Title of Project : Bulk Nanostructured Metals

Term of Project : FY2010-2014

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【Purpose of the Research Project】

The purpose of the present project is to systematically clarify the unique properties (especially, mechanical properties) of bulk nanostructured metals through collaborative researches using advanced tools. 'Bulk Nanostructured Metals (BNMs)' are bulky metallic materials composed of grains and phases having sizes smaller than 1μm. Metallic materials we have widely used are polycrystalline materials composed of many grains, but the minimum grain size we could achieve has been about 10 μm. In BNM, however, fraction of grain boundaries greatly increases with decreasing grain size, as shown in Fig.1. BNMs are considered as the materials full of grain boundaries. As a result, BNMs show various unique properties that cannot be explained by conventional theories in materials science. For example, BNMs show the strength four times higher than that of conventionally grain-sized materials, so that even pure aluminum can be as strong as iron.

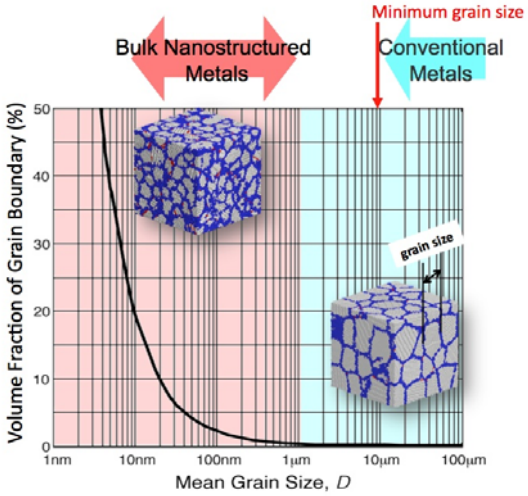

Fig.1 Volume fraction of grain boundaries as a function of mean grain size. BNMs are full of grain boundaries, while conventional metals are rare of grain boundaries.

【Content of the Research Project】

Figure 2 shows basic scheme of the present project. The project team involves 28 scientists of 18 different universities and organizations in Japan, and they belong to either group A01, A02 or A03. The target of each group is 'structure design of BNMs', 'fabrication process of BNMs', and 'mechanical properties of BNMs', respectively, and each group is composed of experimental team and theoretical team. State of the art in the fields of computational simulation and nanostructure analysis of materials is used in the project.

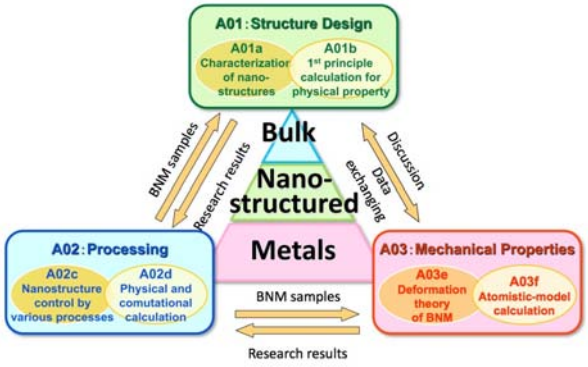

Fig.2 Scheme of the project.

【Expected Research Achievements】

The project would systematically clarify the various unique properties of BNMs together with the mechanisms, so that many common-sense knowledge in materials science and engineering would be revised. Especially, it is expected that the theory to draw the whole mechanics of nanostructured metals is constructed beyond the conventional dislocation theory. The project results would give a great impact on our society as well, since metallic materials are widely used in all technologies of modern world.

【Key Words】

Grain, Phase: Unit constructing bulky polycrystalline materials, within which alignment of atoms and physical properties are the same.
Grain Boundary: Boundary between grains, where periodical alignment of atoms are significantly disordered.
Dislocation: One-dimensional defect in crystal, of which motion governs plastic deformation.

【Homepage Address】

http://www.bnm.mtl.kyoto-u.ac.jp/