DEFORMATION PROPERTIES OF METALS IN PRESSURE PROCESSING

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Metal forming (processing metals under pressure) is one of the most widely used and efficient technological processes in industry. Using this method, it is possible not only to give metal products the required shape, but also to improve their mechanical properties. During processing under pressure, the metal deforms under the influence of external forces, and this process has a significant effect on the metal's internal structure.

In terms of its physical nature, the processing of metals under pressure is a process of plastic deformation. The plastic deformation of a single crystal occurs through slip (glide) and through twinning.

The mechanism of plastic deformation in polycrystals is considerably more complex. This is explained by the fact that, in polycrystalline materials, grains differ from one another in shape and size, possess non-uniform physical and mechanical properties, and have various orientations of slip planes and directions relative to the applied deforming load.

Two types of deformation in polycrystalline materials are distinguished:

- intragranular (within the grains, inside the crystals);
- intergranular (along the grain boundaries, between the crystals).

The first occurs through slip and twinning, similar to deformation in an individual single crystal, while the second proceeds by the rotation and relative displacement of grains with respect to one another. Both types of deformation take place simultaneously in polycrystalline materials.

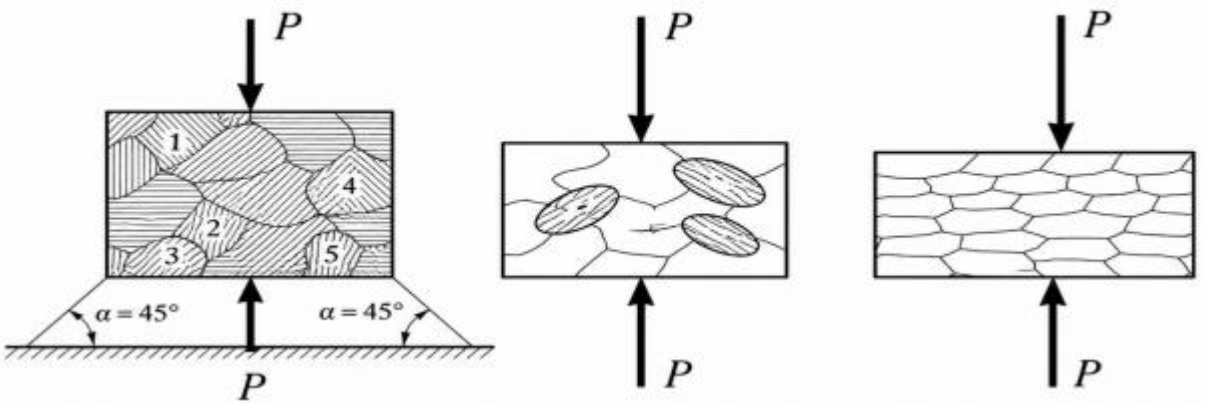
Because the grains in a polycrystal have different orientations of slip planes, plastic deformation under external forces does not begin simultaneously in all grains. First, the most favorably oriented grains deform—namely, those whose shear (slip) planes are inclined at an angle of about 45° to the direction of the applied force (Fig. 1a). As deformation proceeds, the orientation of the slip planes changes toward smaller angles, and a greater load is required to continue slip along the same planes.

The remaining grains rotate due to the moments of forces arising on shear planes inclined at 45° to the loading axis. After this rotation, they also undergo deformation (Fig. 1b). As a result of plastic deformation, the shape of the grains changes. The grains become elongated in the direction of deformation and form a fibrous structure, in which the crystal lattices acquire a common orientation (Fig. 1c).

Plastic deformation of metals occurs both during cold and hot pressure processing.

During cold pressure processing of metals, the metal becomes significantly strengthened and loses its ductility. If it is necessary to continue pressure processing, the workpiece is heated. Products obtained through cold deformation are characterized by

high strength properties, precise dimensions, and a smooth surface. However, only highly ductile materials can be processed in this way.



a) **b)** **c)**

Figure 1. Schematic diagram of the development of plastic deformation in polycrystals

During hot pressure processing of metals, deformation is carried out at temperatures above the recrystallization temperature. In this case, strain hardening is completely eliminated, the metal acquires an equiaxed grain structure, while the fibrous structure is retained. The more the metal is heated, the higher its ductility and the lower its resistance to deformation (for carbon steel, by 10–15 times). At the same time, overheating near the solidus line must be avoided, as it leads to burning (oxidation along grain boundaries).

Proper use of deformation laws during metal pressure processing makes it possible to utilize materials in the most efficient way. By correctly selecting hot and cold processing regimes, it is possible not only to obtain the required shape, but also to improve the mechanical properties of the part and reduce its production cost several times.

References:

1. Abdullaev F.S., Maxkamov Q.X. Metallarga bosim bilan ishlov berish asoslari. O‘quv qo‘llanma. – T.: TDTU, 2000. - 400 b.

2. Larin S.N., Chudin V.N., Pasynkov A.A. Upsetting of edge thickening on housings under non-stationary viscoplastic deformation // Non-ferrous metals. 2020, v.7, pp. 88–78.

3. Лосов М.Г. Теория пластической деформация металлов. Учебное пособие. – Самара.: Изд-во СГАЕУ, 2010. - 175 с.