Fine-tuning radiation processing

Dosimetry for quality control

by J.W. Nam

Interest in the application of radiation in industry is being shown worldwide as the process offers potential technological advantages, as well as safety and economy in various fields. Among them: radiation sterilization, food irradiation, and the production of plastics and other products widely used in modern society.

Radiation dosimetry provides reliable quality control of radiation processes and is the basis for regulatory acceptance of irradiated products. Steps now are being taken by scientists to develop a more reliable dosimetry technique and system, and investigations are being performed for several promising dosimeters to increase reliability and to minimize errors. Since a primary standard for dosimetry at kilogray (kGy) does not now exist, a number of dosimetry laboratories are very active in developing a reference dosimetry system with the highest possible accuracy.

Being actively carried out at several laboratories are calibration of dosimeters and dose intercomparisons. Results of investigations performed on the energy dependence of several dosimeters also are considered to be highly useful for further improving dosimetric reliability. In practice, it is important to estimate not only the average doses absorbed in products, but also to evaluate firmly the doses absorbed by products with different densities. Reliable dosimetry is thus a key parameter in the technological development associated with increasing interest in radiation processing.

The latest developments in this field recently were reported at the IAEA's International Symposium on High-Dose Dosimetry in Vienna, Austria, during October 1984. More than 70 participants from 30 Agency Member States and two international organizations attended. As the first of its kind, the symposium was designed to be of particular interest to scientists now developing dosimetry techniques and dose assurances for both research and industry.

Experts reviewed the standardization of radiation-absorbed doses and dose rates for high-dose measurement of electron and gamma rays, common reference, and routine dosimetry systems and techniques. This standardization generally consists of timely calibration, at the radiation standards laboratories, of dosimeters used in certain dose ranges of interest. Attention was focused on the typical procedure for standardizing both electron and photon quality-control dosimetry, since the standardization procedure is somewhat different by type of radiation source and dose range.

Currently, many different dosimeters are available, and it is important to select the one suitable for the purpose and specific application. Scientists discussed dosimeter selection criteria and sources of routine dosimetry uncertainty, as well as newly employed dosimetry systems for dose and dose-rate measurements in various fields. It was noted there has been remarkable improvement in dosimetry and related accessories and equipment, as well as in utilization of computer techniques.

For radiation processing dosimetry, absorbed doses must be large, ranging from about 10 to above 10^5 Gray. Absorbed dose rates range from about 0.01 to 1 Gray per second, in the case of gamma rays, up to instantaneous dose rates as high as 10^{10} Gray per second in the case of electron beams.

At the symposium, scientists reviewed the following dosimetry techniques and systems: alanine/ESR; aluminium oxide; calorimeters; cellulose triacetate (positive electron current densitometer); ceric sulphate; ethanol chlorobenzene; Fricke; glass optical fibres; G-M tube; LiF; light emitting diode; organic lyo-luminescence; parallel-plate ionization chamber; phosphate glass; polymer and polymeric matrix; potassium and silver dichromate; PVC; quartz resonators; radio-chromic dye (liquid, solid, and liquid core); red and amber acrylic; and silicon diode.

Participants noted that most dosimetry systems now in use need further improvement to better meet the essential characteristics of routine dosimeters and, thus, facilitate the operation of irradiation facilities. Also recognized was that reliable dosimetry could be a unique tool for good irradiation practice, and that standardization could end the problem of quality assurance of irradiated products in the future.

Overall, the symposium clearly aroused wide interest, and hopes are it will prove to be a milestone for future development of high-dose assurance for radiation applications in science and industry.

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