NANOMATERIALS INCINERATION AND PARTICLES RELEASE

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Abstract

INNANODEP is a cooperative project between LNE and ARMINES, supported by ADEME in France, targeting specifically a research on Nanocomposite, Environment and Recycling. The objective of the project is to study current nanocomposites for which there is no recycling or revalorization solution, the only alternative being incineration[1]. The applications under consideration are mainly products from the field of sport, high performance technical equipment or aeronautical/naval area. For such applications, mechanical performances are increased by the incorporation of nanocharges. The polymer matrices that are most often used are thermoplastics such as polyamide-6 (PA6-), polycarbonate (PC) and thermoset (TS) like epoxy resins. Within the framework of this project, we will focus on nanocomposites made of these matrices,and target on those nanocharges which could potentially have an impact on health when released during incineration. The two main interests of this study are: a) to establish the specific emissions of fine particles resulting from the nanocomposite incineration which are not taken into account at the end-of-

life of the incinerated nanocomposites, b) to produce a knowledge complementary to that of projects already carried out, such as in NanoFeu[2,3,4] implementing original methodologies and experimental techniques.

1. Description of the project

1.1. Position of the project

Many National and European programmes devoted to the study of risks related to the production or use of nanoparticles, are under way.

These studies can be considered as specific work on:

- the risks linked to the exposure of populations, especially when nanoparticles are being manufactured;
- the intrinsic toxicity of emerging nanoparticles;
- the understanding of interactions between nanoparticles and the human being;
- the design of specific detection methods;
- the enhancement of experimental procedures aiming at determining the toxicity level;
- the provision of regulations and recommendations.

However, there is no specific programme dedicated to the assessment of potential hazards linked to the release of particles produced at the end of the cycle of life of nanoparticle-based materials.

In Europe, no project considers hazards related to the release of ultrafine particles during intentional burning by incineration of nanocomposites.

Recently, A. Morgan[5] reported the current available knowledge related to the flammability of nanocomposite polymers and flame retardants. Nevertheless, no knowledge on the dissemination of particles through accidental or intentional burning of nanoparticle-based materials is reported.

1.2. General objectives

One of the main objectives of the present research consists in understanding the impact of the nanocomposites characteristics on the structure and composition of ultrafine particles that are released during the incineration process. Different incineration scenarios simulated with a cone calorimeter and characterised by different radiation levels and flammable atmospheres will be followed.

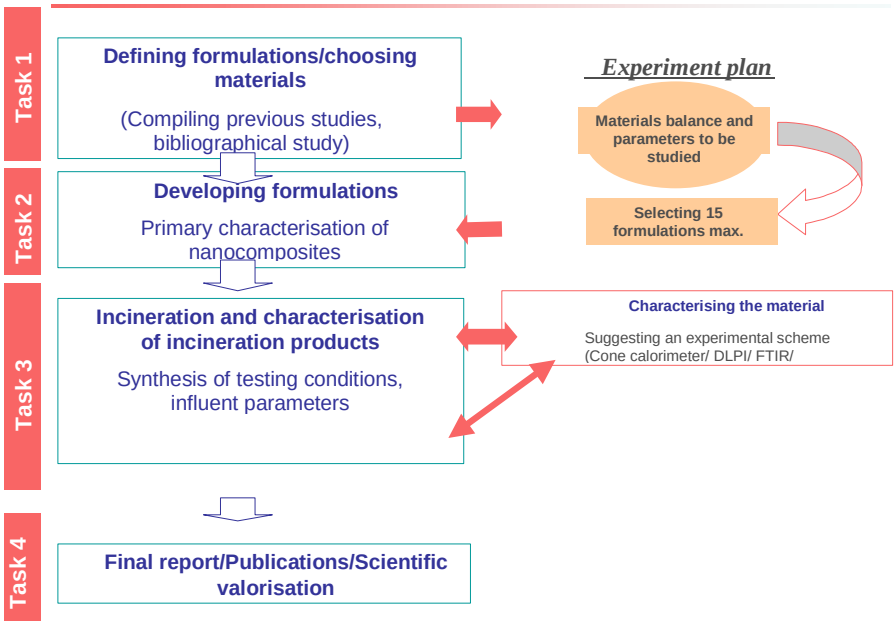
The behaviour of nanocomposites will be compared with that of virgin polymer-matrix ones to determine whether the structure of the released particles is significantly different in function of the incorporation level, and whether nanoparticles are released or not into the flammable atmosphere as a function of their surface or functionalisation treatments. The goal is to draw a precise material balance between the amount of nanoparticles that are released in aerosol compared to that of the burnt residue..

Another objective is to determine whether specific dispersion states of nanoparticles contained in polymer-matrices (state of aggregation or

agglomeration for nodular particles, inserted structure) can modify the composition as well as the granulometry of the released fractions.

Since previous work has shown that the presence of nanoparticles might modify the degradation process of polymers, the project intends to understand the structure and composition of the released particles in relation to nanoparticles/polymer interactions (or associated degradation products) during the degradation process. Some authors succeeded in understanding the nanoparticles/polymer interactions during the degradation process, especially with carbon nanotubes in fire scenarios. However, this is a novel procedure for incineration scenarios. On the basis of the results, recommendations might be made in terms of compositions and optimal surface or functionalisation treatments in order to limit the amount and toxicity of particles that are released during the incineration of the nanocomposite.

The 30-month study programme is made up of four tasks.



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