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The Development of Solid Methane Neutron Moderators at the Intense Pulsed Neutron Source Facility of Argonne National Laboratory*

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ABSTRACT

The Intense Pulsed Neutron Source (IPNS) started using solid methane moderators in 1985 because of their efficient conversion (about 3.5 times greater than was achieved with a liquid hydrogen moderator) of fast neutrons to long wavelength neutrons. However, the solid methane moderators experienced numerous failures due to pressure surges caused by a combination of (1) the release of stored energy, which occurred when methane radiolytic products recombined, and (2) the expansion of hydrogen, which built up in the solid methane during irradiation. During the ensuing years studies were made to determine how to operate the solid methane moderators without causing failure. The rate at which stored energy built up during irradiation and the temperature at which hydrogen was released during annealing were determined. Since 1993 IPNS has successfully operated the solid methane moderators (at about 30 K) by periodically annealing to the liquid state around 90 K after every roughly three days of irradiation.

1. IPNS OPERATION

1.1 Beam Operation

IPNS is a pulsed spallation source that operates as a national user facility for materials research. The accelerator system produces a 450 MeV proton beam at a time-averaged current of 15 μA. Short (~100 nsec) pulses of protons, at a rate of 30 times per second (30 Hz), strike a depleted uranium (^{238}U) target producing fast neutrons with energies around 1-10 MeV. The fast neutrons are slowed down to energies of 1 eV and below by moderators located above and underneath the target. A graphite and beryllium reflector surrounds the moderators and reflects fast neutrons back into the moderators to enhance the neutron flux. Twelve horizontal neutron beam tubes view selected faces of the moderators and permit neutrons to travel to the neutron scattering instruments. The thermal neutrons are collimated to an appropriate size in each beam line then strike the sample. The neutrons are scattered by the sample and their angle of scatter and energy measured by detectors using time of flight techniques.

1.2 Moderator Operation

IPNS has three moderators (C, H and F) located adjacent to the uranium target. The moderator in the F position is maintained by a closed system of flowing liquid methane. The C and H moderators consist of static solid methane cooled by cold helium gas flowing in channels on the back or sides of the container.

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