PLASTIC DEFORMATION ON SINTERED STEELS BY POWDER IRON

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Abstract: *Deformation features were analyzed based sintered material of iron powders. They measured features of the structure depending on the porosity of deformed iron if monoaxiale. Analiza compression results to provide design allows physical deformation, which based on the gradual change of its dominant mechanisms to increase porosity.*

Keywords: sintered material, porosity, compression, powder iron.

1. INTRODUCTION

Use of powder materials and products in conditions of variable external loads and also processing of powder metals claims study of mechanisms of plastic deformation depending on basic parameters of structure [1]. In the case of powder metals the specific peculiarities of physical mechanisms arc still not clearly understood [1-4]. In our paper influence of porosity on behavior of deformed sintered iron were investigated.

2. MATERIAL AND METHOD

The measurements were conducted on specimens made from iron powder with the average size of particles 80 *μm.* The samples were produced single-valued compact up to required integrated porosity *P* and consequent thermal processing in vacuum at the temperature *T* = 1450 *K* during 2,5 hours. They looked like cylinders of height 10-15 mm and diameter 15 mm. The porosity *P* was changed from 4 to 40%. The specimens were subjected to single-axis compression with the deformation *e* from 3% to fracture, for beginning of which magistral cracks was accepted. For comparison as compact material armco-iron was used. To the quantitative analysis of the characteristics of structure of deformed iron were applied optical and electron microscopy. When performing the measurements, we used the scale grid with window of 50 /tm that was laid on a polished section of the lateral surface of the specimen. The average linear dimensions of grain *Rg,* average dimensions of intergrain *R.p* and intragrain pores were measured. For the analysis of strain hardening the average dimensions of mosaic block *D* and densities of dislocations *p* were determined. The dimensions *D* were measured with the help of X-ray difractometer on X-ray interference lines. The results of measurements were presented as dependences on porosity at various fixed deformations.

2. RESULTS AND DISCUSSION

Figure la shows typical microphotos of powder iron in the undeformed state. Figure la illustrates a role of pore as of the basic local concentrator of elastic stresses arising in material at loading. Elastic stresses were relaxing with emitting flows of dislocations, fig. 1.

Availability of pore are resulting by inhomogeneous distribution of mechanical stresses. It calls significant rotational processes exhibited in turns of grain and conglomerates of grains from each other. The given phenomenon is illustrated fig. 2.

A turn of the upper grain rather lower with creation of area of quasi-viscous current on intergrain boundary is shown in Fig. la. The scale grid inside grains is not deformed. It means decreasing a role of intragrain dislocation processes at plastic deformation of material with a high porosity and prevalence of processes in the area near the boundary, in particular, grain-boundary slippage. In Fig. 2 the turn of grain as the whole concerning it next grains is observed. We emphasize, that in compact iron at room temperature and same deformations so strong rotational effects are not observed.

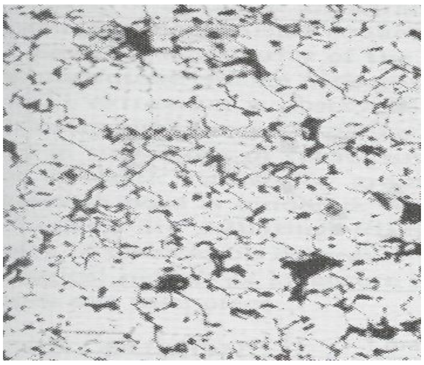

Fig.1 *Microstructure*
P=0,1; ε = 0%x100

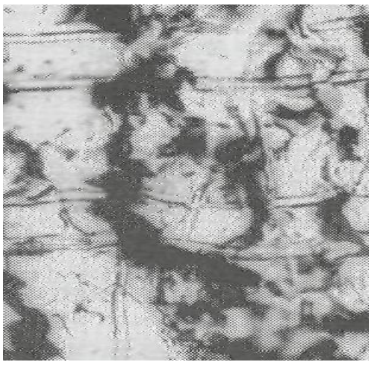

Fig.2 *Microstructure*
P=0,3; ε=0,3%x300

As it is visible from Fig. 2, increase of porosity much influences the average dimension of intergrain pore, measured at fixed deformation. At increase of deformation in case low porous material the average dimension of these pore was changed poorly.

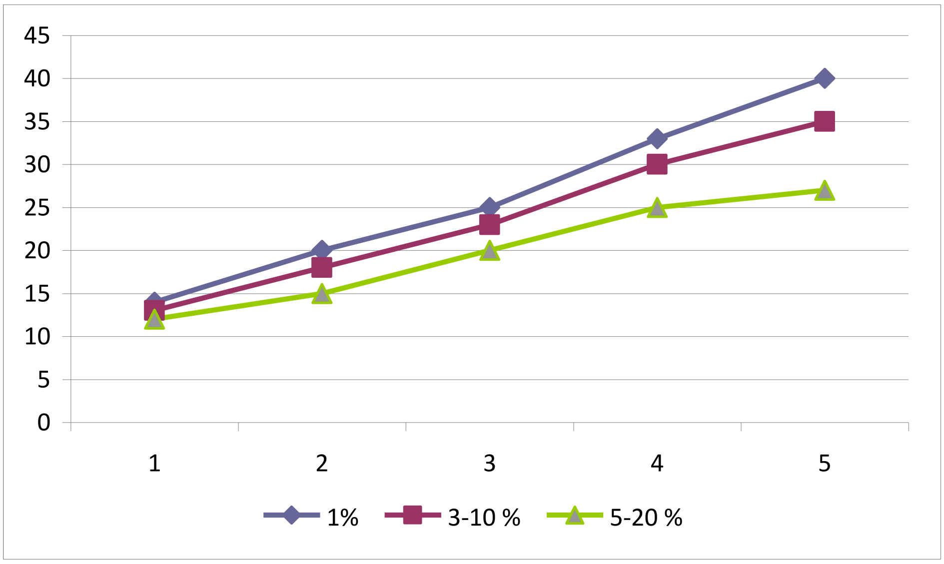

Figure 3. *Dependencies of characteristics of structure of deformed iron on porosity*

In case high porous material the growth of deformation calls significant decreasing of dimension *Rp*. It is explained by effects of extrusion of grain in pores.

In fig. 3 results of measurements of the quantitative structural characteristics are indicated.

It testifies to necessity of the separate account of the contributions of open porosity and close porosity at the analysis of plastic deformation of powder metals [1, 2]. Fig. 4 shows that average dimension of grains decreases with growth of a porosity at fixed deformation. It is stipulated by growth of dimensions and concentration of pores constraining growth of grains at recrystallization during a sintering. In the area of low porosity the increase of deformation calls significant decreasing of dimensions *Rg* on comparison with undeformed state whereas at high porosity grains are deformed rather poorly. It is stipulated by indicated above decreasing of a role of intragrain dislocation processes and gradual prevalence of deformation mechanisms connected to the motion of grains as the whole.

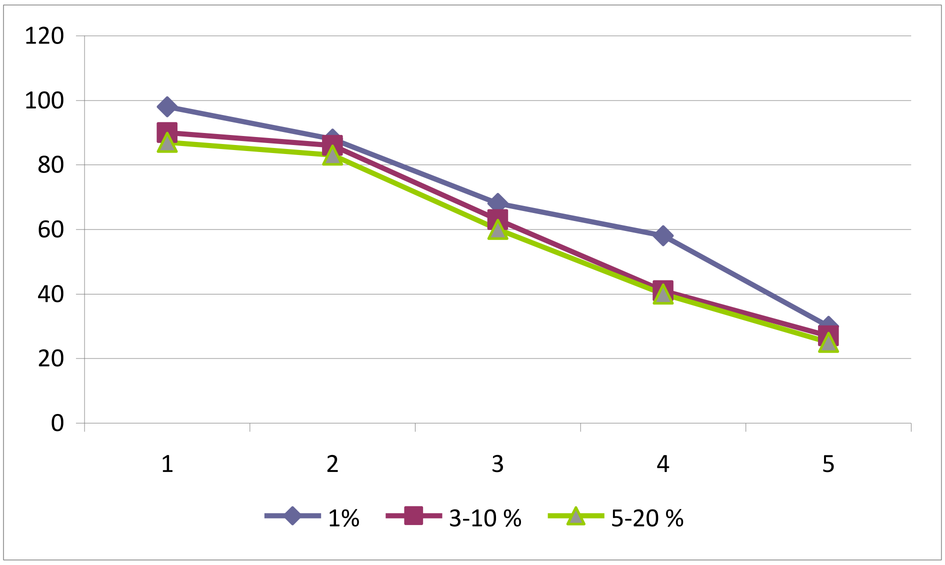

Figure 4. *Dependencies of characteristics of structure of deformed iron on porosity ε with dimension of grain.*

Essential singularity of the X-ray characteristics and densities of dislocations is nonmonotone change with growth of porosity , fig. 5. At porosities P ~ 0.1 extremum is observed. It is brightest expressed at large deformations *e*. This extremum can be explained by accumulation of significant elastic stresses on pores in conditions of rather low porosities (P < 0.1). In these conditions relaxation of elastic stresses by grain-boundary slippage, rotation of grains, extrusion of grain in pore is hindered. At further growth of porosity (P > 0.1) rotational mechanisms are actuating.

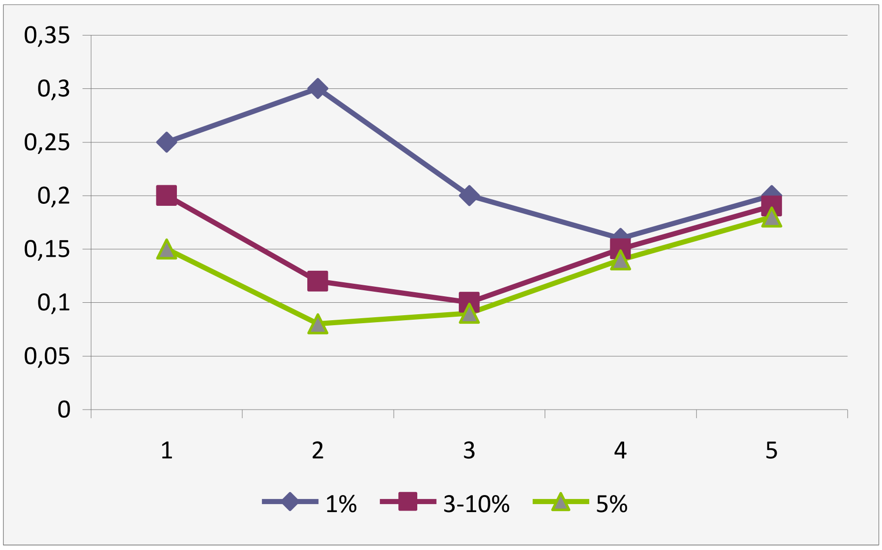

Figure 5. *Dependencies of characteristics of structure of deformed iron on porosity: dimension of mosaic block..*

Plastic deformation of intragrain areas decreases and density of dislocation decreases too. It is important to note, that at P ~ 0.1 the topological picture of structure is changed, just, transition from a closed porosity to open one take place.

3. CONCLUSION

Results the essential influence of porosity in the microstructure. In case of low porosities the plastic deformation is determined first all by intragrain dislocation processes. At growth porosities contribution about the processes connected to motion grains as the whole and concentrated near boundaries become stronger. At high porosities these processes are prevalence ones

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