

# Physical and Chemical Applications

## Objective

*To increase Member State capabilities in the application of radioisotopes and radiation processing as tools for sustainable economic development.*

## Radiochemical Applications

Assisting Member States in the development of new diagnostic and therapeutic radiopharmaceuticals for local use is one of the major goals of the Agency's activities in the area of physical and chemical applications. In this connection, a CRP on the development of technetium-99m based radiopharmaceuticals for infection imaging was completed. Ubiquidine (UBI), an anti-microbial peptide, was labelled with technetium-99m and evaluated in vitro and in vivo. Preliminary clinical studies in Mexico using technetium-99m UBI showed that images with intense accumulation of acute infection were obtained using this radiopharmaceutical.

A CRP for optimizing cyclotron radioisotope production by using solid targets and high current irradiation was completed. It has stimulated collaborative research and produced original data for the fabrication of cyclotron solid targets capable of withstanding high beam currents. This will promote increased reliability and better economics of radionuclide production programmes. The results have shown that compact, medium current cyclotrons can produce adequate amounts of radionuclides such as palladium-103 for cancer brachytherapy applications. Practical radionuclide production yields have been increased by up to 30% in some instances, contributing to an improvement in the efficiency and economics of radionuclide production programmes.

Training in radiochemistry and exploitation of particular applications for nuclear analytical techniques were the focus of radioanalytical activities in 2003. Development began of training modules for radiochemists, comprising training course material, lecture notes and a series of in-depth modules to address subjects such as nuclear analytical techniques, chemical separations, isotopic techniques, radioecology and environmental radioactivity, radiation safety and dosimetry, and quality assurance and quality control.

Under an RCA project for East Asia and the Pacific, the progress of participating Member State

laboratories in achieving compliance with ISO/IEC 17025 in the field of nuclear analytical techniques was evaluated. Reports have shown that most have implemented the quality system. Nuclear analytical laboratories in Hungary, Indonesia, Republic of Korea, Romania and Slovenia obtained national accreditation in 2003 towards ISO/IEC 17025.

The Agency's Analytical Quality Control Services (AQCS) web site ([www.iaea.org/programmes/aqcs](http://www.iaea.org/programmes/aqcs)) was made fully operational to provide on-line facilities for ordering reference materials and to provide information on AQCS activities for Member States. A total of 208 orders for AQCS products were received in 2003 from approximately 200 customers, and 625 AQCS reference materials valued at \$65 430 were sold. The Agency's Laboratories at Seibersdorf produce and distribute reference materials and also provide AQCS services.

## Radiation Processing, Radiography and Radiotracer Applications

Investigation is needed into the effects of irradiation on polymers and natural resources that can be made into marketable products, such as biodegradable materials. To further research in this area, the Agency started a new CRP on controlling degradation effects in the radiation processing of polymers. Participants reported on the application of analytical techniques such as synchrotron radiation, positron annihilation methods and electron spin resonance spectroscopy that permit a deeper analysis of radiation induced effects, opening up possibilities for the development of new materials and products.

Following the commercialization of hydrogel wound dressing technology based on natural and synthetic polymers (Fig. 1), R&D on the process was completed in Egypt and the Syrian Arab Republic. Under the RCA programme, hydrogels commercialized in India, Malaysia and Vietnam; research continues in Bangladesh, China, Philippines and Thailand.

A new CRP on industrial process gamma tomography was initiated to test and validate techniques for multiphase flow systems. This CRP will assist specialists in developing countries in introducing this technique for the visualization and optimization of complex industrial processes. Another CRP, on integration of residence time distribution (RTD) tracing with computational fluid dynamics (CFD) simulation



FIG. 1. Burn wound healing of a leg treated with a radiation processed, chitosan based, hydrogel wound dressing.

for industrial process visualization and optimization was completed. As a result, a CFD-RTD integrated software package was validated for industrial process modelling.

Advances in land mine detection technology were achieved through a CRP on nuclear techniques for the identification of anti-personnel land mines. Specifically, several new prototype instruments for humanitarian demining were developed, as well as a standardized dummy plastic land mine to facilitate intercomparison tests of demining devices. Testing, repair and maintenance of the devices are being performed at the Agency's Laboratories at Seibersdorf. The research has also generated several technical cooperation projects and proposals in and from Member States affected by the presence of land mines. There was also interaction between scientists from Member States with a land mine problem and scientists from other States.

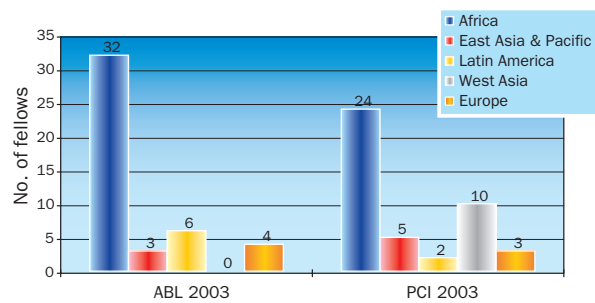


FIG. 2. Number of fellows receiving training in 2003 at the Agency's Laboratories at Seibersdorf, by geographical region (ABL: Agriculture and Biotechnology Laboratory; PCI: Physics, Chemistry and Instrumentation Laboratory).

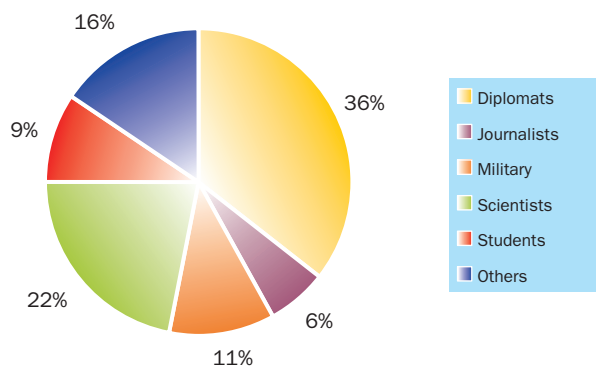


FIG. 3. Profession of visitors who toured the Agency's Laboratories at Seibersdorf in 2003.

The Agency's Laboratories at Seibersdorf support the implementation of the various scientific and technical programmes of the Agency by providing experimental facilities and services. For example, the Safeguards Analytical Laboratory conducts sample analysis. In 2003, the number of environmental samples analysed in the Clean Laboratory increased from about 400 to 600. The Laboratories also continued to attract many fellows, with 89 receiving training (Fig. 2). The Laboratories received 371 visitors during the year; the percentage breakdown by profession of the visitors is shown in Fig. 3. ■

### A Milestone in the Radiation Treatment of Flue Gas

A breakthrough in radiation technology for flue gas purification from sulphur and nitrogen oxides was achieved in 2003. After testing, an industrial plant in Poland with a 1 MW power electron accelerator, the biggest radiation processing facility ever built, commenced full operation in June 2003. The by-product is used as a fertilizer, making the technology very competitive.