Proposal for 2010-2011 Faculty Grants for International Connections

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Background and Rationale

A new type of alloy called Gum Metal has been developed from a Titanium alloy by Drs. Kuramoto and Furuta at Toyota Central R&D laboratories, Aichi, Japan. Unlike conventional alloys, the Gum Metal exhibits very unique properties such as super elasticity and super plasticity just like rubbers (this is why the name "Gum Metal" comes from). They also discovered similar super elastic peoperty in iron-base alloys. Recently, Prof. Horita at Kyukyu Univerisity, Fukuoka, Japan applied special processing called severe plastic deformation (SPD) to both Ti- and Fe-based Gum Metals and found that the strength of these alloys is significantly improved (~twice of conventioal alloy) after applying the SPD process. However, the reasons to exhibit such rubber-like super elasticity are still unknown and the mechanisms of strength enhancements in the SPD-processed materials are not revealed at all. Last fall, Prof. Horita contacted me in characterization of microstructures in the Gum Metals to understand their unique properties using Lehigh's state-of-the-art aberration-corrected electron microscopes. Then, we have started collaboration to study the Gum Metals.

At this moment, the author does not have any chance to see the materials fabrication and the SPD processing. Obviously, it is very important to see the orignal fabrication and following processing for understanding materials' nature. Therefore, the author is seeking a funding opportunity (1) to establish stronger network among reseachers at Industory R&D lab and at University in Japan, (2) to view a whole map of fabrication and processing of the materials, (3) to show Lehigh's characterization capabilities. Based on this initial contact with these researchers, the author will seek research fundings, such as the Materials World Network program in National Science Foundation (NSF) and the Basic Science program in Department of Energy (DOE) in this fall. Furthermore, we are planning to exchange graduate students between Kyushu and Lehigh for mutual education once the project is funded. This international connection will be utilized as a keystone for future collaboration on the Gum metals.

Expected outcomes

- Short term: (1) establishment of stronger research network on the Gum Metal study, (2) Understanding of complete process from fabrication through SPD of the materials, (3) demonstration of Lehigh's characterization capability and (4) publication of peer review papers from the collaboration.

- Long term: (1) seeking appropriate funding opprtunities for international collaboration, (2) possible exchange of graduate students between Kyushu and Lehigh Universities and (3) optimization of the Gum Metal processing for further improvements of mechanical properties in proctical applications.

Institutions to visit

- Prof. Zenji Horita, Kyushu University, Fukuoka, Japan.
- Drs. Shigeru Kuramoto/Tadahiko Furuta, Toyota Central R&D Labs., Aichi, Japan.

Pre-trip planning

The author has already recieved several Gum Metal specimens from Prof. Horita. So, before travelling, the author will conduct some preliminal characterizations of those specimens using Lehigh's aberration-corrected electron microscopes. When the author visits to Kyushu University and Toyota Central R&D laboratories, we will discuss the preliminal results. Futhermore, they are expecting several seminars from the author on the latest characterization procedure in the aberration-corrected electron microscopes. So, the author will prepare several talks and possiblly one or two practical lectures on electron microscopy for undergraduate and graduate students in Kyushu University

Expected follow-up

Besides preparation of report of this trip, the author will compose an original research article based on the preliminary results taken from Lehigh for publication. In addition, the author will prepare at least one research funding proposal either to NSF or to DOE based on for fall submission to expand the collaboration.

Proposed schedule and budget

- July/9/'10: Departure to Fukuoka, Japan and arrival on July/10.
- July/11-17: Visiting to Kyushu University, Fukuoka Japan.
- July/18-20: Visiting to Toyota Central R&D laboratories, Aichi, Japan
- July/21-22: Revisiting to Kyushu University, Fukuoka Japan.
- July/23/'11: Returning to Lehigh

Air fair (round trip to Fukuoka via Naria): $1,400.00

Transportation (round trip between Fukuoka and Aichi): $300.00

Hotel (at Fukuoka: $80.00 x 10 nights and at Aichi $100.00 x 3 nights): $1,100.00

Meal ($50/day x 14 days) : $700.00

Total: $3,500.000

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Feb. 7, 2011

Professor Masashi Watanabe
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Dear Professor Watanabe,

Thank you very much for contacting me on your possible visit to our department in July. You are very welcome to visit us. As you requested, I am very happy to show our facility to apply severe plastic deformation (SPD) process to materials. As you know, we have developed various SPD processes. I think it would be mutual benefits to show our facility to you since I believe that knowing the whole process would bring more idea on materials' nature during characterization in your University using the state-of-the-art aberration corrected electron microscopes. I would like to see your preliminary results taken from our specimens, especially of Fe-based super elastic alloy. We should discuss the results and future direction of our collaboration on the Gum Metals. During your visit, I also expect you to give us several seminar talks not only in my research group but also for undergraduate and graduate students in my department. Personally, I would like to see the latest updates of advanced characterization techniques in transmission electron microscopy.

In addition, I will take you to Toyota Central R&D laboratories, Aichi, Japan tentatively between July 18th and 20th, to introduce Drs. Shigeru Kuramoto and Tadahiko Furuta who originally developed Ti- and Fe-base Gum Metals. We will also discuss your characterization capabilities at Lehigh University, your preliminary results and future plans of our collaborations at Toyota Central R&D laboratories as well.

I look forward to seeing you in July.

Best regards

Zenji Horita

Zenji Horita
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