

Evaluation of filament materials for polymer gel dosimetry in fused deposition modeling (FDM)

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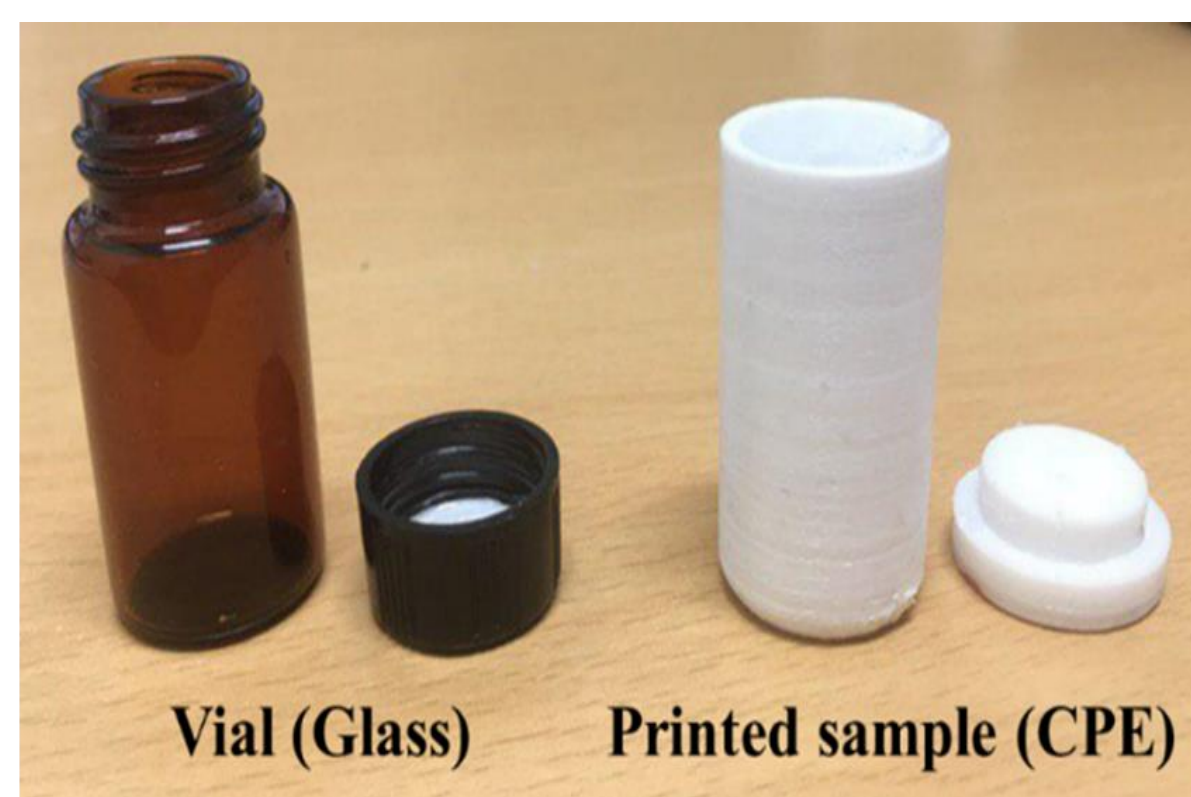
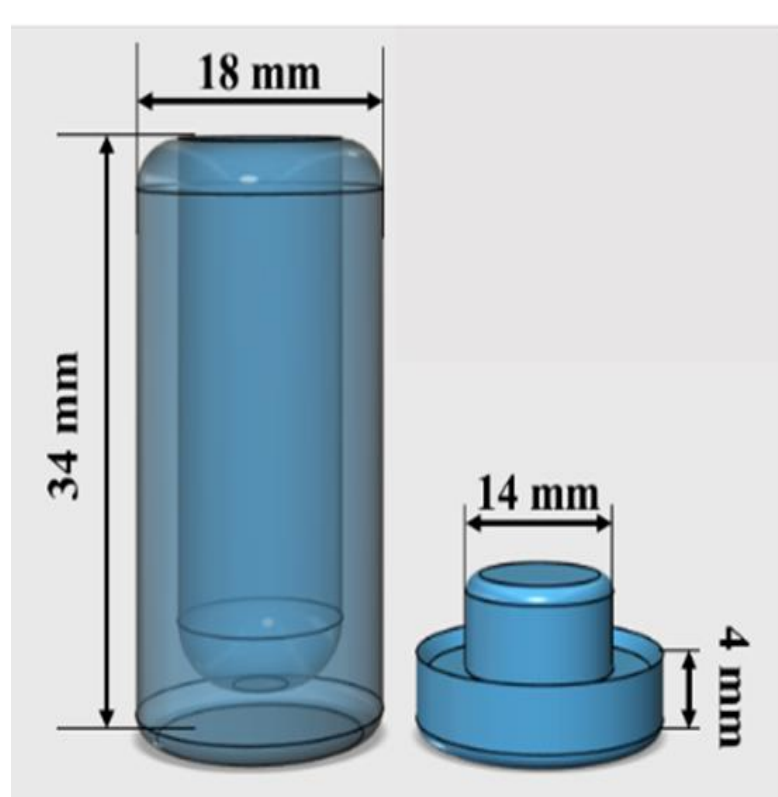
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Purpose

- **3D printing** technology can be applied to numerous fields
 - Medicine: Patient-specific design and fabrication of complex 3D structures
 - In this study, accurate dose verification in 3D (PSQA)
- 3D dosimetry → **Gel dosimetry**
 - High spatial resolution, tissue equivalent medium
 - **Strong reactivity** with oxygen and other contaminants
 - ✓ Gel storage container is also critical
 - ✓ Glass container mainly used → shaping limitations
- To utilize, 3D printing and gel dosimetry
 - **Low reactivity 3D printing container**

Materials & Methods

1. Polymer Gel : MAGAT normoxic polymer gel
 - Distilled water 85 %
 - Gelatin 6 %
 - Methacrylic acid (MAA) 9 %
 - THPC 10mM
2. 3D printing material (Ultimaker 3 Extended™ (Ultimaker, NLD))
 - Glass vial (reference)
 - Acrylonitrile butadiene styrene (ABS)
 - Co-polyester (CPE)
 - Polycarbonate (PC)
 - Polylactic acid (PLA)
 - Polypropylene (PP)

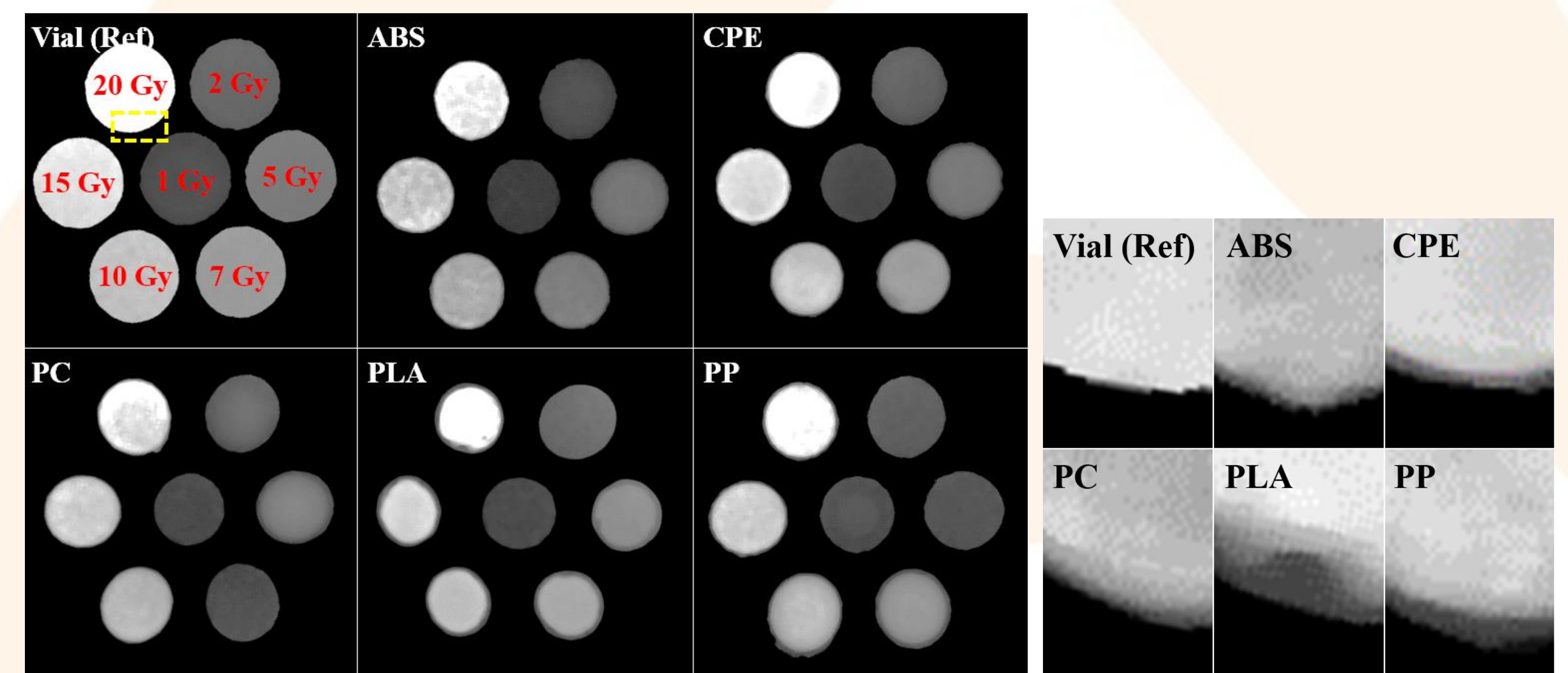


Design of container

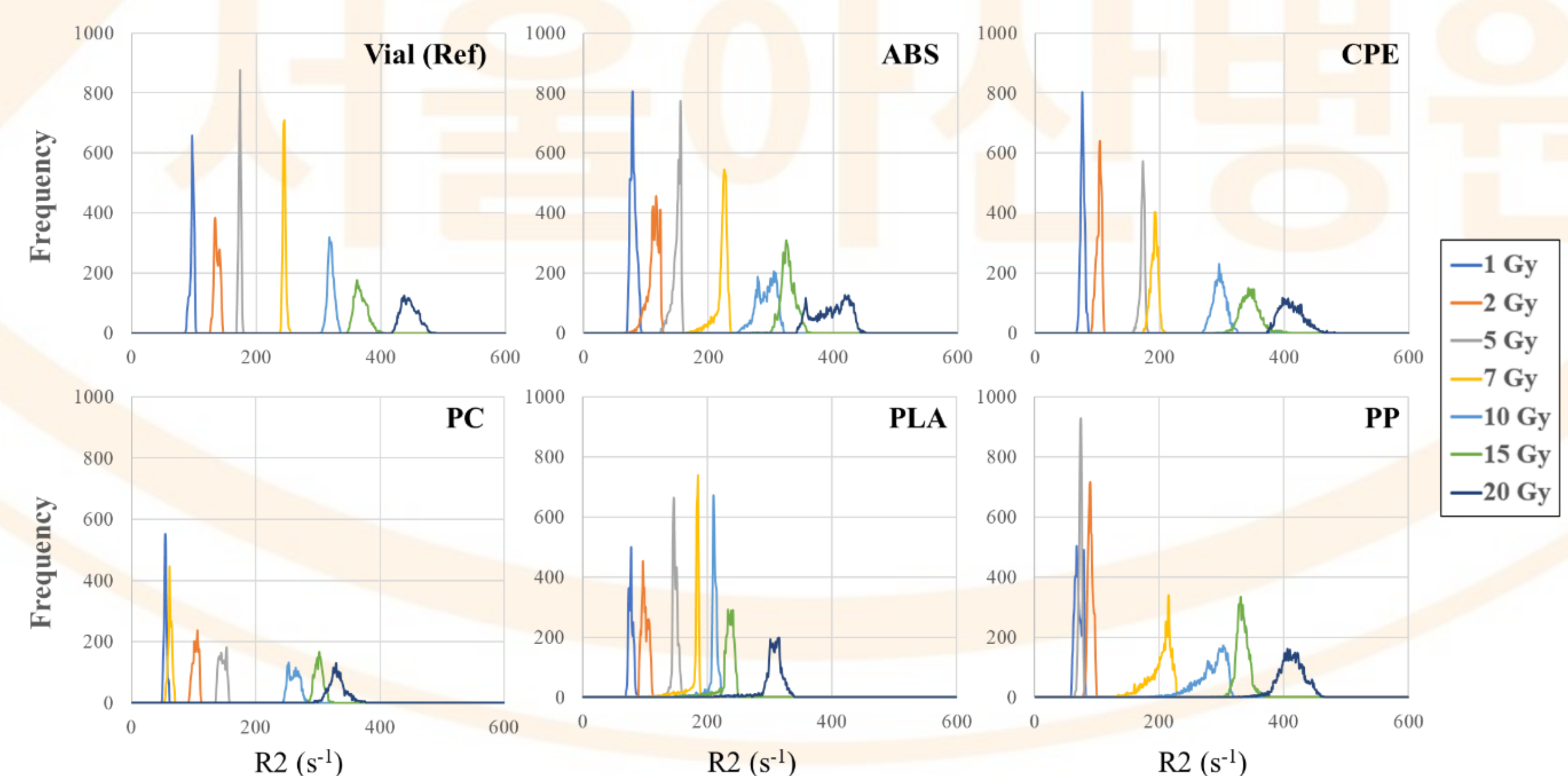
3. Dose delivery
 - 10 MV, 600 MU/min (0, 1, 2, 5, 7, 10, 15, and 20 Gy)
 - 10 × 10 cm field size at a 100 cm SAD
 - Bilateral beam directions of 90 and 270 degrees
4. MR scanning
 - 9.4T/160 mm Agilent MRI scanner (Agilent Technologies, USA)
 - TR = 3000 ms, 15 TEs = 12, 24, 36, 48, 60, 72, 84, 96, 108, 120, 132, 144, 156, 168, and 180 ms
 - Resolution = 256 × 256

Results & Discussion

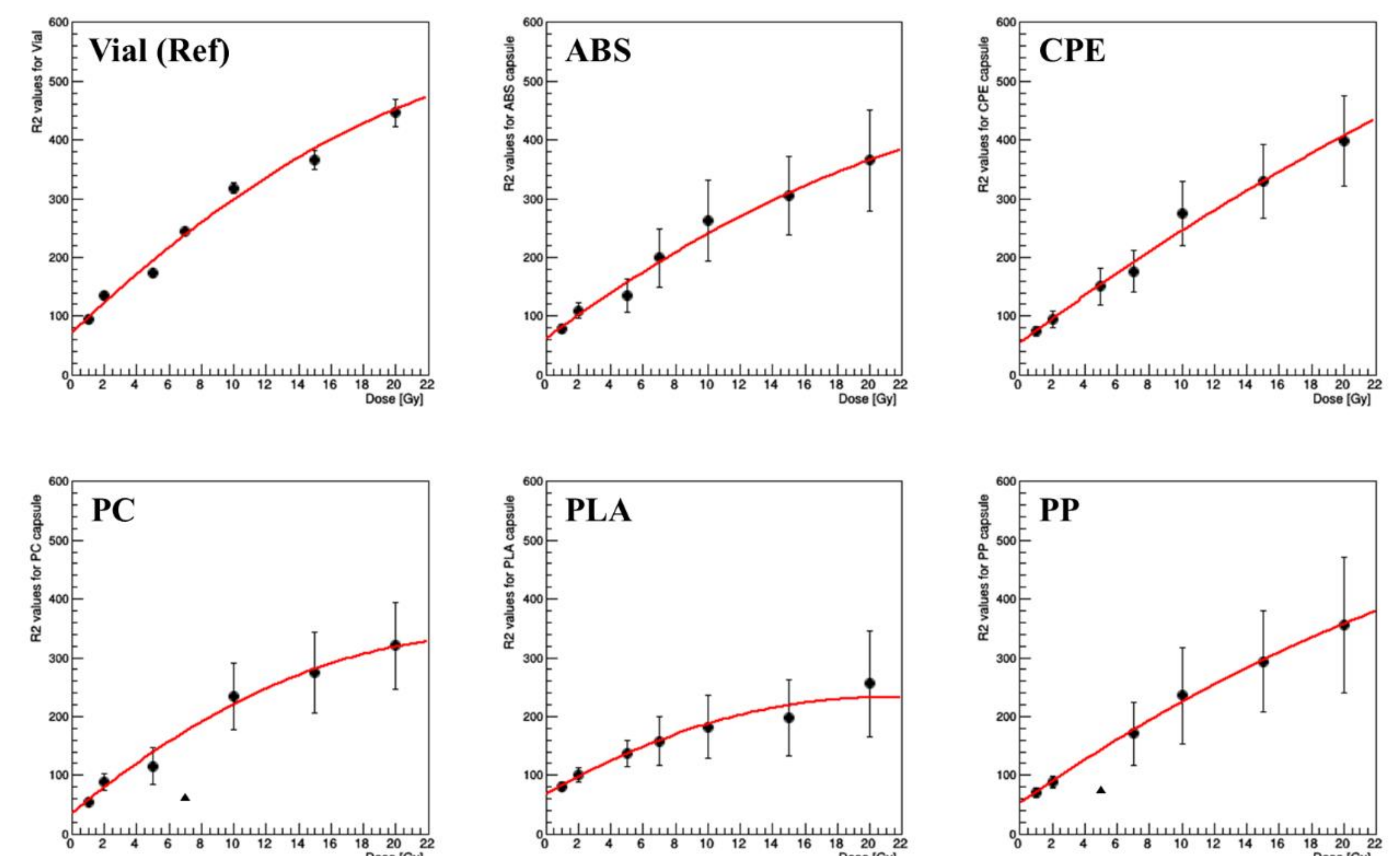
- **R2 maps of the irradiated gel bottles**



- **Histogram**



- **Calibration curves**



Conclusion

- The present study investigated several polymer-based **3D FDM printing materials** for gel dosimetry.
- **CPE** is the most suitable material for FDM type 3D printing of gel containers