Development of high sensitivity polymer for MEMS gamma rays sensors

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Polymers are known to be quite sensitive to radiolysis. Therefore, the trend has been to increase their radiation stability by inserting energy traps (usually aromatic groups). In the current work, we seek to significantly improve the radiation sensitivity of Poly (methacrylic acid) (PMAA) in terms of gas emissions by inserting gold nanoparticles as radiation sensitizing elements.

The effect of high-Z metal nanoparticles is based on two phenomena: the first phenomenon is to artificially increase the apparent dose received by the polymer near the polymer/metal interface, thanks to the additional energy deposition provided by the secondary electrons emitted during the interaction between gamma rays and metal atoms [1]. The energy of these secondary electrons is hundreds of keV. The stopping power of secondary electrons at these energies being greater in polymers than in high-Z metals [2], the secondary electrons emitted in the metal will deposit an additional dose in the polymer around the metal NP. The second phenomenon involves the possible catalytic activity at the metal nanoparticle surface, as their high division level and important aspect ratio may promote certain pathways in the free radical reaction process [3].

Nanocomposites (PMAA/AuNPs) and (PE/AuNPs) with nanoparticles of various concentrations were synthesized and irradiated under gamma rays, in sealed glass ampoules, and the resulting radiolysis gases were characterized ex-situ by the association of high-resolution mass spectrometry and micro-GC. In addition, as this work is new, macromolecular defects created in these materials under electron beams were studied by online analyses using FTIR spectroscopy in the transmission mode.

We will discuss the effect of the presence of nanoparticles in the polymer on gas emission and on the formation of macromolecular defects.

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