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HARDENING OF THE SURFACE LAYER OF SPHERICAL WORKPIECES AT THE ROLL FORMING BY A FLAT TOOL

The paper is aimed at forecasting of hardening of the surface layer of spherical parts using the scheme of rolling by flat surfaces, on the basis of experimental studies of strain hardening layer depth.

Spherical billet of pure titanium VT1-0 was tested. To create significant strain and significant refinement of the structure in the layer of hardening, rolling of a sphere by flat tools was applied. Microhardness was measured by PMT-3 device.

The depth distribution of hardness of the surface layer of the ball was measured by PMT-3 and calculated by the method developed by us. The hardness values obtained experimentally agreed satisfactory at the depth of 0.2 mm. At lower depth, actual hardness values exceed the estimated ones.

The differences in the calculated and measured values of the microhardness of the surface layer up to 0.2 mm thick are explained, apparently, by the fact that in our experiments, the balls to be rolled were processed by conventional lathe turning. Thus the deviation from the spherical form was 0.2–0.25 mm. The deviation from the spherical form of a workpiece after rolling was ~ 0.03 mm. The deformation of the surface layer ~ 0.2 mm thick substantially exceeded the deformation of the underlying layer.

The developed method for calculating the stress-strain state can predict with reasonable accuracy the parameters of strain hardening in spherical blanks after rolling by flat surfaces at the depth exceeding the deviation from sphericity of the original piece.

The technology of the rolling of spherical workpieces by flat surfaces is promising for obtaining fine and nanocrystal structure in the surface layer.

Keywords: pure titanium, endo-articular hip, rolling, depth of deformation, increase of surface layer hardness

Fig. 1. The scheme of rolling of a spherical workpiece by flat surfaces

Fig. 2. The structure of the surface layer of the spherical workpiece of VT1-0 after the rolling by flat surfaces (*a*) and micro-hardness distribution in the superficial layer of the sphere: ○ – obtained by PMT-3 with four-sided pyramid; ♦ – obtained by «Micron-gamma» device using Berkovich pyramid

Fig. 3. The scheme of the plastic region

Fig. 4. Accumulated deformation increment Δe_i at the fixed depth of the layer h

Fig. 5. Deformation Δe_i at the end of plastic region: *а* – isolines, *б* – width change at varied depth h, mm: *1* – 0, *2* – 0.2, *3* – 0.4, *4* – 0.6, *5* – 0.8, *6* – 1.0

Fig. 6. Distribution of hardness in the surface layer of a ball of VT1-0 after rolling: ● – 50 g, ▪ – 200 g, ▲ – theoretical values