Available online at www.sciencedirect.com
SCIENCE DIRECT®
ELSEVIER
Journal of Nuclear Materials 343 (2005) 366
journal of nuclear materials
www.elsevier.com/locate/jnucmat

Report on summary session

Cavitation-erosion in mercury spallation neutron target source

J.R. Haines *

Oak Ridge National Laboratory, USA

Recent developments in quantifying, understanding, and mitigating cavitation-erosion in mercury spallation targets were discussed in a series of five papers including:

Summary of cavitation erosion investigations for the SNS mercury target – J. Haines.
Pitting damage caused by proton bombarding in mercury target – M. Futakawa.
Assessment of cavitation-erosion resistance of 316LN stainless steel in mercury as a function of surface treatment – S. Pawel.
Improved cavitation resistance of structural materials in pulsed liquid metal targets by hardening – P. Jung.
Prediction of cavitation erosion rate by measuring cavitation intensity – H. Soyama.

Off-line tests by M. Futakawa et al. and S. Pawel showed that mercury cavitation damage follows the classical relationship between cavitation erosion and exposure time. The early phase, referred to as the incubation phase, shows little net erosion loss but significant surface damage is observed. This is followed by later phases, where a net loss of material is easily detected. The net erosion rate during the so-called steady state phase was shown to have a power law dependence with exposure time (t^{α}, where α is between 0.8 and 1.4). Both researchers showed that hardening treatments were effective at extending the incubation time well beyond that with untreated, cold-worked 316 type stainless steel.

M. Futakawa also showed that by using his off-line MIMTM apparatus he could reasonably well match the damage from in-beam tests reported by J. Haines et al. This greatly facilitates extrapolation of the in-beam tests that were limited to ~100 pulses to the number of pulses needed for a reasonable target lifetime (~10^8 pulses).

J. Haines et al. summarized the cavitation erosion tests that have been conducted as part of the SNS project. In addition to summarizing off-line tests, he presented results from the latest series of in-beam tests conducted at Los Alamos National Laboratory's WNR facility. These tests have provided quantitative understanding of cavitation pitting damage for ~100 pulses at beam intensities in the range expected for the SNS and J-PARC targets. The most noteworthy results are the strong power/intensity dependence, encouraging results for hardening treatments, and some promise for mitigation by bubble injection.

H. Soyama et al. demonstrated a methodology for predicting erosion rate from measurements in the early stage of cavitation damage or using a sensor that measures the intensity of the cavitation from a single pulse. This is an especially useful result since in-beam tests are likely to continue to be limited to a low number of pulses, hence this methodology could prove very useful in extrapolating the results from limited in-beam tests to the high number of pulses required for a reasonable spallation target lifetime.

P. Jung et al. showed that hardening of the surface of martensitic steels using intense pulsed or scanned electron beam treatments significantly reduced the cavitation erosion in both off-line and in-beam tests. Future work will focus on optimization of process parameters, study of irradiation effects, and applicability of these techniques to complex target geometries.

* Tel.: +1 865 574 0966.
E-mail address: hainesjr@ornl.gov

doi:10.1016/j.jnucmat.2005.03.005