

Investigate optimal refractive index of matching liquid for 3D NIPAM gel dosimeter using optical CT

Bor-Tsung Hsieh¹, De-Shiou Chen¹, Jay Wu², Yuan-Jen Chang^{3, 4}

¹ Department of Medical Imaging and Radiological Science, Central Taiwan University of Science and Technology, 666,Po-Tze Lane, Taichung, 406, Taiwan

² Department of Biomedical Imaging and Radiological Science, China Medical University, No.91, Hsueh-Shih Road, Taichung, 40402, Taiwan

³ Department of Management Information Systems, Central Taiwan University of Science and Technology, 666,Po-Tze Lane, Taichung, 406, Taiwan

⁴ Institute of Biomedical Engineering and Materials Science, Central Taiwan University of Science and Technology, 666,Po-Tze Lane, Taichung, 406, Taiwan

ronchang@ctust.edu.tw

The accuracy of optical computed tomography scanners is strongly affected by refractive index of matching liquid. Mismatching refractive index will induce reflection and refraction while laser beam passes through gel phantom. The unwanted rays collected by photo-detector produce image artifacts after performing image reconstruction from collected data. In order to obtain best image quality, this study investigated optimal refractive index of matching liquid for NIPAM gel dosimeter. The NIPAM polymer gel used in the study was composed of 5% gelatin, 5% NIPAM, 3% N,N'-methylene bisacrylamide, and 10 mM Tetrakis (hydroxymethyl) phosphonium chloride. This study used a commercial optical computed tomography scanner (OCTOPUS-10X, MGS Research, Inc., Madison, CT, USA) as the readout tool for NIPAM polymer gel dosimeter. An acrylic cylindrical phantom with 10 cm (diameter) by 10 cm (height) by 3 mm (thickness) was filled with NIPAM gel and was immersed in an aquarium. The matching liquid was prepared using glycerol and deionized water.

The refractive indices were varied from 1.3392 to 1.4115, which were measured by a refractometer (ATAGO, Model:PAL-RI, Japan) at room temperature 22°C.

The results showed that the reconstructed image became blurred when refractive index larger than 1.4115. As refractive index decreasing, the central region became flat and the contour of gel container became clearer. The optimal refractive index is from 1.346 to 1.348 and the central flat region attain largest. As refractive index smaller than 1.345, the central flat region decreased and the contour of container became blurred again. This study also investigated the effect of color of matching liquid. Two matching liquids, one mixed with red dye and the other transparent, were compared with same refractive index 1.346. The results showed that maximum average deviation were less than 0.07% for the red color and transparent matching liquids. It concludes that the color of the matching liquid does not affect the measurement accuracy of NIPAM gel dosimeter measured by optical CT.