LA-DC-12996

N7410611

CONF-710624--2

THE TRITIUM TRICK*

W. V. Green, with E. G. Zukas and D. T. Eash
Los Alamos Scientific Laboratory
University of California
Los Alamos, New Mexico 87544

Helium is thought to be very insoluble in solid metals as it is a noble gas. When forced in solution in some way, it is trapped in bubbles at high pressures. Small quantities, less than 1 ppm helium atoms per metal atoms are sufficient to modify high temperature mechanical properties. Just how, and to what extent properties like creep ductility will be degraded by large quantities of helium (200 ppm increase per year over 20 years) is unknown, but large effects are likely.

Helium will be produced in unprecedented amounts in wall materials of proposed power producing fusion reactors, the above figure of 200 ppm per year being typical for such a reactor design, while fast breeder fission reactors would produce about 0.3 ppm per year. Helium effects, therefore, could be very important to fusion reactor technology.

Large controlled amounts of helium in uniform concentration throughout thick samples can be readily obtained through radioactive decay of dissolved tritium gas to ^{3}He. We coined the name "tritium trick" when helium added by this method is used to simulate (n, α) production of helium in (simulated) hard flux radiation damage studies.

Tritium decays to helium with a half life of about 12 years so that about 1/2 percent decays per month. The only radiation emitted is a very weak, 12 kev, beta particle. It is too weak to cause significant damage. Tritium, being an isotope of hydrogen, is very soluble in many metals. It also diffuses into and out of metals quickly. Thus tritium can be dissolved, allowed to decay to the desired helium content, and pumped away selectively relative to the ^{3}He. Only ^{3}He will remain to change properties.

---

* Work performed under the auspices of the U.S. Atomic Energy Commission and with the support of National Aeronautics and Space Administration.

Published phase diagrams show the amount of hydrogen (and therefore tritium) that will dissolve in various metals at any temperature and pressure. As an example, at 1000°C (the operating temperature likely for some fusion reactor walls) at 1/100 atmosphere pressure of tritium, the ^{3}He production rate in niobium (presently the first choice metal for structural parts in the walls of fusion reactors) via beta decay will exactly equal the ^{4}He production rate at full power via (n, x α) reactions. This amount of tritium in uniform solid solution would only be 1/4 a/o. As another example, niobium charged at 600°C under one atmosphere of tritium gas will collect 200 ppm helium in only ten days, thereby allowing accelerated damage rate studies. The tritium trick should not be difficult, nor expensive, once a tritium handling facility is available. Initial charging experiments are now in progress. We hope to establish how helium diffuses, collects in bubbles and modifies creep properties with electron transmission microscopy, internal friction and creep experiments.