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Corrosion of Steel by Lead Bismuth Eutectic: Quarterly Report November- December 2002 January 2003

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Student thesis

In November, graduate student Dan Koury defended his master's thesis. Dale Perry flew in to attend the thesis defense. Ning Li, also on the committee, could not attend in person but made an important contribution. Ning Li interviewed Koury separately, and sent in valuable comments. In December, Dan Koury received his MS degree in physics. This is the first graduate degree granted in the UNLV College of Sciences under the Transmutation Program. Koury is continuing on for his Ph. D. degree.

Brian Hosterman, graduate student, continued making progress on the task of Raman spectroscopy to examine corroded steel samples. This technique can determine the chemical species present. Brian Hosterman obtained an excellent spectrum of iron oxide using laser Raman spectroscopy. He examined a standard of iron oxide - not an exposed steel sample. This is an important step towards his master's degree program.

Umar Younas finished up the fall semester as a Special Student (non-degree student). Younas received his BA in electrical engineering from UNLV in 1994, and worked in industry from 1994-2002. In December, Younas was admitted to the graduate program in physics, and joined the research group in January. He is partially supported by the TRP program.

In January, Julia Manzerova entered the graduate program in chemistry. This project is now supporting four graduate students: three in physics (Koury, Hosterman, Younas) and one in chemistry (Manzerova). There is also one valuable undergraduate student (Denise Parsons).

Julia Manzerova began collecting a library of reprints about LBE so that all members of the research group can be familiar with the scientific literature.

Instrumentation

The XPS instrument can be somewhat tricky to operate, and the expertise of Allen Johnson in this regards is very valuable. Efforts were started in October to get Service Physics to come to UNLV to service the XPS instrument. Those efforts continued in November. In January we received a field service visit to fix a persistent problem in the XPS machine. They fixed it! Data was taken on SiO₂ on a chip as a test of the condition of the XPS machine.

Data taking and data analysis

We continue to get valuable data from sputter depth profiling of steel samples. We meet weekly to discuss progress. We took depth-profiling data on D9 steel that had been exposed to LBE. This the first time we have examined this type of steel. This is important because it will enable us to separate out two effects and determine their effect on corrosion: composition of the steel vs surface preparation. We have more than enough data for another paper.

Planning for experiments at small lead facility

We started to plan a small experiments using a crucible of heated LBE, with the research program to be conducted at UNLV, on basic aspects of corrosion in this system. The idea is to conduct small-scale experiments to corrode steel samples using lead-bismuth eutectic. These experiments would be conducted using small "pots" of molten LBE, not the massive LBE loop that UNLV now has. A proposal was submitted at the end of February 2003. While that was not funded because of budget constraints, we hope to make a start on such a program on a much-reduced budget.

Collaboration with national laboratory LBE effort

On December 9-13, Los Alamos postdoc Dr. Jinsuo Zhang (postdoc for Ning Li) visited the UNLV campus. He gave a talk on the fundamental science of corrosion. We have a very creative interaction with him. This contact could potentially lead to a new series of bench-top-scale experiments.

Talks

"Surface Studies of Corrosion of Stainless Steel by Lead-Bismuth Eutectic", A. L. Johnson, D. Koury, B. Hosterman, D. Parsons, J. Manzerova, D. Perry, and J. Farley, poster presentation at meeting of American Vacuum Society 49th International Symposium, Denver CO, Nov 3-8, 2002. Presented by Allen Johnson.

A copy of the poster was given to Tony Hechanova for display at a conference on transmutation.

Invited Talk

Allen Johnson delivered an invited talk at a materials meeting in Ensenada, Mexico in January 2003.

title and authors of talk

Surface Studies of Corrosion of Stainless Steel by Lead-Bismuth Eutectic D. Koury, B. Hosterman, J. W. Farley, D. L. Perry, D. Parsons, J. Manzerova, and A. L. Johnson

abstract of talk

There has been a resurgence of interest in the use of Lead/Bismuth Eutectic (LBE) and similar high Z liquid metals as neutron spallation targets and coolants in advanced technology reactors. LBE was used in the Russian Alpha class nuclear submarines, with encouraging results. We have been investigating the corrosion of some western steels by oxygen controlled LBE in a Russian test loop using a number of techniques including SEM, EDAX, and XPS. We shall discuss the effects of surface and near surface preparation and composition on this interesting oxidation/dissolution corrosion system.

Manuscript in preparation

We started to write a manuscript describing the progress of our studies of corrosion. The data is taken from Dan Koury's master's thesis and subsequent work using the XPS.

Spectroscopic and Microscopic Investigation of the Interaction of Lead-Bismuth Eutectic (LBE) with

316 and 316L Stainless Steel at Elevated Temperature. Authors: Dan Koury, Brian Hosterman, Julia Manzerova, John W Farley, Dale L. Perry, and Allen L. Johnson. The manuscript will be submitted to J. Nucl. Materials.