Bulk nanostructured metallic materials with multifunctional properties: innovative applications and challenges in commercialization

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Multiple fundamental and experimental studies in recent years have proved severe plastic deformation (SPD) techniques as a very reliable mechanism to produce nanostructured metals and alloys with significantly improved mechanical and functional properties, the latter affected by several factors, including ultrafine grains and also the atomic structure of boundaries in resulting nanomaterials. This report presents the results of complex studies of the formation of different grain boundaries (low angle and high angle ones, special and random, equilibrium and non-equilibrium with strain-distorted structure as well as with the presence of grain boundary segregations and precipitations) in nanostructured materials processed using SPD with various regimes and routes. This entails the materials with superior multifunctional properties, i.e. the combination of high mechanical and functional properties (corrosion and radiation resistance, electrical conductivity, etc.) that are induced by grain boundary design. Particular emphasis is laid on the physical nature and the use of multifunctional nanomaterials in products that are presently or will soon become available for their innovative applications in medice and engineering as well as some challenges in their commercialization.