Preliminary measurement results on aerosol emission from materials combustion

M. Targosz*, C. Chivas-Joly, L. Saragoza, C. Motzkus, F. Gaie-Levrel

LNE, 29 Avenue Roger Hennequin, 78197 Trappes Cedex, France
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Presenting author e-mail: marta-malgorzata.targosz@lne.fr

Introduction

The use of composite materials for aeronautical and naval applications becomes widespread nowadays. Due to their specific properties, composites have the potential to reduce the mass of vehicles (and thus fuel consumption) and contribute to the improvement of some other characteristics like mechanical strength and stiffness. Generalization of the use of composite materials in transportation should also reduce its environmental impact by decreasing CO_2 emissions.

However, one of the main problem of using composite materials is their behavior in case of fire, including post-crash fires. At higher temperatures, the organic matrix of composites decomposes with gaseous species and aerosols release, which toxicity aspects are still unknown. For that reason, the assessment of potential health and environmental impacts caused by the dispersion of solid and gaseous degradation products from aeronautical materials in a post-crash fire is essential.

This research project intends to understand and characterize the production of aerosols and gases from the combustion of composite materials as well as to model their dispersion into the atmosphere, based on experimental and numerical results.

Experimental setup

The fire behavior, qualitative and quantitative production of aerosol and gaseous species will be determined by using a Cone Calorimeter (CC) coupled with a set of metrological devices (Figure 1) as Dekati Low Pressure Impactor (DLPI), Dilutor L7 (hot stage dilution), Dilutor VKL10 (cold stage dilution), Condensation Particle Counter (CPC 3022), Aerodynamic Particle Sizer (APS 3321), and Scanning Mobility Particle Sizer (SMPS 3080). The morphology of aerosol particles collected on each DLPI stage will be analyzed by Scanning Electron Microscopy (SEM).

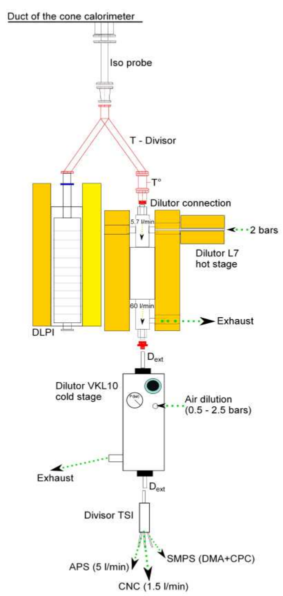

Fig.1. Experimental layout.

First results

The fire behaviour of various structural aircraft and naval composites under defined combustion conditions (75kW/m^2) has been studied in order to select materials characterized by the shortest burnthrough time, the highest level of damages, the highest yield of smoke release and the presence of volatile soot and fibers. A preliminary analysis of gaseous and solid combustion products for two selected composite materials was performed. The number of particles generated over time during combustion of MAT4 and MAT7 (epoxy resin/carbon fibers and epoxy resin/unidirectional carbon fibers, respectively) in two experiments performed for both materials, are shown in Figure 2.

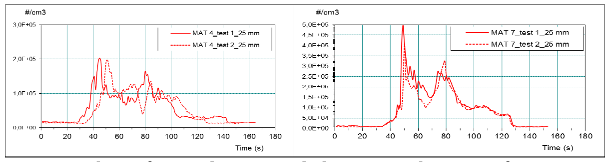

Fig.2. Number of particles emitted during combustion of MAT4 and MAT7, sample size 25x25 mm.

The SEM pictures presented in Figure 3 show the morphology of collected soot particles in the 6th and 10th DLPI stage during combustion of nanocomposite MAT4.

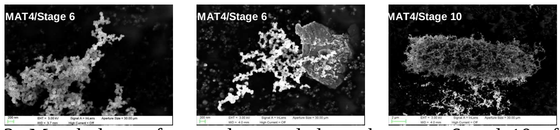

Fig.3. Morphology of aerosols sampled on the stage 6 and 10 of the DLPI during MAT4 combustion.

Conclusions

Smoke production during combustion of structural composites is related to the burnthrough test, applied fire conditions, and specifically by the presence of fibers and the nature of polymer materials. The preliminary SEM observations of the aerosol surfaces helped to identify several visible fibers depending on the composite composition. The soot particles morphology seems be different between the DLPI stages for both tested materials.

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