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Report on summary session

Materials issues in a high power spallation target

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High energy proton irradiation can have significant effects on the mechanical properties of structural materials. Many future accelerator driven systems are concerned with these effects. These systems can be categorized into those proposing a liquid metal target: mercury for SNS and JSNS and lead bismuth for AFCI, Megapie and MYRRHA and those proposing a solid target: LANSCE, KEK, CIAE concept, ISIS and TRADE. Under high energy proton irradiation, spallation can occur (energies greater than ~5 MeV) which in addition to typical effects observed from irradiation in a fission spectrum results in higher primary knock-on energies, larger displacement cascades and significantly increased generation rates of helium and hydrogen. These effects of irradiation are discussed in the following papers on austenitic steels (316L, 316LN and welds), ferritic/martensitic steels (9Cr–1Mo, F82H and Optifer) and AlMg3.

In summary, for the austenitic stainless steels (316L and 316LN), high energy proton irradiations at 50–300 °C to doses of 4–9 dpa result in a reduction of uniform elongation to less than 1%. The details of this ductility loss are strongly dependent on irradiation and test temperature. For irradiation temperatures greater than 300 °C, helium bubble formation is observed after accumulation of helium greater than 500 appm. There is still a question as to what effect the helium has on mechanical properties and swelling for irradiations at temperatures greater than 300 °C. For temperature below 300 °C, the helium/hydrogen effects appears to be small. For the ferritic/martensitic steels (9Cr–1Mo, F82H and Optifer), at irradiation temperatures of 50–350 °C, a reduction of uniform elongation to less than 1% is observed for doses greater than 0.5 dpa. In this irradiation temperature range, the DBTT shift appears to increase linearly with increasing helium concentration. There still remains a question as to what effects helium will have for higher temperature irradiations (>400 °C) where very little hardening from displacement damage occurs. Finally, recent results were presented on irradiation effects on an AlMg3 window used at the SINQ accelerator. Helium formation is observed on grain boundaries and within the bulk. This appears to result in a small decrease in uniform elongation.

In addition to the effects of high energy proton irradiation on mechanical properties, unique studies are being performed on the combined effects of irradiation and lead–bismuth corrosion on T91 in preparation for the much larger irradiation of the Megapie target. Many of the questions of the effects of a high energy proton irradiation on mechanical properties of materials at elevated temperature will soon be answered as results are obtained from STIP II, III and IV irradiations.

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