DEVELOPMENT AND APPLICATION OF RADIATION DETECTORS

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The evolution of the fundamental and applied research in the nuclear field is entailed to the development of the new types of radiation detectors, which have determined different technological applications in several areas, such as, Nuclear Medicine, Industry, Agriculture, Environmental Science and Radiological Protection. Aiming to reach these goals, the following activities have been carried out in the period covering the years 2002-2004:

Development of radioguided surgery probe: In this work two probes were developed for radioguided surgery. The first probe was built with a crystal of CsI(Tl) coupled to a PIN photodiode. The final configuration of the probe, with internal collimator, has an external diameter of 21,5mm, presenting a space resolution of 14mm at a distance of 1cm from the source and a maximum sensibility of 10cps/kBq. The second probe was built using a crystal semiconductor of Bromide of Talio (TlBr), that is being developed at IPEN. It is not still available in the market. This probe presented a diameter of 10,5mm, a spatial resolution of 17 mm to 1cm of distance and a maximum sensibility of 5cps/kBq.

Study of the Radiation Damage in the Organic and Inorganic Scintillators: A study of radiation damage in CsI(Tl) crystals has been conducted to determine how the scintillation mechanism is affected by the irradiation. For organic scintillator detectors, analysis concerning the radiation damage in each of the detector chemical constituents were evaluated. The damage effects for the liquid solution was isolated in: (a) the scintillator PPO, (b) the second scintillator (POPOP) and (c) the toluene. These studies may be useful to understand the degradation mechanism of the detector system and provide a tool for the development optimization of new detectors.

Development of a Scintillator Detector Set with Counter and Data Acquisition for Flow Measurements: A portable counter with data acquisition system for flow measurements was developed, to determine the tracer transit time mixed homogeneously with the liquid or gas pipelines. The counter comprises: a) two CsI(Tl) crystal solid state detectors, associated with Si PIN photodiodes; b) amplification units; c) analogue-to-digital interface, which processes and displays the detectors counting separately and in real time, but in a same temporal axis, via a computer screen and d) 30-meter coaxial cables for signals transmission from each detector to the processing unit. The equipment showed to be suitable for flow measurements in an industrial plant, in the real situation.

Mini Ionization Chamber Detector for High Dose Monitoring on Line Inside a Gamma Irradiation Facility: A cylindrical ionization chamber of 0.9 cm^3 has been developed for monitoring high doses on line during the sample irradiation at a static position in a ^{60}Co gamma industrial plant, with about 25.9 PBq (700 kCi). Nitrogen gas at different pressures from 1.0 to 1.8 bar was utilized to fill the ionization chamber and to determine an appropriate configuration to be used as a detector for high dose measurements. The first detector tests showed a good linearity between the collected charge and the dose, independently of the dose rate. These results suggest that the developed ionization chamber is suitable to be used as a dosimeter on line in an industrial plant.

Purification And Crystal Growth Of Tlbr For Application As A Radiation Detector: Thallium bromide is a high atomic number compound semiconductor with a high density and thus has excellent gamma ray stopping power, which makes it very attractive for applications as radiation detector. TlBr has the CsCl-type simple cubic crystal structure, which are non-hygroscopes. TlBr crystals are relatively soft becoming easy handling semiconductor. This crystal is growth by Bridgman method. It has a large applicability, at room temperature, as X and gamma-ray detector and photodetector. In this development, efforts have been concentrated on the purification of the TlBr. The crystal quality was evaluated by X-ray diffraction and optical transmission measurements. The characterized TlBr crystal as detector have shown good response to the alpha and gamma radiation and has great potential to be used as a semiconductor detector in radioguided surgery probe (FIG.1).

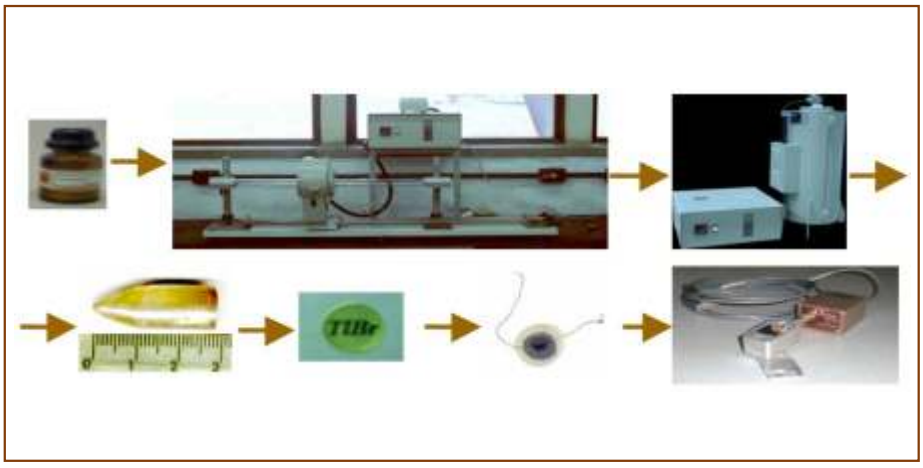

FIGURE 1 - Purification and Growth of the TlBr crystal and its Preparation as a Radiation Detector.