Potential Applications of the RIA Facility

Production of Medical Isotopes

Medical applications could be one of the most direct impacts of RIA to society. Recent work at ISOLDE concentrated on production of medical isotopes for combining therapy and diagnosis (1-3). The idea is to find isotopes of the same element, one an electron emitter and the other a positron emitter. The emitted electron destroys the cancer cells while the positrons allow PET diagnosis. Two examples of such elements so far found are samarium and yttrium which both have isotopes with the desired properties. In addition, the isotope terbium-149 that emits alpha particles 17% of the time and positrons 4% of the time, combines diagnostic and therapeutic properties into a single isotope. Terbium-149 is at the very frontiers of medical research (2-3).

A number of problems have been related so far to medical radionuclides that is high cost, unreliable availability, low specific activity, chemical contamination, radionuclide impurities and low production yields. In the 1998 meeting of leaders of the biomedical industry in Dallas it was mentioned that a DOE facility for production of medical radionuclides could find support from the National Cancer Institute and possibly the DOD Breast Cancer Program. There is a lot of funding for cancer research and a lot of interest in radionuclide therapy. Thus, the National Cancer Institute can be a driving force in the effort for funding a program for radionuclide production (4).

Tribological Studies

Direct implantation of radioactive ions into a surface can be used for wear studies of different types of materials such as plastics and ceramics by monitoring the γ-ray activity worn away. Implantation of these ions in sufficient doses for easy study does not produce detectable surface damage or alteration. In addition, the amount of radioactivity involved is small and nondangerous (5-6). Applications are envisioned for both industry as well as medicine. An example of such an application in medicine is the wear studies of hip and knee joint prostheses using ^{7}Be or ^{22}Na (6-7).

Materials Research

Semiconductors are very important for the computer industry. They rely on implanting certain materials into other materials. Radioactive atoms used for such implants make it possible to tell precisely where these elements end up inside semiconductors (8-10). This provides an invaluable tool for the computer industry, helping to refine chip-manufacturing techniques. Collaboration with the computer industry could lead to several research funding opportunities.

One example of recent work at ISOLDE involves study of the hydrogen impurity that is one of the most important impurities in semiconductors. By doping with radioactive ^{111m}Cd provided by ISOLDE, the acceptor-hydrogen interaction in semiconductors such as GaAs, InAs etc. was studied. A question of fundamental interest in semiconductor physics is the diffusion of hydrogen and has also been studied by using ^{117}Cd in InAs or InP semiconductors. The parent atom ^{117}Cd represents an acceptor trapping hydrogen while the daughter ^{117}In represents a normal lattice atom in InAs or InP where no binding exists any more with hydrogen. Thus the free hydrogen diffusion can be observed (9).

The future applications of radioactive ion beams are not restricted to semiconductor physics. Radioactive ion beams have been applied in the study of the structure and defects of oxide materials (11).

Radioactive ion beams may offer a special tool in the study of fullerenes by trapping a radioactive atom inside fullerenes. Fullerenes are actually metals and there are still basic questions about them such as how do other atoms bond in their inner and outer surface, how they are shaped etc. Answering these questions may lead to the production of new materials (12). In addition, fullerenes have also been found to have biological effectiveness. C-60 is just the right size to fit into the active cavity of HIV Protease, an enzyme important to the activity of the virus that causes AIDS. A bucky ball into the active cavity deactivates the enzyme and kills the virus. Ways of getting the enzyme into the molecule are under investigation. Therapeutic applications for cancer have also been envisioned by attaching a radioactive atom in the fullerene. Thus, study of fullerenes may lead to significant applications both in materials science as well as medicine.

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