Development and Characterization of the CsI:TI scintillator grown by the Bridgman technique for use as a radiation detector

Karoline Feitoza Suzart[1*], Maria da Conceição Pereira[1], Carlos Henrique de Mesquita[1], Maria da Penha Albuquerque Potiens[1]

Email: karolinesuzart@usp.br
[1]Instituto de Pesquisas Energéticas (IPEN), Avenida Lineu Prestes, 2242-Cidade Universitária, CEP 05508-000, São Paulo/SP

Scintillation materials are characterized by the emission of photons of visible or ultraviolet light when exposed to ionizing radiation, partially or totally absorbing the radiation. The present work aimed to grow crystals of pure cesium iodide (CsI) and activated with thallium (CsI:Tl) by the Bridgman technique. The thallium iodide dopant concentration was 10^{-3}M. The zonal refining technique was used in order to reduce the impurities found in the CsI salt. To quantify the impurities, the plasma optical emission spectrometry (ICP-OES) technique was used. The CsI:Tl crystals were submitted to physical-chemical characterization such as: X-ray diffraction to confirm the crystal lattice, transmittance of pure and thallium-doped crystals, luminescence emission with maximum emission peak at 520 nm due to the presence of thallium, Tl concentration distribution along the crystal and optical microscopy to compare the unpolished and polished crystal surface. To evaluate the response of the scintillator crystals regarding their detector characteristics, experiments were carried out using sealed radioactive sources, namely: ^{133}Ba (80 keV, 355 keV), ^{60}Co (1173 keV, 1333 keV), ^{22}Na (511 keV, 1275 keV), ^{137}Cs (662 keV) at room temperature. The study of light responses of CsI:Tl crystal after interaction with gamma radiation was performed by acquisition of single scintillation signals using a photomultiplier (ET Enterprise, Model 9924SB, England) and PIN-type photodiode. Data were processed with an integration time of 600 s. The growth of CsI:Tl crystals by the Bridgman technique proved to be efficient and can be immediately applied for detection of gamma radiation.

Characterization of a Commercial PIN Diode for Radiotherapy Photon Beam Dosimetry

Iandra T. Silva[1], Karen Pieri[1], Lucas D. Albino[1], Thiago S. Fontana[1], Matheus F. dos Santos[1], Ernesto Roesler[1], Viviane K. Asfora[2], Charles Oliveira[2], Josemary A. C. Gonçalves[3], Carmen C. Bueno[3] , Helen J. Khoury[2]

Email: vikhoury@gmail.com
[1]Real Hospital Português de Beneficência em Pernambuco (RHP), Pernambuco, Brasil
[2] Departamento de Energia Nuclear, UFPE, Pernambuco, Brasil
[3]Instituto de Pesquisas Energéticas e Nucleares, 05508-000 Cidade Universitária, São Paulo, Brazil

Introduction

In this work, the dosimetric features of commercial diodes (BPW34) are investigated for radiotherapy photon beam dosimetry by evaluating their dose response, dose rate dependence, field output factor, and percentage depth dose profile (PDD). The experimental results are compared with those available in the literature and, whenever possible, benchmarked against Varian Eclipse treatment planning system (TPS) predictions, essential for radiotherapy quality assurance programs.

Methods

The low-cost commercial PIN photodiode, BPW34, supplied by Osram, was manufactured in planar technology with an active area of 7.45 mm². The diode was covered with a black resin and connected in the photovoltaic mode to an integrating electrometer (PTW, Unidos E model) to be used as a dosemeter. The diode was positioned at the center of a PMMA plate with 30 x 30 cm² and 1 cm thickness, with its front face leveled with this plate surface. The dosimetric characterization was performed using a Varian True Beam 1762 accelerator, located at Real Hospital Português de Beneficência (PE), with filter flattening (FF) photon beams of 6 and 15 MV and filter flattening free (FFF) of 6 MV.

Results

The dose-response curves are linear (R^2 = 1) with less than 0.1% nonlinearity and 0.3% of repeatability parameters, regardless of the photon beam energy. The average dose rate effect (0.7%) is almost negligible within the range of 20-600 MU/min (6 MV, 15 MV) and 400-1400 MU/min (6 MVFFF). Despite these good results, the diode response depends slightly on the energy, within 5% for 6 MV-15 MV. Moreover, the general output field factor measurements and the percentage depth dose profiles are in excellent agreement with the Eclipse TPS calculations,

Conclusions

All assessed results adhere to the standard radiotherapy dosimetry protocols demonstrating that the diode BPW34 is a low-budget alternative radiotherapy photon beam dosemeter.