

The workshop summary. A vision for further studies.

On July 30, 2019, the Laboratory for Mechanics of Advanced Bulk Nanomaterials for Innovative Engineering Applications held the working meeting “Structural Features and Related Properties of Amorphous Alloys with High Defect/Interface Density” in the framework of DFG and SPbU cooperation.

The announcement, the scientific program and the abstracts of the workshop can be found on the Laboratory website: <http://nanomat.spbu.ru/ru/node/358>, http://www.nanomat.spbu.ru/sites/default/files/Program_30.07.19.pdf, http://www.nanomat.spbu.ru/sites/default/files/Abstracts_30.07.19.pdf

11 participants took part in it:

1. H. Hahn (KIT, Karlsruhe, Germany)
2. J. Ivanisenko (KIT, Karlsruhe, Germany)
3. A. Kilmametov (KIT, Karlsruhe, Germany)
4. L. Velasco (KIT, Karlsruhe, Germany)
5. G. Iankevich (KIT, Karlsruhe, Germany)
6. R.Z. Valiev (SPbU, St. Petersburg, Russia)
7. D.V. Gunderov (SPbU, St. Petersburg, Russia)
8. E.V. Boltynjuk (SPbU, St. Petersburg, Russia)
9. N.A. Kazarinov (SPbU, St. Petersburg, Russia)
10. A. Bazlov (MISiS, Moscow, Russia)
11. V. Astanin (USATU, Ufa, Russia)

Following the workshop, a discussion on future prospects of DFG-SPbU cooperation was held. The discussion included following topics:

- Preparation of joint articles in top rated journals; preparation and publication of minimum 2 articles by the end of this year from Russian side
- The issue of grant №6.65.43.2017 extension for the next year for Russian side
- Submission of joint applications for future projects
- The issue of program for further joint research

Three themes are most important for solving these tasks.

1. Analysis of shear band formation under HPT conditions by means of TEM studies of Vitreloy 105 BMG

TEM studies of shear bands in Vitreloy, which were recently carried out by Dr. L. Velasco, have shown that their visualization is highly dependent on oxidation process. Collaborative work is going on for publishing the article concerning the results of these studies.

As the next step, comparative analysis of the shear bands appearance should be done for other amorphous alloys subjected to HPT, in particular for TiNiCu system. In addition, Dr. E. Ubyivovk should complete the publication on TEM observations of shear bands formation in Zr₆₂-based BMG subjected to HPT processing.

Responsible scientists for this task are Leonardo Velasco and Evgeniy Ubyivovk.

2. Strain rate sensitivity measurements using nanoindentation and micropillar compression tests

Study of strain rate sensitivity of nanoglasses and HPT-processed metallic glasses is a subject of high interest. The nanoglass produced from plates of Vitreloy 105 will be used for such studies. Different states of Vitreloy system, namely as initial BMG, nanoglass and HPT-processed alloys, should be used for comparative studies of their mechanical properties.

Values of strain rate sensitivity (SRS) can be obtained via nanoindentation (group of Prof. Yu.I. Golovin, Tambov) or micropillar compression test (using facilities of INT). Comparison of values of SRS obtained by both these methods even on conventional metallic glass is of interest. Literature on this topic should be studied. We need to determine optimal or required diameters of micropillars for SRS measurements due to effects of sample size on strength and ductility.

Values of hardness, Young's modulus, shape of indentation P-h curves should be obtained under different indentation/compression strain rates. It will allow determining the values of strain rate sensitivity and sizes of shear transformation zones (STZ) using cooperative shearing model. DSC tests are required to determine glass transition temperature for STZ's estimation.

Samples for measurements (nanoglasses and HPT-processed BMGs) should be stored at the same conditions and studied about the same time due to effect of oxidation observed by L. Velasco.

Evgeniy Boltynjuk is currently preparing the publication on this subject concerning Zr₆₂-based BMG subjected to HTP.

Responsible scientists for this task are: Julia Ivanisenko, Evgeniy Boltynjuk.

3. Study of density and morphology of shear bands in nanoglasses and BMG during HPT processing

This study requires three samples. The first – the initial Vitreloy. The second – Vitreloy processed by HPT for few revolutions (e.g. 5 or 10). The third – Vitreloy-nanoglass. All samples should be of the same size. These samples should be cut into two halves or two sectors, mounted in epoxy resin, polished and fixed together using thin layer of glue. Further, all samples are subjected to the same degree of HPT-deformation of 1/10 revolution, for example. Halves should be separated, and internal surfaces could be studied using SEM and AFM.


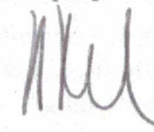
Such study will allow investigating the formation of newly formed shear bands in various states of amorphous structure. Nanoglass and HPT-processed states should contain internal shear bands and interfaces that will somehow influence on the formation of new shear bands or development of previously formed bands under further deformation. Data on shear bands morphology (density, orientation, number of various systems, etc.) will be obtained using SEM and AFM.

Responsible scientists for this task are: Dmitri Gunderov, Vasiliy Astranin.

In addition, during the working meeting there was an active discussion of other relevant issues: chemical/phase segregation processes during HTP, approaches of enhancing ductility and other service properties (wear, erosion and corrosion resistance) in amorphous alloys by HTP processing.

These issues are the subject of further research within the framework of this project.

The meeting co-chairmen

 H. Hahn,
 R.Z. Valiev

The meeting coordinator

 A.A. Martyusheva