Performance Improvement of Acrylic Acid Polyvinyl Alcohol Gel Dosimeter with Organic Additive for Radiation Oncology Applications

Belal Ali Moftah, PhD[1,3], Khalid A Rabaeh, PhD[2], Akram Almousa, MSc[1], Md. Abdullah Kafi, PhD[1]

[1]Medical and Clinical Affairs, King Faisal Specialist Hospital & Research Center, Saudi Arabia | [2]Medical Imaging Department, The Hashemite University, Jordan | [3]Medical Physics Unit, McGill University, Canada

Purpose

Develop and characterize a novel polymer gel dosimeter for 3D radiation dosimetry in advanced radiotherapy techniques (IMRT, VMAT).

Innovation

ACAGLPVA Gel Advantages:

- Room temperature stability (no refrigeration)
- Enhanced dose sensitivity with glucose additive
- Tissue-equivalent formulation
- Wide linear dose range (0–30 Gy)

Methods

Formulation: Acrylic acid–glucose PVA (ACAGLPVA) polymer gel

Irradiation: 6-MV linear accelerator, 0–60 Gy

Readout: Spin-spin relaxation rate (R_2) via NMR spectroscopy

Parameters:

- Dose rate: 200–600 cGy/min
- Beam energy: 6–15 MV
- Temperature: 5°C–35°C

Key Results

Dose Response: Strong linear relationship ($R^2 = 0.9979$) in 0–30 Gy range with dose sensitivity of 0.1766 $Gy^{-1}s^{-1}$

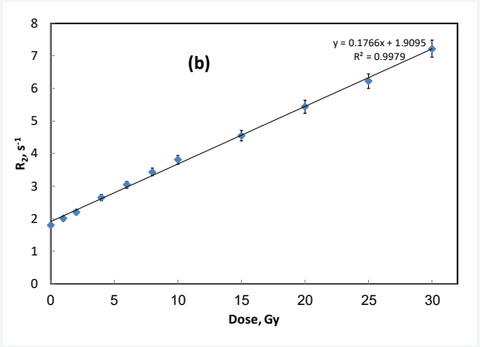

Figure 1: Spin-spin relaxation rate (R_2) vs. absorbed dose showing excellent linearity and sensitivity.

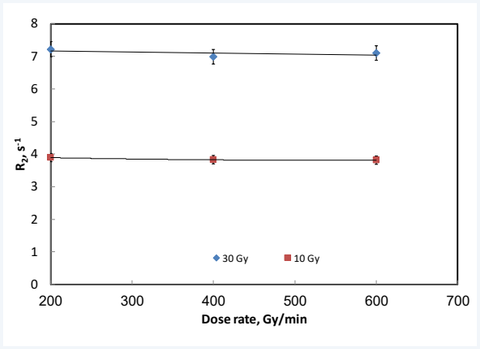

Figure 2: Dose rate independence (200–600 cGy/min) demonstrates robust performance.

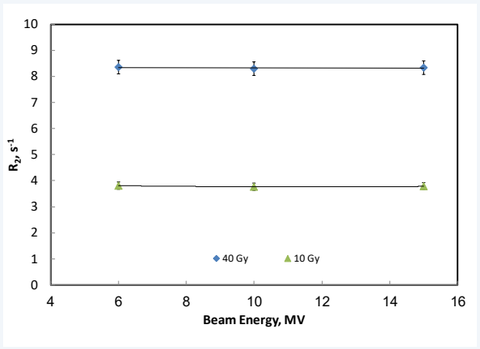

Figure 3: Stable response across photon beam energies (6–15 MV).

Environmental Independence

The dosimeter demonstrates consistent performance independent of key irradiation parameters:

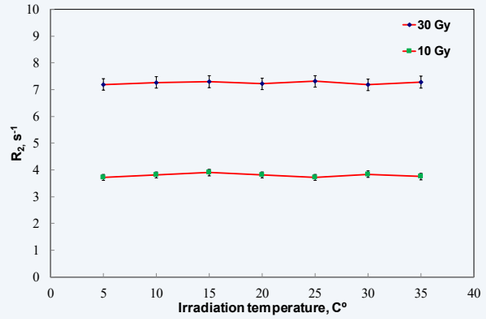

Figure 4: Temperature independence (5°C–35°C) confirms robust formulation.

Stability

Post-irradiation stability achieved after 4-day polymerization period, enabling delayed 3D dose readout and verification.

Conclusion

The novel ACAGLPVA gel with glucose additive offers:

- Robust linear dose response
- High sensitivity
- Independence from dose rate, energy, temperature
- Room-temperature stability

This provides a practical, reliable solution for accurate 3D dose verification in advanced radiotherapy, enhancing patient safety and treatment precision.

Contact: Belal Ali Moftah, PhD | bmoftah@kfshrc.edu.sa