

THERMAL DECOMPOSITION OF IRRADIATED POLY (VINYL CHLORIDE)

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Introduction: Poly (vinyl chloride) is widely used in nuclear industry (plastic bags, filter...) making it one of the main constituent of nuclear waste packages. Radiolysis of PVC and its behavior in nuclear waste package has been widely studied at room temperature [1]. However, the temperature of waste materials contained in transportation packages is often higher than room temperature and can reach up to 150°C in accident conditions (i.e. in case of fire of the transportation casks). Few studies have investigated the behavior of irradiated PVC at high temperature. The objective of this study is to determine the impact of the dose on the thermal decomposition of PVC. Industrial PVC was first irradiated in air at high doses (2, 4, 6 and 10 MGy) with a γ cobalt source at room temperature. Then, TGA/MS/FTIR analysis and FTIR analysis of the PVC polymer are used to characterize the thermal degradation.

Results and discussion: In non-irradiated industrial PVC, the thermal decomposition is initiated by dehydrochlorination at 250°C [2]. In irradiated industrial PVC, from 2 MGy up to 10 MGy, the thermal degradation is accelerated and occurs at lower temperature (100°C) as shown in Figure 1a. The analysis by mass spectrometry and gas FTIR reveals the formation of water, hydrogen chloride, CO₂ and small amount of benzene (Figure 1b). Moreover, FTIR of the PVC material reveals the decomposition of oxidation products, mainly hydroperoxides. Figure 2a and 2b illustrate the evolution of bands characteristic of hydroxyl groups ($\bar{\nu}_{O-H}$) and of chlorine ($\bar{\nu}_{C-Cl}$) when PVC is heated at 120°C, after irradiation at room temperature under oxidative conditions.

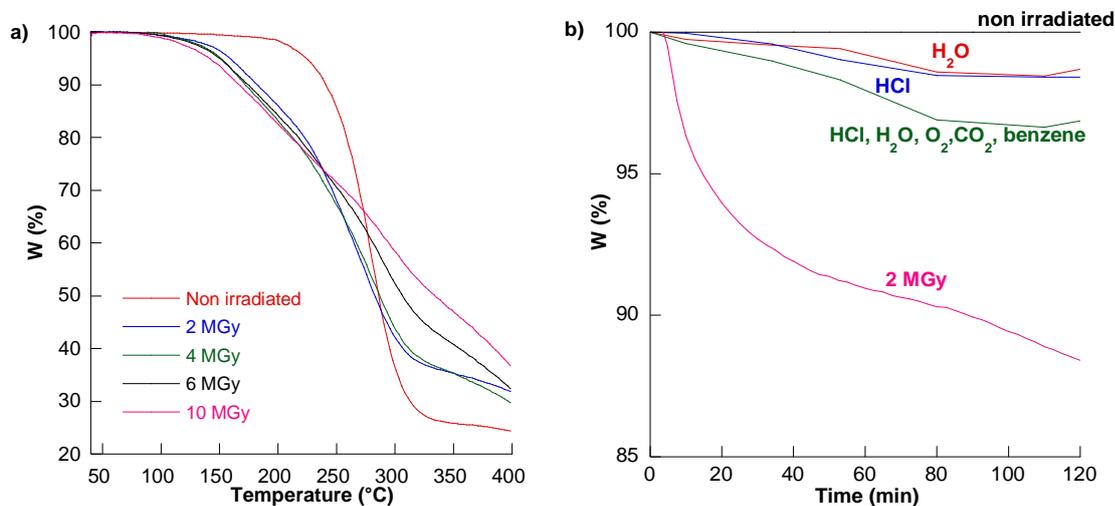


Figure 1: Thermal decomposition of PVC: a) Dose effect, b) Isothermal weight loss and HCl and water formation at 120°C.

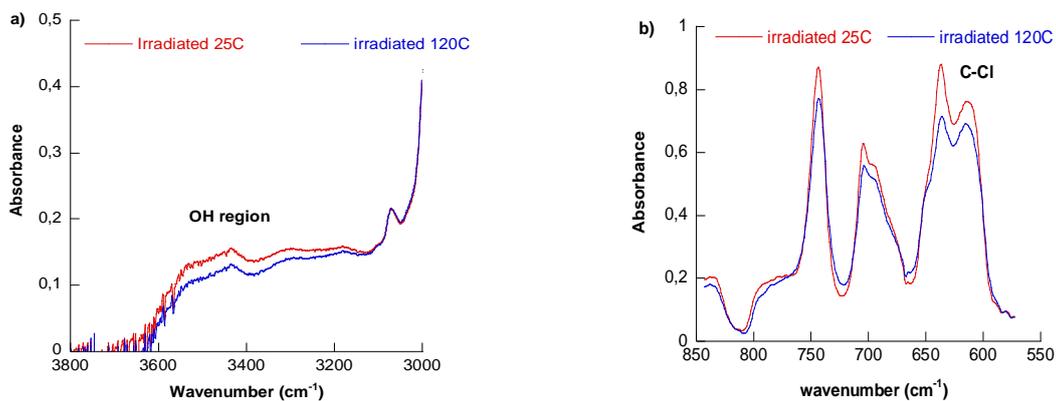


Figure 2: FTIR spectra of industrial PVC film irradiated at room temperature under air and followed at room temperature (in red) and at 120°C (in blue) under inert atmosphere: a) OH region b) C-Cl region.

Key words: PVC, radiolysis, thermolysis, thermogravimetry analysis

1. Colombani, J., et al., *ESR studies on poly(vinyl chloride) irradiated at medium and high doses*. *Polymer Degradation and Stability*, 2006. **91**(7): p. 1619-1628.
2. Benes, M., et al., *Thermal degradation of PVC cable insulation studied by simultaneous TG-FTIR and TG-EGA methods*. *Journal of Thermal Analysis and Calorimetry*, 2004. **78**(2): p. 621-630.