The characteristics of the microstructure anisotropy of the plastically deformed material

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Final properties of formed steel or another alloy pieces are affected even by plastic deformation of material. Therefore it is needful to know detail structure changes of material under conditions of plastic deformation caused by forming, milling, turning, grinding, drilling etc. Estimation of the deformation based on its observable macroscopic effects doesn't correspond fully with microscopic structural changes in whole volume of deformed parts and such estimation is quite impossible in case if only surface layers are deformed. In case of plastic deformation a non deformed isometric structure will take an anisometric status. In the polycrystalline material (metal, alloy) the main microstructural parameter is grain boundary – surface interface between individual grains. In case of isotropic structure the grains have isometric dimension mean grain size or size distribution of grains is sufficient specific surface area of grain boundaries can be measured. In case of anisotropic structure the grains have anisometric dimension, it is necessary to describe their anisotropy [1]. Grains boundaries orientation is the same as direction of deformation and due to it in most of deformation processes prior knowledge of the axes of orientation are known. It allows scalar measurement of anisotropy – to determine degree of orientation. The anisotropic microstructure is decomposed into isotropic, planar and/or linear oriented components - specific surface area of grain boundaries and these parameters are measured using stereology [2]. Degree of grain boundary orientation can be used for estimation of local plastic deformation. Real state of grain shape is quit impossible to describe [3], therefore model of conversion of degree of grain boundary orientation to deformation based on an idealized shape of grains has been proposed. Our conversion model is independent on an initial grain size (as it is in another model [4]) – strain depends only on the shape of the grain and does not depend on its dimension. It allows experimental estimation of local plastic deformation by means of measurement of anisotropy of structure - grain boundary orientation in various areas of plastically deformed parts.

This work was supported by the VEGA Grant No. 1/0477/14 of the Grant Agency of the Slovak Republic Ministry of Education

[1] C.S. Hartley, Strain and the quantitative characterization of anisotropic microstructures, Metallurgical and Materials Transactions A: Physical Metallurgy and Materials Science 37 (2006) 3531-3539.

[2] S.A. Saltykov, Stereometric metallography, third ed., Metallurgia, Moskva, 1970.

[3] P.R. Riosa, M.E. Glicksmanb, Modeling polycrystals with regular polyhedra, Materials Research 9 (2006) 231-236.

[4] Q. Zhu, M.C. Sellars, H.K. D.H. Bhadesia, Quantitative metallography of deformed grains, Materials Science and Technology 23 (2007) 757-766.