Contribution to the study of particle resuspension kinetics during thermal degradation of polymers.

S. Delcour[1, 2], F.-X. Ouf[1], N. Azema[2], A. Coppalle[3], J.Yon[3], L. Ferry[2], F. Gensdarmes[1], J.-M. Lopez-Cuesta[2]
[1]Institut de Radioprotection et de Sûreté Nucléaire (IRSN), PSN-RES, SCA, LPMA, Gif-Sur-Yvette, 91192, France.
[2]Ecole des Mines d'Alès, Centre des Matériaux (C2MA)-Pôle Matériaux Polymères Avancés
6 Avenue de Clavières, 30319 Alès Cedex, France.
[3]UMR 6614 CORIA, INSA de Rouen, Avenue de l'université, B.P. 8, Saint-Etienne du Rouvray, 76801, France
Keywords: resuspension, fire, polymers.
Presenting author email: simon.delcour@irsn.fr

In the nuclear industry, solid radioactive powders are manufactured, handled and treated in a confined way using glove boxes mainly composed of PolyMethyl MethAcrylate (PMMA) or PolyCarbonate (PC) sheets. The handling of such radioactive material may contaminate the inner walls of glove boxes and this surface contamination by particles may be released in case of accidental situation such as a fire. Therefore, in order to quantify the toxicological and environmental impact of a fire occurring in a nuclear facility, it is necessary to be able to predict the emission rate of radioactive aerosols in the event of such accidental situation. Given the complexity of using radioactive particles in fire experiments, alumina oxide (Al_2O_3) is used as a thermally stable (same as PuO_2) surrogate to investigate the effect of particle size. A theoretical model is being developed to help the identification of specific criterion for the choice of the surrogate.

The experimental setup is composed of a mass loss cone calorimeter modified for aerosol sampling. It is composed of a conical radiative heater which allows applying heat fluxes ranging from 10 to 100 kW/m^2 at the surface of the sample placed on a weighing cell. Soot and alumina oxide aerosol released are sampled using an isokinetic probe and filter holders on cellulose acetate membrane. The release fraction (ratio between emitted and initially available mass of contaminant aerosols) of surrogate aerosols deposited on sheets of PMMA and PC is determined by ICP-MS as a function of the size distribution of aerosol (Al_2O_3 with respectively 0.7 µm and 3.6 µm for geometrical diameter) and incident heat flux (from 25-35 kW/m^2 for pyrolysis to 45-50 kW/m^2 for auto-ignition). Further details could be found in Ouf *et al.* (2013).

Experimental results are reported on the resuspension of particles deposited on polymer samples representative of glove boxes used in the nuclear industry, under thermal degradation. A parametric study was carried out on the effects of heat flux, air flow rate, fuel type and particle size. Small-scale experiments were conducted on 10x10 cm² PMMA and PC samples covered with aluminium oxide particles. It was observed for both polymer (fuel) samples that heat flux has no effect on the airborne release fraction (ARF), whereas particle size is a significant parameter. In the case of the PMMA sample, ARF values for 0.7 and 3.6 µm diameter particles range from 12.2% (+/- 6.2%) to 2.1% (+/- 0.6%), respectively, whereas the respective values for the PC sample range from 3.2% (+/- 0.8%) to 6.9% (+/- 3.9%). As the particle diameter increases, a significant decrease in particle release is observed for the PMMA sample, whereas an increase is observed for the PC sample (see figure 1).

Furthermore, a peak airborne release rate is observed during the first instants of PMMA exposure to thermal stress. An empirical relationship has been proposed between the duration of this peak release (DT_{flash}) and the external heat flux (see figure 2). This relationship also fits the time to reach a surface temperature of 275°C.

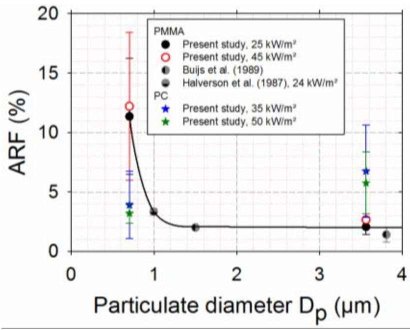

Figure 1. Evolution of ARF for alumina particles deposited on horizontal PMMA and PC sheets

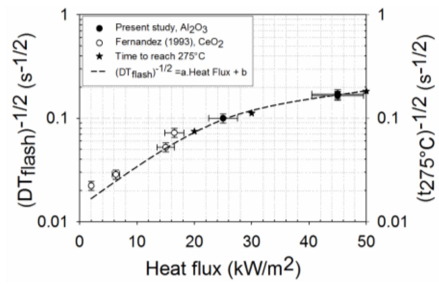

Figure 2. Evolution of duration of peak release as a function of heat flux for PMMA

Buijs, K., Chavanne de Dalmassy, B. and Pickering, S. (1989) *J. Nucl. Mater.***166**, 199-207.

Halverson, M., Ballinger, M. and Dennis, G. (1987) Combustion aerosols formed during burning of radioactively contaminated materials. Experimental results, NUREG/CR 4736. PNL-5999.

Ouf, F.-X., Delcour, S., Azema, N., Coppalle, A., Ferry, L., Gensdarmes, F., Lopez-Cuesta, J.-M., Niang, A., Pontreau, S. and Yon, J. (2013) *J. Hazardous Materials,* http://dx.doi.org/10.1016/j.jhazmat.2013.01.060

Fernandez, Y., Experimental study on release of radioactive aerosols during the thermal degradation of contaminated organic materials present in nuclear installation, *In French*. PhD Thesis, Université de Savoie. Rapport CEA-R-5663 (1993).