeneity of plastic deformation has developed in a similar manner as with the compact materials, i.e. the size of the ferrite grains was the main parameter affecting the microinhomogeneity. Thus using metallographical methods, we have confirmed that the plastic deformation is preferentially developed in microvolumes of partide connections - necks at higher porosities [4,5].



$P_{CB}, P_{XB} > P_{XA}, P_{CA}$

Fig. 1. Scheme of geometrical parameters of particle connections

Problems of the microinhomogeneity of plastic deformation of the porous metallic materials have also been evaluated using a mathematic model of the development of elastic and elasto-plastic deformations. The solution was based on the method of final elements, which was applied on spatially symmetrical body, which is schematically depicted in Fig. 1. Three sintered particles of powder with different total and plain porosities are depicted in planar view in parts A and B of this figure. Symbol P_{CB} is for total volume porosity, P_{XB} for plain porosity, which are larger than P_{cA} and P_{xB}. This is expressed by different radius r of partide connections - necks in the scheme.

Fig 1clarifies the significance of the parameter m, which characterizes the geometrical development of bridges and its relation to dimensions of spherical particles of Fe powder; *m = M/R*, where *M* is the thickness of particle connections - bridges, *r* is the radius of necks, *R* is the radius of powder particles.

It follows from this diagram that local deformations 5-25% can correspond to the macroscopical deformation of porous body with porosity e.g. 2% in necks in dependence on their perfectness, which is characterized by various parameters *m.* Therefore porosity and partide connections - necks are the key factors of Fig.2.

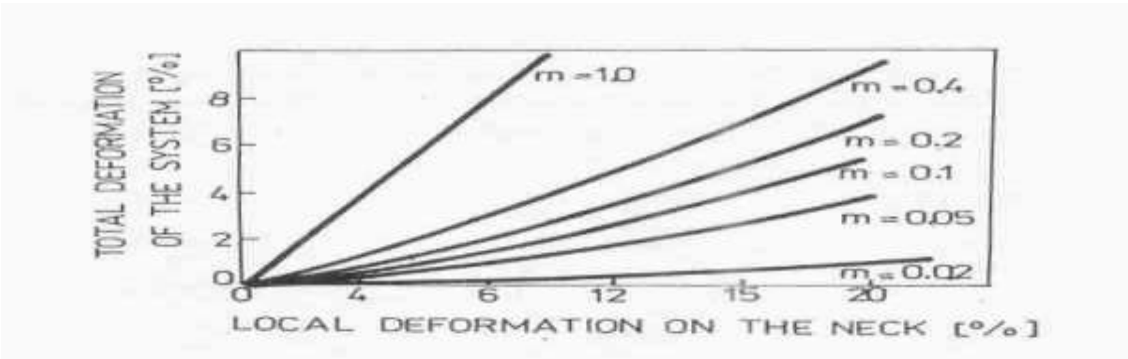


Fig.2 Relationship between the size of local deformation of necks and macrodeformation

3.CONCLUSION

Relationship between the size of local deformation of necks and macrodeformation of porous Fe the development of microinhomogeneity of plastic deformation of sintered bodies. The experimentally determined relationships of values of elongation and reduction of area in dependence on porosity are manifestations of the above described laws. Only small volumes of bodies with porosities larger than 12% participate in the process of plastic deformation [4,5]. Microinhomogeneity of plastic deformation has been classified among the most important specific features of plastic deformation of the sintered materials. Wehave found out, using the method of statistical evaluation of micronetwork deformation, that we are able to determine so called "microinhomogeneity index". Main attention has been paid to the microinhomogeneity of plastic deformation due to porosity and presence of particle connections. This was based on knowledge of relations of the total porosity P_T and plain porosity P_x to macroplastic characteristics of

Certain portions of the volume of spherical powders also participate in various extents in plastic deformation along with the necks - connections at porosities P_c from 6 to 12-15%.

Isolated particle connections - necks prevail in the structure of sintered iron pressings with spherical particles and porosities of approximately 12-15% and higher. Microinhomogeneity of plastic deformation has been classified among the most important specific features of plastic deformation of the sintered materials. Wehave found out, using the method of statistical evaluation of micronetwork deformation, that we are able to determine so called "microinhomogeneity index".

Their sizes and quality cause, when compared with the maximum cross section of powder particles, that the stresses and the plastic deformation are dominantly concentrated in them. The particle connections are developed in such an extent at approximately 6% porosity P_c and a smaller that powder particles participate in macroplastic deformations of plastic deformation.

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