Using high pressure torsion to produce novel materials with exceptional properties

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Abstract

Statement of the Problem: Novel materials with superior properties are continuously required in many industrial sectors. Nowadays, ultrafine grained (UFG) and nanocrystalline materials have attracted growing scientific interest as they exhibit properties not achievable for conventional counterparts. UFG and NC materials are often fabricated using SPD methods, which are based on the concept of transformation of microcrystalline structures into fully developed nanocrystalline ones by reorganizing the dislocation structures formed during plastic deformation. Among SPD methods, high pressure torsion (HPT) is appreciated by many researchers as the one that allows the most efficient grain refinement. However, HPT can be used not only to refine the grains size of conventional metals and alloys but also to produce novel hybrid metallic systems (including immiscible ones) and metal matrix composites reinforced with nanoparticles (2D and 3D).

In the present communication, 4 cases will be reported and discussed:

1. β titanium alloys for biomedical applications;
2. Al-Ti hybrid systems with exceptionally high mechanical strength;
3. Al-CNTs and Al-graphene nanocomposites with enhanced electrical conductivity and thermal stability;
4. Cu-Mo nanocomposites with tailored thermal conductivity.

Conclusion & Significance: The results demonstrate the potential for using HPT processing at room temperature to create advanced microstructures and excellent mechanical properties, enhanced functional properties as well as thermal stability that are not generally achievable through other processing routes.

Image

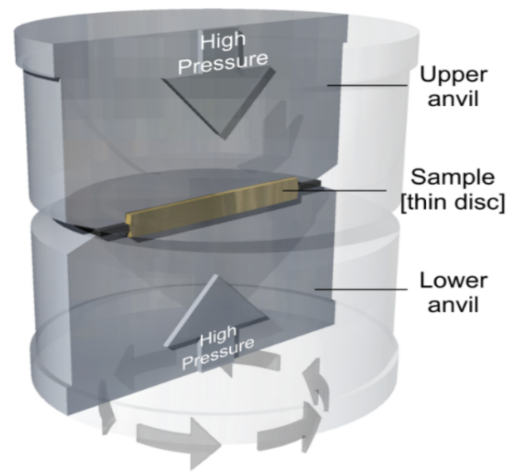

Fig. 1 The principle of HPT processing.

Recent Publications

1. M. Emerla, P. Bazarnik, Y. Huang, M. Lewandowska, T.G. Langdon (2023) J. Alloys Comp. 968:171928.
2. P. Bazarnik, A. Bartkowska, Y. Huang, K. Szlązak, B. Adamczyk-Cieślak, J. Sort, M. Lewandowska, T.G. Langdon (2022) Mater. Sci. Eng. A833:142549.
3. A. Bartkowska, P. Bazarnik, Y. Huang, M. Lewandowska, T.G. Langdon (2021) Mater. Sci. Eng. A799:140114
4. Y. Huang, P. Bazarnik, D. Wan, D. Luo, P.H.R. Pereira, M. Lewandowska, J. Yao, B.E. Hayden, T.G. Langdon (2019) Acta Materialia 164:499-511.
5. K. Sharman, P. Bazarnik, T. Brynk, A. Gunay Bulutsuz, M. Lewandowska, Y. Huang, T.G. Langdon (2015) J. Mater. Res. Tech. 4:79-83.

Photograph

Biography

Malgorzata Lewandowska – professor at the Faculty of Materials Science and Engineering of Warsaw University of Technology. Her scientific interest is focused on ultrafine grained and nano-crystalline metals. She is in particular interested in the microstructure evolution during processing by severe plastic deformation as well as post-processing phenomena such as precipitation, joining and surface modification. She combines experience in material processing with the expertise in materials characterization in nano-scale using advanced microscopic techniques. She co-authored over 240 scientific papers published in renowned materials science journals. She is one of the World's TOP 2% Scientists (TOP 2% most cited scientists), according to the list announced by Stanford University in collaboration with Elsevier.

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