MOLECULAR OXYGEN AS THE RADIATION PROTECTER OF THE PLASTIC SCINTILLATORS

V.K.Milinchuk[1], V.B.Taraban[2], I.P.Shelukhov[2],G.S.Zhdanov[2], N.I.Voronkina[2], E.R.Klinshpont[2]

[1]Obninsk Institute of Nuclear Power Engineering,249020 Obninsk, Kaluga Region, Russia
[2]Branch of Karpov Institute of Physical Chemistry,249020 Obninsk, Kaluga Region, Russia

INTRODUCTION

The yield of the luminescence plastic scintillators decreases on the action of an ionizing radiation. The absorbed dose at which the luminescence yield decreases by 20 % is equal to 15 - 20 kGy for such the most suitable polymeric matrices as polystyrene (PS), polyvinyl xylene (PVX), polyvinyl toluene (PVT) and polymethylmetha crylate (PMMA). The luminescence yield decreasing is caused by the different reasons, for example, the deactivation of the excited states of polymeric matrices by the intermediates that are formed under the scintillator radiolysis, the lowering of the scintillator transparency as a result of new absorbing or scattering events (1). The paper summarizes the results of the study of the formation and reactions the macroradicals in vacuum and presence of oxygen and deterioration of the plastic scintillators under gamma-irradiation.

RESULTS AND DISCUSSION

The dependencies of the stabilized macroradical concentration and light yields vs absorbed dose in vacuum are antiabatic (at 300 K). The same changes of macroradical concentration and light yields vs heating time at 360 K are observed. Thus, the light yeild recover as a result of macroradical decay. The decreasing of the macroradical concentration take place on the postradiation oxydation process. On the contrary the light yeild increases in the presence of an atmospheric oxygen. The macroradical concentration and the light yeild dependencies on the absorbed dose in PS and PVX in presence of dissolved oxygen are an induction period on the curves. The induction period is absent when the dissolved oxygen is removed from the sample (2). These results show that an atmospheric oxygen and dissolved oxygen induces the decay of the macroradicals and promotes the light yield preservation. The molecular oxygen is the "victim" type. The reversible character of the radiation damage makes it evident that the macroradicals are the exited state quenchers. The overlapping of the energetic donor and acceptor levels are necessary for quenching. In the case of PMMA, PS and its substituted, this condition is fulfilled for both dopant containing matrix and macroradicals. The energy transfer from the matrix and primary dopant to the macroradical is allowed. Probably the macroradical quenching of the electron-exited states has an unlike mechanism caused by the spescific structure of macroradicals near the dopants. The dopant locations are the defects in which all radiation processes (such as the localization of the absorbed energy, the formation and reaction macroradicals and so on) proceed. The mechanism of the radiation-chemical processes in the plastic scintillators shows the following ways of the scintillator radiation resistance increasing: it is necessary to promote the oxygen diffusion into bulk of the scintillators by incorporation of low molecular additives or by decreasing the scintillator sizes; the decreasing of the macroradical radiation-chemical yield in polymeric matrices; the increasing of the macroradical dycay rate by the intensifying of the matrix molecular mobility (plasticizing, rise of the temperature and so on).

REFERENCES

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