COMMENT

Comment on ‘The influence of antioxidant THPC on the properties of polymer gel dosimeter’

To cite this article: Mahbod Sedaghat and Martin Lepage 2016 Phys. Med. Biol. 61 4342

View the article online for updates and enhancements.
Clarifications on the effect of antioxidant on dosimetry with normoxic polymer gels

Dear Editor, Sir;

The recent publication of Spěváček et al in 2014 Phys. Med. Biol. 59 5141–61 titled ‘The influence of antioxidant THPC on the properties of polymer gel dosimeter’ attracted our attention (Spěváček et al 2014). We strongly disagree with the model presented and with the simplified underlying physical and chemical processes proposed to take place in polymer gel dosimeters.

The paper investigated chemical effects of adding tetrakis(hydroxymethyl)phosphonium chloride (THPC) to a polyacrylamide-based (PAG) gel dosimeter and suggested a tentative model to estimate the amount and kinetics of chemical reactions in the dosimeter after irradiation. The purpose of the paper is to present a ’simpler’ model capturing the essential variations recorded from gel dosimeters.

We were satisfied to see results supporting our previously proposed theory that THPC modifies the structure and morphology of acrylamide/BIS polymer network in a gel dosimeter. However, no credit was given to the original idea proposed and tested in ‘Preliminary studies on the role and reactions of tetrakis(hydroxymethyl)phosphonium chloride in polyacrylamide gel dosimeters’ Phys. Med. Biol. 57 5781–994 by Sedaghat et al and their previous publications (Sedaghat et al 2011, 2012). It is our opinion that the physical and chemical processes in gel dosimeters presented by the authors should have been more thoroughly compared and discussed with regards to existing formerly published results.

Previously we showed that THPC acts as an active radical scavenger that reacts with oxygen as well as water and polymer radicals. In our opinion, the authors failed to consider two very fundamental aspects of the known chemistry in gel dosimeters.

First, BIS reacts more efficiently than AA. This was clearly established and further confirmed by the authors’ results. In the absence of THPC, the first few Grays of radiation will generate polymer with a very high BIS fraction. This fraction will gradually decrease as a function of dose and the degree of polymerization will increase as a function of dose. We previously proposed that the relaxivity of the polymer depends on its BIS content; it is plausible
that its optical properties also depend on the BIS content (Lepage et al. 2001). In the model proposed by the authors two exponential terms are required and interpreted by ‘(...)' the amount (and the character of the linkages) of water molecules in the polymer micelles (...'). Proof for either of these was not presented. They continued to propose that ‘(...)' it is necessary to assume the presence of another type of radical ‘(...)' again, proof or support for this chemical species was not presented. Further, the authors mention that ‘(...)' the decreased response of the dosimeter with a growing concentration of THPC cannot be explained by the decreased level of polymerization. Thus, its structure and its properties are influenced by THPC.' We partially agree with this statement as less polymer is formed AND the composition of the polymer differs because of early termination with unreacted THPC molecules.

Second, both monomers and THPC diffuse in irradiated gels. We provided results which were easily interpreted by these phenomena. The authors ignored diffusion of THPC in their model without explanation. In our opinion, diffusion of THPC is likely as important as the diffusion of monomers in the interpretation of the so-called ‘overshoot'. Consistent with our previous results, our interpretation of smaller overshoots in THPC-containing gels is that polymerization is terminated rapidly by unreacted and diffusing THPC molecules such that diffusing monomers cannot participate in the reaction.

It is worthy to note that while THPC is inevitably and continuously consumed by oxygen during gel fabrication and storage, its effective concentration decreases as a function of time. THPC reacts with the monomer and water radicals during polymerization such that its concentration decreases rapidly as a function of dose. Therefore, the extent and kinetics of polymerization also vary according to the consumption of THPC. For the same reason that by increasing or decreasing THPC concentration the dose response curve of a gel dosimeter shows a different behaviour, when THPC is consumed, the dose response of the gel tends to change as a function of the extent of this consumption. Therefore we cannot agree with the authors that ‘The addition of THPC... simplifies the entire reaction system of gelatine-oxygen-THPC and contributes to the reproducibility of the results’.

On a minor note, the authors stated that THPC ‘has proved to be the best’ oxygen scavenger and then cited our publication. We have not shown this. Instead our publications investigated the influence of THPC in polymer gel dosimeters. The authors also include statements such as ‘The presence of THPC in the gel also influences the scope of change of R2 in the period after the end of irradiation. With growing THPC concentration the scope of post irradiation changes decreases.’ We had reported such observations earlier (Sedaghat et al. 2011).

In conclusion, we commend the authors for trying to push the boundaries of our knowledge of polymer gel dosimeters. We recommend that future work attempts to account for all published observations made to-date and that a thorough discussion on existing interpretations should be presented and supported by experimental observations.

References