

Journal of Materials Science 2015 vol.50 N20, pages 6730-6738

Superior strength of carbon steel with an ultrafine-grained microstructure and its enhanced thermal stability

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Abstract

© 2015, Springer Science+Business Media New York. The paper presents the results of a study on the microstructure and mechanical properties of a medium-carbon steel (0.45 % C) processed by severe plastic deformation (SPD) via high-pressure torsion (HPT). Martensite quenching was first applied to the material, and then HPT processing was conducted at a temperature of 350 °C. As a result, a nanocomposite type microstructure is formed: an ultrafine-grained (UFG) ferrite matrix with fine cementite particles located predominantly at the boundaries of ferrite grains. The processed steel is characterized by a high-strength state, with an ultimate tensile strength over 2500 MPa. Special attention is given to analysis of the thermal stability of the microstructure and properties of the steel after HPT processing in comparison with quenching. It is shown that the thermal stability of the UFG structure produced by HPT is visibly higher than that of quenching-induced martensite. The origin of the enhanced strength and thermal stability of the UFG steel is discussed.

<http://dx.doi.org/10.1007/s10853-015-9227-2>
