Session IV
Facility Utilization

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Old Bones, Hard Rocks, Smoke, and Reactor Utilization

Mark Moore, Quality Service Associates, Inc

Abstract

Several visits were made to research reactor facilities looking at general capabilities and the character of the utilization programs. Meetings and field visits were then held to explore the possibilities in expanding reactor programs in archeology, geology, other related sciences, and areas of current concern such as the environmental area. This discussion summarizes these visits.

BNCT and MIT: A Status Report

Tom Newton, MIT

Abstract

A clinical trial of Boron Neutron Capture Therapy on human subjects with metastatic melanoma was initiated at the MIT Nuclear Reactor Laboratory in September of 1994. To date, five human subjects have been irradiated under this Phase I dose escalation protocol, three to a healthy tissue dose of 1000 RBE-cGy, and two to a dose of 1250 RBE-cGy. A separate Phase I clinical trial using subjects with Glioblastoma Multiforme or brain melanoma metastasis was initiated in July of 1996, beginning at a normal brain tissue dose of 880 RBE-cGy. Ten subjects have thus far been irradiated under this protocol, the latest irradiation completing the 1065 RBE-cGy dose level.

The MIT Nuclear Reactor Laboratory has received funding in the amount of $2.5M from the U.S. Department of Energy for construction of a fission converter facility in the reactor thermal column region. This facility, using MITR-II fuel in a subcritical arrangement, will deliver a high quality epithermal beam resulting in a therapeutic dose to a patient in just a few minutes. Construction is estimated to take two and a half years.

The BNCT program at MIT, including the fission converter project is under the direction of Prof. Otto K. Harling. Medical partners are at the Beth Israel Deaconess Medical Center where Dr. Robert Zamenhof and Dr. Paul Busse are the principal researchers.

From Licence to Research and Development Quality at the IRI

Adrian Verkooijen,Technical University, Delft

Abstract

The Interfaculty Reactor Institute (IRI) combines two main activities: Operation of the nuclear research reactor and nuclear research in five departments. During the last years the following issues have required substantive efforts of the staff.

- Conversion of the core from HEU to LEU.
- Design and construction a new beam hall.
- Renewal of our operation license including safety assessment an environmental impact statement.
- Assurance of safe and certain nuclear waste disposal. As dual path is followed.
- Assuring R & D quality through self assessment and peer review.

In this contribution these efforts will be elucidated and the synergy, wherever existing will be shown.

Reactor-Based Slow Positron Beam at the University of Texas

Bernard Wehring, University of Texas

Modern variable-energy slow-positron beams are powerful nondestructive probes of surface and near-surface material properties. For example, they have been used for characterizing defects in semiconductors and polymers, profiling damage in ion-implanted semiconductors and metals, and for positron microscopy. In addition to the use of slow-positron beams in materials research, they are also important tools in atomic physics for fundamental studies of positron scattering, positronium, an the formation of antihydrogen.

The successful operation of a variable-energy slow-positron beam depends on moderating high-energy positrons to low energies and then focusing and accelerating these positrons into a sample. To obtain a high fluence in the beam, it is necessary to moderate the positrons with minimum loss due to trapping (and subsequent annihilation) in voids and vacancies in the moderator. Low defect density single crystals with negative work functions for positrons and solid noble gases are moderators that satisfy this requirement. Low energy positrons that leave the surface of the moderator are then accelerated to selected energies in order to sample different depths in the material to be studied.

A reactor-based slow positron beam facility is being developed at the Nuclear Engineering Teaching Laboratory (NETL) at The University of Texas (UT) at Austin. This is a joint effort between UT-Austin and UT-Arlington researchers. The facility (Texas Intense Positron Source, TIPS) will be one of a few reactor-based slow positron beams in the world when completed and should be capable of delivering > 10^8 positron/s in a beam with a diameter of less than 5mm. This intensity is two orders of magnitude larger than can be reasonably obtained with commercially available positron sources. e.g., ^{22}Na and ^{58}Co.

The source of positrons for the TIPS facility will be the beta decay of ^{64}Cu (12.7-hr half-life, 19% positron emission) produced by neutron capture in ^{63}Cu (69% natural abundance). A copper lattice of cylinders (circular or square, 1 or 2 cm high) mounted on a 10 x 10 cm base will be irradiated in the middle section of the through beam port of the NETL 1-MW TRIGA research reactor. After a daily irradiation of ~ 6 hr, the copper lattice will be moved, under high vacuum, to outside of the reactor biological shield by a 4-m long transport system. A second shorter transport system will move the lattice through a vacuum gate valve to a position inside an ultra-high vacuum chamber where it will form one fact of a box, 10 x 10 x 10 cm. The remaining five faces, made out of tungsten, will be held at various potentials during positron measurements to maximize the probability of low-energy positrons escaping through a hole (~ 4 mm diameter) in the box face opposite the copper lattice. To provide optimum moderation and remoderation, a thin layer of Kr will be frozen on all faces of the box with the entire box assembly cooled to 15K. The positrons emerging from the hole will be accelerated and transported to a sample by the use of standard positron transport optics.

A facility to provide a high-intensity variable-energy slow-positron beam has been designed and is being constructed that makes use of the modest neutron flux available at a 1-MW TRIGA research reactor. A unique box design for moderation and remoderation of the positrons provides a bright beam with a usable size which is considerably smaller than the area required for the positron source. Initially, this facility will be used for depth profiling of defects in semiconductor materials. Later, a brightness enhancement stage will be added to reduce the positron beam to micron size allowing measurements on individual semiconductor devices.