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Rational Methods of Plastic Deformation Providing Formation of Ultrafine-Grained Structure in Large-Sized Products

F.Z. Utyashev, A.V. Botkin, E.P. Volkova, R.Z. Valiev

Ufa University of Science and Technology, Ufa, 450076, Russia

Received: March 14, 2024 Corresponding author: E.P. Volkova

Abstract. Based on the peculiarities of plastic deformation mechanics and physical mesomechanics, the processes are considered and technological schemes for their realization are proposed to ensure the formation of ultrafine-grained structure in axisymmetric products of large sizes. Deformation of coarse-grained materials in temperature-velocity conditions of superplastic deformation and methods of severe plastic deformation are taken as methods of preparation of such a structure. All of these deformations include large strain, and they are carried out at low hydraulic press speeds, but at different temperatures: in the mode of superplasticity at hot temperatures, and in the mode of severe plastic deformation at warm or cold temperature deformation. The first mode allows grains to be refined to microcrystalline sizes of 1–10 microns, and such a material acquires the ability to deform in a state of superplasticity, i.e., in tension with low resistance to deformation and high elongation. The second mode (severe plastic deformation) refines grains to submicro- (1÷0.1 μm) and nanosizes (less than 0.1 μm), thus giving metal materials record structural strength, as well as the possibility to use processing in extended temperature-velocity conditions of superplastic deformation in comparison with microcrystalline structure.

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