



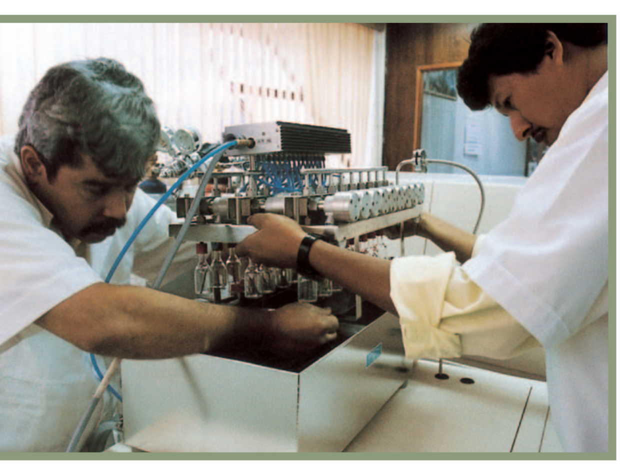

New materials from natural polymers: using nuclear technology to improve Nature's gifts

A programme of the Regional Cooperative Agreement for Research, Development and Training in Nuclear Science and Technology in Asia and the Pacific (RCA)

Countries in Asia and the Pacific are making great headway in deploying nuclear technology to develop an astonishing variety of advanced materials for use in medicine, agriculture, environmental protection and a wide range of industrial applications. The RCA has played a pivotal role in introducing this technology, known as radiation processing. Since 1997, and with support from the International Atomic Energy Agency and additional funding from the United Nations Development Programme, the RCA has run an ongoing technical cooperation programme to help participating countries acquire the skills and establish the infrastructure to undertake radiation processing research and development. Recently the programme has been focussing on one of the most exciting and innovative areas emerging in materials science today: the use of radiation processing to 'redesign' Nature's own materials.

Firstly, though, how does radiation processing work? Essentially, when a material is exposed to ionizing radiation from a radioactive source emitting gamma rays, such as cobalt-60, or to a beam of highly accelerated electrons, the energy of the radiation alters the material's molecular structure. Certain physical, chemical and/or biological properties of the material can be altered too, for example its strength, viscosity and biodegradability. Under controlled conditions, different effects can be achieved depending upon the 'base' material used, the 'dose' of radiation it absorbs, and the particular processing techniques employed. Molecules can be broken down ('degradation'); they can be made to stick together ('cross-linking'); or they can have different molecules stuck on to them ('grafting'). In other words, by carefully modifying a material's molecular structure, it is possible to redesign that material for a very specific, tailor-made purpose.

Radiation processing has several advantages over conventional chemical methods for developing new materials. In the first place, it's simpler and faster. It can also be controlled with much greater precision. And it's much 'cleaner': this is because radiation processing changes the molecular structure of materials without requiring chemical catalysts or extreme physical conditions such as high temperatures and immense pressures; it neither uses toxic chemicals nor generates noxious fumes. Furthermore, irradiated materials do not themselves become radioactive (just as a patient x-rayed for a bone fracture does not become radioactive). Radiation processing therefore offers the potential of a fast, efficient and toxin-free alternative to conventional methods of developing and manufacturing new materials and products.



Perhaps the technology's most promising use, which the RCA programme has been promoting recently, is the application of radiation processing to natural polymers. Polymers are large molecules consisting of long chains of repeated blocks of atoms, and they are found throughout nature: the cellulose in plants and trees; the starch in bread, corn and potatoes; chitin in the shells of shrimps, crabs and other crustaceans; agar, carrageenan and alginates in seaweeds. These and other natural polymers may prove to be the perfect 'base' resource from which to develop new materials. They are abundant, inexpensive, biodegradable, locally available and renewable. They also have some remarkable inherent properties. Chitin, for example, is naturally waterproof, and hard yet flexible.

Countries participating in the RCA programme have produced great results already. Prime examples are the radiation processing of chitin to produce hydro-gels and of polysaccharides (such as starches and cellulose) to produce what are termed 'oligomers'. Hydro-gels are basically water-soluble, super-absorbent materials, but they are now being custom-designed for a remarkable variety of uses: antibacterial dressings for wounds and burns; biodegradable adsorbents for removing heavy metals from rivers and lakes; biocompatible coatings for delivering drugs into the body; controlled release agents for pesticides and herbicides; skin moisturisers and other cosmetics; and biodegradable packaging. Oligomers are being developed for medical uses, because of their anti-bacterial and anti-fungal properties, as well as to promote plant growth and extend the shelf-life of fruits, vegetables and eggs.

By facilitating the transfer of radiation processing technology, the RCA programme has helped countries of the region develop the capabilities to design new and exciting products and deliver them to an eager market. Indeed, over the last ten years, interest in this groundbreaking technology has grown faster in Asia and the Pacific than in any other region in the world, bringing with it the potential for significant benefits to industry, economic growth, health, agriculture and the environment. All the countries that have participated in the programme are actively engaged in researching and developing new materials, patenting their discoveries, or bringing new products to market for sale domestically and internationally. By promoting the use of natural polymers, the programme is also encouraging affordable, sustainable and environmentally-responsible development. As research teams across the region continue to experiment with new possibilities and explore new applications for their work, materials science in Asia and the Pacific looks set for a promising future.

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