AOARD REPORT

Trip Report - Kyoto University and Kyoto Institute of Technology (8-10 Mar 94)

Mar 8-10, 94
P. McQuay
AOARD

Report summarizes meetings with Professor Z. Maekawa of the Kyoto Institute of Technology, Professors Masuharu Yamaguchi and Yasuharu Shirai of the Department of Metal Science and Technology of the University of Kyoto, and Professors Mikio Takano, Teruya Shinjo of the Institute for Chemical Research, University of Kyoto. Prof Maekawa is well known in Japan in the field of polymer science, especially in Fiber Reinforced Plastics (FRP). He is the Chairman of the '95 Japan SAMPE International Conference and Exhibition. Prof Maekawa expressed an interest in pursuing some kind of support from AOARD. Prof Yamaguchi has conducted very important basic research on the deformation of lamellar gamma titanium-aluminide alloys. This work has led to some interesting concepts for the development of DS gamma alloys for turbine engine applications. Prof Takano, an expert in the field of high temperature superconductors, requested support to bring a colleague from AT&T laboratories to work with him at the Univ of Kyoto for several months.

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MEMORANDUM FOR AOARD

FROM: Capt Paul McQuay

SUBJECT: Trip Report - Kyoto University and Kyoto Institute of Technology (8-10 Mar 94)

1. Abstract: Report summarizes meetings with Professor Z. Maekawa of the Kyoto Institute of Technology, Professors Masuharu Yamaguchi and Yasuharu Shirai of the Department of Metal Science and Technology of the University of Kyoto, and Professors Mikio Takano, Teruya Shinjo of the Institute for Chemical Research, University of Kyoto. Prof Maekawa is well known in Japan in the field of polymer science, especially in Fiber Reinforced Plastics (FRP). He is the Chairman of the '95 Japan SAMPE International Conference and Exhibition. Prof Maekawa expressed an interest in pursuing some kind of support from AOARD. Prof Yamaguchi has conducted very important basic research on the deformation of lamellar gamma titanium-aluminide alloys. This work has led to some interesting concepts for the development of DS gamma alloys for turbine engine applications. Prof Takano, an expert in the field of high temperature superconductors, requested support to bring a colleague from AT&T laboratories to work with him at the Univ of Kyoto for several months.

2. Kyoto Institute of Technology (KIT), 8 Mar 94

KIT was founded in 1949 as a national university incorporating two national colleges: Kyoto College of Industry and Kyoto College of Textile Fibers, both of with date back to the turn of the century. Although KIT is the schools official name in English, it is different in meaning than the title in Japanese, Kyoto Kogei Sein Daigaku, and the English version is virtually unknown in Japan. The institute is broadly divided into two schools, the Faculty of Engineering and Design, and the Faculty of Textile Science. Within the former are the Departments of Mechanical and System Engineering, Electronics and Information Science, Chemistry and Materials Technology, and Architecture and Design. The later includes the Departments of Applied Biology,, and the Department of Polymer Science and Engineering.

Undergraduate enrollment for the 92-93 academic year was 3,362, and 649 in the graduate school. KIT offers a doctoral program in three broad areas, Applied Science for Functionality, Material Science and Information and Production Science. Polymer science, one of the major long term strengths of the school, are stressed in the first two of these programs, with 69, 31 and 29 doctoral students enrolled in each program respectively.

I met with Professor Z. Maekawa, professor of polymer science, and Dr. Gabriel O. Shonaike, a research associate in the same department on the afternoon of 8 Mar 94, on the invitation of Dr. Shonaike. I gave a brief introduction to the AOARD and its programs, which was received with some interest, particularly on the Conference Support Program (CSP). Professor Maekawa is evidently very well known in Japan in the field of polymer science, especially in Fiber Reinforced Plastics (FRP). He is the Chairman of the '95 Japan SAMPE International Conference and Exhibition. We discussed briefly the meeting, and Prof Maekawa expressed an interest in pursuing some kind of support from AOARD. One possibility, which was discussed, is for AOARD to sponsor one of the symposium

sessions in an area of interest to the Air Force, which was done at the last SAMPE conference in Dec 93.

Professor Maekawa also offered to introduce me to one of his colleagues, Prof Tanimoto, of Shonan Daigaku, who he said might also be interested in some kind of collaboration in the field of composite design and properties. A meeting with Prof Tanimoto was arranged for 28 Mar 94, at his laboratory in Kanagawa. Prof Maekawa intimated that because Shonan Daigaku is a private school, they may be more receptive to Air Force entanglements.

Dr. Shonaike then gave me a very brief tour of some of the facilities of the Department of Polymer Science and Engineering. Prof Maekawa seemed reluctant to discuss any of his research programs in any detail, which may have been a sensitivity towards me as a representative of the Air Force, or perhaps just a misunderstanding regarding my request.

3. University of Kyoto - Department of Metal Science and Technology (9 Mar 94)

My visit to the University of Kyoto was to accept a long standing invitation from Professor Masaharu Yamaguchi. Professor Yamaguchi is known for his work on two phase single crystal alpha-2 plus gamma specimens, which he named Poly-Synthetically Twinned or PST crystals. His much heralded work has led to a great increase in understanding regarding the complex deformation behavior of the two-phase lamellar structure materials. His work has aptly demonstrated the anisotropy of the lamellar structures response to compression and tensile deformation, and fracture toughness under various atmospheres and a range of temperatures. His work has also elucidated the effect of structure and orientation on environmental resistance, and fracture behavior of the lamellar structure.

His most recent results on a particular orientation with temperature indicate a very good opportunity for DS crystals with orientations parallel to the stress direction. In that orientation, PST crystals exhibited good retention of strength up to high temperature and good ductility (up to 20% at RT). This indicates a possible tailored orientation for DS gamma, with an attractive combination of room temperature strength and ductility, and high temperature strength.

A possible difficulty is that the normal growth orientation for most typical alloys in perpendicular to the growth direction, which would pose a problem for growing blades, etc. However, other authors have shown that the solidification direction can be altered in lower Al alloys, where the dominant primary solidification phase becomes the beta phase. This has also been demonstrated by Prof Yamaguchi's group. Further research in needed to determine whether the growth direction in this class of alloys is controllable. This change in solidification pathway may also be accomplished by adding beta stabilizing elements to the alloys, such as Cr, Mo, or Ta. Prof Yamaguchi said that his group was planning to try either Cr or Mo additions.

We discussed the interest of many groups in Prof Yamaguchi's research, including the Air Force Materials Directorate (WL/MLLM). Prof Yamaguchi seemed very willing to participate, at least informally in cooperative research in this area, and said he is willing to supply at least several PST samples to the AF. He is very interested in what other research is going on in DS gamma. This may be an interesting area for some collaboration.

I also met with Prof Yasuharu Shirai, an associate professor in Prof Yamaguchi's group. He has performed very interesting work, trying to relate the effects of equilibrium point defects with deformation at room and high temperature. He is using positron radiation to

characterize defects and voids in various materials as a function of temperature, with the hypothesis that they play a significant role in deformation behavior. One of his initial findings is that titanium-aluminides and nickel aluminides do not exhibit off stochiometric vacancies. He is currently using "white" positron radiation sources, which cannot analyze point defects as a function of specimen depth, and is planning to develop new testing equipment which can produce positrons of specific energy to do this type of research.

4. University of Kyoto - Institute for Chemical Research (10 Mar 94)

The University of Kyoto operates a technical research institute of considerable size in a nearby town of Uji. The institute takes only graduate students, and is divided into 5 institutes, for Wood, Food, Chemistry, Nuclear Power and Radio Science. I met with several of Dr. Fujishiro's colleges, who were very gracious hosts.

I first met with Professor Mikio Takano, of the Laboratory of Solid State Chemistry. Prof Takano's area of research is in the area of ceramic superconductors. Specifically, his interest is to elucidate the mechanism responsible for high T_C ceramic superconductors. His staff has recently completed a high pressure, high temperature apparatus for the purpose of producing metastable crystal structures not found at normal pressures and temperatures. It has been theorized that some of these metastable structures may also exhibit high temperature superconductivity, which would verify a proposed theory regarding the mechanism of high temperature superconductivity.

We also discussed Prof Takano's request to provide funding to support a month long research visit by one of his colleagues, Dr. Robert Cava of AT&T laboratories. I explained that the cognizant organization to handle that request would be AFOSR/NI, and told him that I would work with NI to evaluate his proposal.

I then had a very brief meeting with Prof Shinjo, of the same Laboratory. He is internationally known for his research on the magnetic properties of Metallic Multi-Layers (MML). He is also interested in artificial superlattices for their other potentially important physical and structural properties. Lastly, I met with a research associate of Prof Bondo, world renowned for his work on thin films, especially thin film superconductors.