

# Evaluation of filament materials for polymer gel dosimetry in fused deposition modeling

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## **Purpose:**

Accurate dosimetric verification is becoming more crucial in radiotherapy, as modern treatment techniques require more complex beam control mechanisms and larger dose fraction sizes. Polymer gel dosimetry can be used to measure complex 3D dose distributions, but its use may be limited due to its strong reactivity with oxygen and other contaminants. For these reasons, the composing materials of the gel storage container are critical. The present study evaluated the dosimetric influence of air and the chemical transmittance of various polymer-based materials in fused decomposition modeling (FDM) type 3D printing.

## **Materials and Methods:**

The dosimetric gel material was composed of MAGAT normoxic polymer, with the reference container being a glass vial. Five types of filament materials that can be applied to the FDM type 3D printer were compared: acrylonitrile butadiene styrene (ABS), co-polyester (CPE), polycarbonate (PC), polylactic acid (PLA), and polypropylene (PP). The map of relaxation rates  $R_2$  ( $1/T_2$ ) measured by magnetic resonance imaging (MRI) of each material was evaluated, and response histograms and dose calibration curves were derived.

## **Results:**

The  $R_2$  distribution showed that CPE had clearer boundaries and a more regular size than the other materials. The profile of CPE was also closest to the reference vial, despite a slight distortion. Histograms and dose calibration curves showed that CPE provided the most homogeneous and the highest relative response of 83.5%, with 8.6% RMSE, compared with the reference vial.

## **Conclusions:**

These results indicate that CPE is the most suitable material for the FDM type 3D printing gel container, as shown by homogeneity and dose resolution. Although CPE has not been compared with every available material, the superiority of CPE to the other materials tested in this study suggests its suitability for 3D printers.

## **Keywords:**

3D printing, Gel dosimetry, filament material, CPE, FDM.