Improvement of irradiated polymers by inorganic compounds - pertinent solution in respect with phenolic antioxidants

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The durability of polymers is one of the most important features that characterize their operation potentials. The material strength is often not convenient for peculiar applications like nuclear engineering. The stability improvement of radiation processed polymers can be effectively obtained not only by crosslinking, but also by the presence of appropriate additives. Looking for high tech materials, the addition of several fillers, for example silica, mitigates the oxidation and maintains the polymer composites in a convenient stable state. Though the classical solutions for the extension of durability are the synthesis or natural antioxidants, the new options for thermal and radiation stabilization are inorganic structures. The coordinated metal atoms forming complex structures are able to scavenge free radicals generated by the scission of macromolecules. The copper complexes are a pertinent solution for the protection of polymers (Fig. 1 [1]). The application of high energy irradiation promotes oxidative degradation, but the presence of an appropriate structure scavenging the free radicals slows down the progress of sample degradation (Fig. 2 [2]). The stabilization effects are tightly correlated to the electron distribution around an active spot, where the unpaired electron belonging to any free radicals may be attached. These places are characterized by an electron deficit, where the attachment of radicals is possible. A special stabilization activity is sustained by the lattice defects, which appears by doping. The structural modifications occurred in the filler molecules (polyhedral oligomeric silsesquioxane) by breaking Si-O bonds allow the penetration of radical in the trap.

The greatest advantages of the addition of inorganic compounds are their stabilities and the lack of decomposition and the migration through the degrading material. The coupling with other antioxidants reveals a prominent synergistic effect. The protection of polymer does not depend on the compatibility degree or on the irradiation dose; the delay of oxidation is only correlated with the radiation strength of polymer which generates high concentration of radicals.

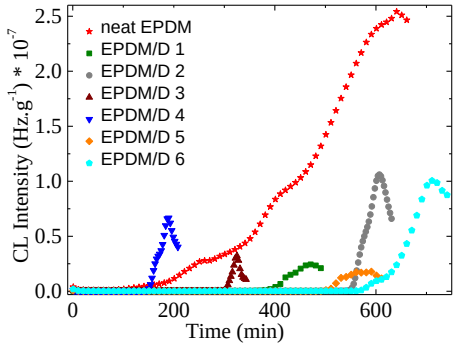

Fig.1. The isothermal CL spectra for the EPDM samples modified with some Cu complexes

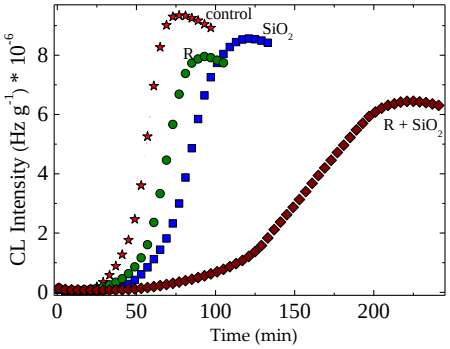

Fig.2. The isothermal CL spectra recorded on SIS samples irradiated at 50 kGy.

References:

[1] T. Zaharescu, A. Dumitru, M. E. Lungulescu, G. Velciu, Radiat. Phys. Chem. 118, 133-137 (2016)

[2] T. Zaharescu, Radiat. Phys. Chem. 206, 110765 (2023)