EPR characterization of a medical grade polyethylene for high dose dosimetry

Khaled Farah and Faouzi Hosni

Energy and Matter Research Laboratory. National Center for Nuclear Sciences and Technology. 2020, Sidi-Thabet, Tunisia.

kafarah@gmail.com

International Conference on Applications of Radiation Science and Technology (ICARST 2017)

24 to 28 April 2017, Vienna, Austria

Aim of the study

- Study the nature and kinetics of the formation, conversion and thermal stability of the free radicals induced by gamma and e-beam radiation in polyethylene (P.E.),
- Find the correlation between the dose and the increase in the concentration of the various free radicals,
- Solve the main problem, the initial strong fading, that limits the use of P.E. as EPR high dose dosimeter.

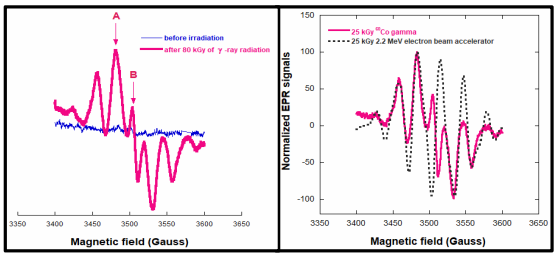
Materials and Methods

- Commercial medical grade polyethylene sheets of 28 microns thick and were cut into pieces of 10 mm x 2 mm dimensions for EPR measurements.
- The PE samples were subjected to different doses irradiation in air and in nitrogen at room temperature of Cobalt-60 gamma rays (5-193 kGy) and 2.2 MeV electrons beam (25-1000 kGy).
- The EPR measurements were recorded at room temperature by means of X-band Bruker EMX machine with a microwave frequency of about 9.5 GHz.

Results and Conclusion

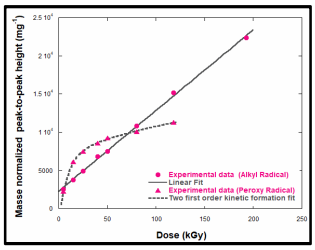
1. EPR spectra of gamma and e-beam irradiated P.E.

- No resonance for the not irradiated sample
- Superposed spectrum composed of singlet **B** and sextet patterns **A** was observed : **A : Alkyl Radical; B: Peroxy Radical**
- Peroxy Radicals are not observed in e-beam irradiated samples. It appears only after irradiation at 1000 kGy in Helium.



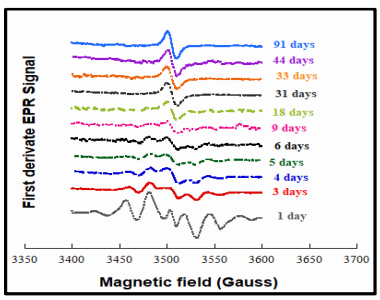
2. Dose response of gamma irradiated P.E.

- The increase of **Alkyl Radical** and dose is linear,
- The concentration of the **Peroxy Radical** as a function of the dose follows a model of two first order kinetic functions.



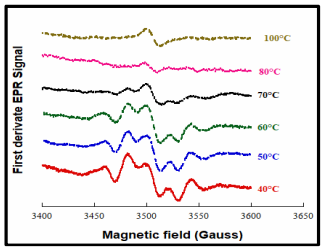
3. Room Temperature post-irradiation stability

- It has been found that the Alkyl Radical is not stable at room temperature.
- Only the Peroxide Radical persists.
- PR is a good candidate for dosimetry, but the very long time to stabilize it remains a disadvantage.



4. Effect of heat treatment

- We found that the Peroxy radical is completely separable after annealing for 20 minutes at 100 ° C.
- Peroxy radical remains relatively stable in air and at room temperature for several months following the heat treatment.



5. Conclusion

- Gamma and e-beam radiation induces two types of free radicals in polyethylene: Radical Alkyl and Radical Peroxide,
- The increase in the absorbed dose in the polyethylene is correlated with the concentration of the induced radicals,
- The radicals are unstable at room temperature, the isothermal annealing of the polyethylene at 100 ° C for 20 minutes makes it possible to obtain a stable signal which can be used to measure the high doses