HIGH-SENSITIVITY QUADRUPOLE MASS SPECTOMETER SYSTEM FOR THE DETERMINATION OF HYDROGEN IN IRRADIATED MATERIALS - B. M. Oliver, F. A. Garner, L. R. Greenwood, and J. A. Abrefah (Pacific Northwest National Laboratory)*

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ABSTRACT

Very high levels of helium and hydrogen are generated in metals in fusion, spallation neutron, and high energy charged particle environments. Hydrogen generation is typically an order of magnitude higher than that of helium, but the hydrogen is thought to quickly diffuse out of the metal, although there appears to be some conditions where significant retention can occur. While helium in radioactive materials is routinely measured with high accuracy at PNNL, concurrent measurement of hydrogen is a much more challenging task.

To address this issue, a high-sensitivity analysis system has been developed for the measurement of hydrogen in irradiated solid materials. Measurements can be made in both total release mode or in stepped-anneal or ramped release mode. The system is based on a low-volume extraction furnace in combination with a quadrupole mass spectrometer detector. Very small volumes of radioactive material are required, minimizing safety and waste concerns. Tests conducted using 2 to 5 mg sized specimens cut from a hydrogen-standard steel rod containing approximately 5 wppm indicate a detection limit of ~1 x 10^{14} atoms, or ~2 appm for a 5 mg specimen.

Hydrogen measurements have been conducted on both tungsten and Inconel 718 irradiated with spallation neutrons and 700 to 800 MeV protons, a number of iron-based alloys from the U.S. and U.S.-Japan JUPITER fusion materials programs in HFIR and ATR, vanadium alloys, and stainless steels from light water reactors. Measurements are in progress on SiC and aluminum alloys from a wide variety of radiation spectra. Hydrogen levels measured on irradiated specimens to date have ranged from ~50 to ~7000 appm. Details on the system, and typical hydrogen release curves will be shown.

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