Award

Zenji Horita	May 2011, Light Metal R&D Furtherance Medal, Japan Institute of Light Metals
Zenji Horita	April 2011, The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, Prizes for Science and Technology (Research Category)
Nobuhiro Tsuji	April 2011, The 2011 Sydney H.Melbourne Award, SAE International.
Hiromi Miura	March 2011, Scientific Achievement Commemorative Prize (Nishiyama Commemorative Prize), Iron and Steel Institute of Japan
Tomotsugu Shimokawa	November 2010, Best Poster Award, (the 2nd prize), International Symposium on Giant Straining Process for Advanced Materials (GSAM2010)
Hiromi Miura	November 2010, The Best Paper award, Journal of Japan Research Institute for Advanced Copper-Base Materials and Technologies
Hiromi Miura	November 2010, Distinguished Contribution Award, Journal of Japan Research Institute for Advanced Copper-Base Materials and Technologies
Alexei Vinogradov	November 2010, Best Paper Award, the 20th International Acoustic Emission Symposium (IAES-20)
Yoshiteru Aoyagi	September 2010, Young Scientist Award, International Symposium on Explosion, Shock wave and High-energy reaction Phenomena 2010 (3rd ESHP Symposium),
Akinobu Shibata	September 2010, Young Researcher Award (Microstructures), The Japan Institute of Metals
Shigenobu Ogata	September 2010, The Best Paper Award (Materials Physics), The Japan Institute of Metals
Hiromi Miura	September 2010, The Best Paper Award, The Japan Institute of Metals (Materia Japan)

Press

[1] Nikkei Sangyo newspaper, 7 July, 2010, “The University of Electro-Communications develop High Strength Magnesium alloy with good formability", Hiromi Miura.
[2] Chemical boutique (web site), 23 July, 2010, “Lightweight and high strength magnesium alloy which is developed by Multi-Directional Forging (MDF) process", Hiromi Miura.
[3] Nikkei Sangyo newspaper, 10 January, 2011, “The University of Electro-Communications develop Highest Strength Magnesium alloy without rare-earth element", Hiromi Miura.
[4] Journal of Japan aeronautical engineers, January, 2011, “A magnesium alloy which exhibits higher strength than that of A7075", Hiromi Miura.
[5] Radio Japan Focus, New Technology for the Age of Rare Metal(NHK radio), 7 February, 2011, “No Rare Earth Metals Required! An Ultra-strong Magnesium Alloy", Hiromi Miura.

New Project Members in 2011-2012 Name (Affiliation), Subject of research

A01	Terukazu Nishizaki	Tohoku University
	Superconducting properties in bulk nanostructured metals studied by low-temperature nanoprobe microscopy and transport measurements	
	Yukio Takahashi	Osaka University
	Structure Analysis of Bulk Nanostructured Metals by Coherent X-ray Diffraction	
	Hiroaki Nakano	Kyushu University
	Control of corrosion resistance factor of ultrafine-grained aluminum alloys processed by severe plastic deformation	
	Minoru Nishida	Kyushu University
	Grain boundary control and analysis in bulk nanostructured Ti-Ni alloys	
	Masato Ueda	Kansai University
	Static/dynamic analysis of lattice defects by extra-precision electrical resistivity measurements	
	Hirotaka Kato	Fukui National College of Technology
	Clarification of the unique tribological behavior in Bulk Nanostructured Metals	
A02	Hee Young Kim	University of Tsukuba
	Fabrication of Bulk Nanostructured Metals through stress induced phase transformation and clarification of physical properties	
	Hiroyuki Miyamoto	Doshisha University
	Synthesis of nanostrucutred nickel with oxide nanoparticles by electrodeposition	
	Seiichiro ii	National Institute for Materials Science
	Grain boundary character control of bulk nanostructured metals with chemical interaction	
	Ikumu Watanabe	National Institute for Materials Science
	Multiscale analyses of severe plastic forming	
	Tadahiko Furuta	Toyota Central R&D Labs., INC
	Strengthening of Bulk Nanostructured Metals with elastic anomaly up to ideal strength	
A03	Hiroyuki Sato	Hirosaki University
	Evaluation of long term deformation characteristics by strain acceleration parameter and microstructures	
	Yoji Mine	Kyushu University
	Simultaneous enhancement of strength, ductility, and fatigue properties in hydrogen environment in bulk nanostructured austenitic stainless steels	
	Hidenari Takagi	Nihon University
	Creep characterization of the bulk nanostructured metals	

Latest information

< International Meeting >

Ultrafine Grained Materials VII, 2012 TMS Annual Meeting & Exhibition March 11-15, Orlando, FL, (2012) http://www.tms.org/annualmeeting.html.

< Domestic Meeting >

Meeting of A01(a) Research Group September 3, 2011, Kyoto, Japan http://www.bnm.mtl.kyoto-u.ac.jp/index_e.html

The Japan Institute of Metal (JIM) Seminar "Bulk Nanostructured Metals" September 14, 2011, Tokyo, Japan
http://www.sendai.kopas.co.jp/METAL/EVENTS/seminar/017.html

Meeting of All Research Groups September 30 - October 1, 2011, Fukuoka, Japan http://www.bnm.mtl.kyoto-u.ac.jp/index_e.html

The 55th Japan Congress on Materials Research,
OS3: Bulk nanostructured metals as advanced structural and functional materials, October 19-21, 2011, Kyoto, Japan http://www.jsms.jp/kaikoku/55zaiboshu.htm

"Bulk Nanostructured Metals" Symposium in 2011 Annual Autumn Meeting of The Japan Institute of Metals November 7-9, 2011, Okinawa, Japan
http://wwwsoc.nii.ac.jp/jim/An-Me/2011_Fall-index.html

Contact Address
Nobuhiro TSUJI, Professor Dept. Materials Science & Engineering, Graduate School of Engineering Kyoto University
Yoshida Honmachi, Sakyo-ku, Kyoto, 606-8501, Japan
TEL: +81-75-753-5462 FAX: +81-75-753-4978 e-mail:nobuhiro.tsuji@ky5.ecs.kyoto-u.ac.jp

BNM August 2011 NEWS LETTER No.1
http://www.bnm.mtl.kyoto-u.ac.jp/

Bulk Nanostructured Metals

Project Leader : Nobuhiro Tsuji (Kyoto University)

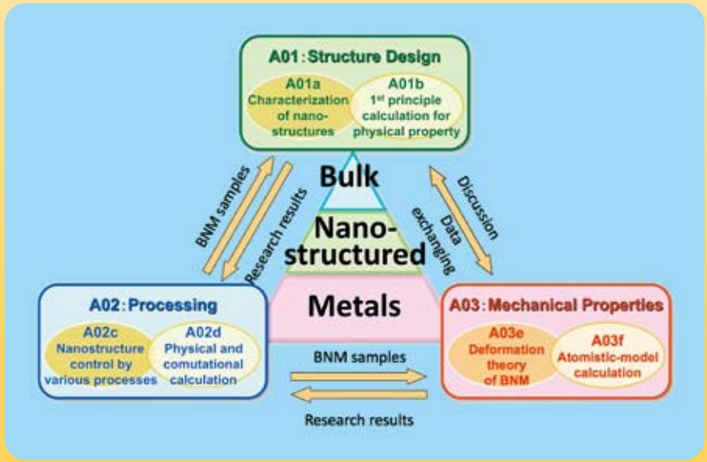
Since September 2010, we have started a new research project “Bulk Nanostructured Metals” supported by the Ministry of Education, Culture, Sports, Science and Technology. The program is categorized in the Innovative Area of the Grant-in-Aid for Scientific Research (*Kakenhi*, in Japanese), and a five-year project ending in March 2015. We are going to issue News Letters periodically as a part of the activity of the program.

Most of the metallic materials we are widely using in our society are polycrystals which consist of a large number of grains having different crystal orientation. It is empirically known that various properties of polycrystalline metals are improved by grain refinement. Accordingly, the refinement of grains through conventional thermomechanical processes have been always an important issue in metallic materials. So far, however, the minimum grain size of bulky metallic materials we could achieve have been about 10 μm. From a simple calculation, the volume fraction of grain boundaries in the polycrystal with the mean grain size larger than 10 μm is expected to be almost 0 %. This indicates that the most of metallic materials we have conventionally used are polycrystals with “rare of grain boundaries”. In contrast, the volume fraction of grain boundaries greatly increases when the grain size becomes smaller than 1 μm. We determine the bulky polycrystalline materials composed of matrix grains or phases having sizes smaller than 1 μm as “Bulk Nanostructured Metals (BNM)”. The BNMs are considered as the materials “full of grain boundaries”. Because atomic configuration around grain boundary is different from the periodical one inside a grain, the BNMs are expected to exhibit peculiar properties that have never seen in conventional metallic materials. For example, BNMs exhibit strength four times higher than the same materials with conventional grain sizes. As a result, aluminum can be as strong as steel, for example. Furthermore, it is also possible to manage both high strength and large ductility or/and toughness in some kinds of BNMs, though strength and ductility/toughness are in trade-off relationship in conventional materials. BNMs also show unique mechanical properties that have never found in conventional metals. In addition, high density of grain boundaries and other lattice defects increase the free energy of system, leading to peculiar solid-solid reactions, i.e., phase transformation, precipitation, and recrystallization. As the peculiar phenomena in BNMs is attributed to the high density of grain boundaries, they can appear even in pure metals or low alloy materials. Accordingly, BNMs can become the promising structural materials in future, with simple chemical compositions that lead to nice recyclability as well. It is also expected that the BNMs can give a discontinuous and drastic development in the field of metallic materials, and can give a big impact on our society.

The goal of the research project is to systematically clarify the relationship between the peculiar properties of BNMs and their structures through close collaboration of researchers in various fields. During the research period, the project focuses on three topics shown below;

(1) Structure design of BNMs (Group A01)
(2) Fabrication process of BNMs (Group A02)
(3) Mechanical properties of BNMs (Group A03)

The targets of the groups A01, A02, A03 in the project and the relationship between the groups are illustrated in the figure shown below. The project also aims to establish new and innovative areas of materials science through integrating the experimental results and theoretical/numerical results. Recently, development of the state of the art nanostructure analysis in materials science, such as three dimensional transmission electron microscopy tomography, three dimensional atom probe, etc, is remarkable, and the project involves such novel techniques. Large-scale computer simulation based on atomic models is used within the project as well. Each A01, A02, A03 group consists of 2 sub-groups: one is focusing on experimental studies, the other on theoretical and simulation studies. Whole of the research project aims to create new methodology and research fields in novel materials science through integrating experimental studies and simulation studies.

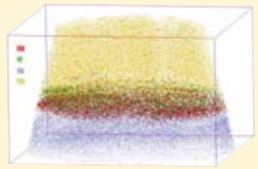


A01(a) Structure Design and Characterization of Bulk Nanostructured Metals

Nobuhiro Tsuji (Kyoto University), Kazuhiro Hono (National Institute for Materials Science), Satoshi Hata (Kyushu University), Yoshikazu Todaka (Toyohashi University of Technology), Rintaro Ueji (Kagawa University), Daisuke Terada (Kyoto University), Akinobu Shibata (Kyoto University)

The aim of this group is to establish the concepts for structure design of the bulk nanostructured metals, that perform excellent mechanical properties, such as managing both high strength and large ductility/toughness. One of the interesting and unknown subjects in bulk nanostructured metals is phase transformation and precipitation from nanostructured mother phase. To clarify such solid-solid reactions in bulk nanostructured metals would lead to new concepts for structure control and creation of non-equilibrium phases. Control of grain boundary character, such as introduction of coherent twin boundaries, is another challenging topic in the group. The group involves specialists of nanostructure analysis using various advanced techniques, i.e., 3D-tomography in TEM, HREM, 3D Atom-Probe, and so on. Quantitative analysis of the structures of bulk nanostructured metals fabricated through the concept of materials design, which is proposed by A01 group, is correlated with their mechanical properties, which would contribute to drive the research in groups A02 and A03.

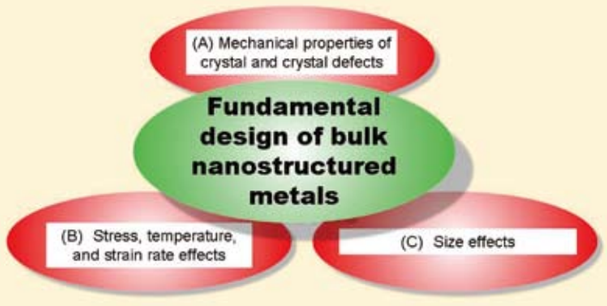
Martensite Transformed from Nanostructured Austenite


3D Atom-Probe

A01(b) First-Principles Computational Design for Bulk Nanostructured Metals

Shigenobu Ogata (Osaka University), Masanori Kohyama (National Institute of Advanced Industrial Science and Technology), Hajime Kimizuka (Osaka University), Shingo Tanaka (National Institute of Advanced Industrial Science and Technology)

We clarify the underlying mechanism governing the unique mechanical properties of bulk nanostructured metals on the basis of first principles and multiscale modeling approaches, and establish universal theoretical and computational frameworks for quantitative design of new bulk nanostructured metals. We tackle wide range of problems pertain to the mechanical properties, e.g., impurity, temperature, strain rate, grain shape and grain size effects to the plastic deformation properties, using density functional theory based electronic structure analysis, atomistic modeling and more coarse-grained deformation field analyses.

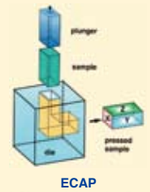


A02(c) Production of Bulk Nanostructured Metals

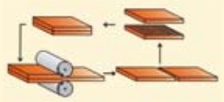
Zenji Horita (Kyushu University), Koichi Tsuchiya (NIMS), Kei Ameyama (Ritsumeikan University), Tohru Yamasaki (University of Hyogo), Hiromi Miura (University of Electro-Communications)

The aim of this group is to produce bulk nanostructured metals using various forms of processing methods as illustrated in the figure. One form makes use of severe plastic deformation (SPD) and the other of electrodeposition (ED). We investigate mechanisms how nanostructured grains are attained by SPD and compare with the mechanical and functional properties with those produced by ED to examine how the processing procedures affect the resultant properties. Our group has also an important task to provide nanostructured materials to other groups so that it is possible to correlate between microstructural states and their properties.

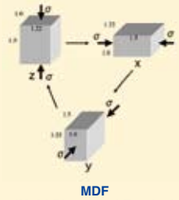
<SPD>



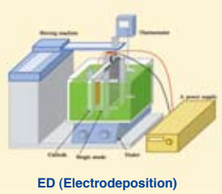
ECAP
(Equal-Channel Angular Pressing)


ARB (Accumulative Roll Bonding)


HPT (High-Pressure Torsion)


MDF
(Multi Directional Forging)

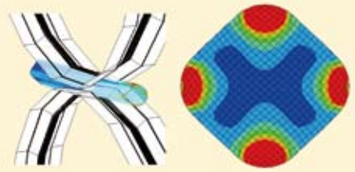
<ED>


ED (Electrodeposition)

A02(d) Physical and numerical simulations on the processing of bulk nanostructured metals

Jun Yanagimoto (The University of Tokyo), Tadanobu Inoue (National Institute for Materials Science), Noriyuki Tsuchida (University of Hyogo), Akira Yanagida (Tokyo Denki University)

In order to clarify the window for the processing of bulk nanostructured metals, the formation mechanism should be quantitatively investigated through experimental and numerical approaches. This research group aims at revealing the effects of the mode of severe plastic deformation (SPD), such as severe shear deformation, severe reciprocating deformation and severe combined deformation, on the formation of bulk nanostructured metals and their mechanical properties, mainly focusing on the nanostructuring of metals through transformation after various hot SPDs. Physical simulation methods, numerical simulation methods and evaluation methods are now being investigated to meet the target of above objectives of this group.

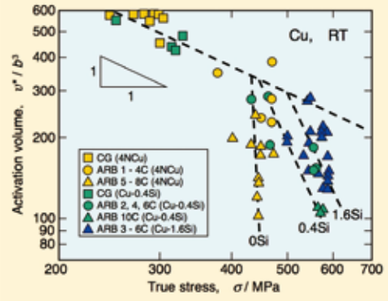

Numerical simulation on groove rolling

Physical simulation on severe shear deformation

A03(e) Mechanical Properties and Deformation mechanisms

Masaharu Kato, Susumu Onaka (Tokyo Institute of Technology), Yo Tomota (Ibaraki University), Yoshihisa Kaneko (Osaka City University), Masaki Tanaka (Kyushu University), Naoya Kamikawa (Tohoku University)

Mechanical properties and deformation mechanisms of bulk nanostructured metals (BNMs) are being studied. Experimental and theoretical studies on structure-property relationship, temperature and strain-rate effects on deformation and fracture, quantification of defects, etc. are considered to be essential to reveal the deformation mechanisms of BNMs. Upon investigating the activation volume of ARB-processed Cu and Cu-Si alloys, we have found that the stress dependence of the activation volume reflects a dislocation-mediated deformation mechanism that takes place either in grain interiors or at grain boundaries.



Activation volume of BNM Cu changes with addition of Si.
(Kunimine et al., *J. Mater. Sci.*, 46, 4290-4295 (2011).

A03(f) Development of Complicated Interior Lattice Defects in Bulk Nanostructured Metals by Atomic and Continuum Simulations

Tomotsugu Shimokawa (Kanazawa University), Yoshiteru Aoyagi (Japan Atomic Energy Agency)

In bulk nanostructured metals, the volume fraction of grain boundary and interface (plane defects) rapidly increases. Thus, it is very important to investigate the development of lattice defects through grain boundaries, which is closely related with the anomalous mechanical characteristics of BNMs. In this group, the development of complicated interior lattice defects in BNMs is expressed by the large-scale calculation by the atomistic model which can directly express atomic structure of grain boundary (molecular dynamics) and the continuum modeling considering the effect of grain boundaries (crystal plasticity theory), and we investigate the grain size dependence of the following phenomena: (1) dislocation emissions from grain boundaries, (2) the crack tip plasticity based on the interaction between dislocations and grain boundaries, and (3) the propagation mechanism of the plastic deformation based on the formation and dissipation of lattice defects.