NANOHOUSE

# 5. 'Nanowaste' management

*NanoHouse Dissemination report N° 2013-05*

HOUSE COATING NANOPRODUCTS

*Grant agreement N° 247810*
*Activities towards the development of appropriate solutions for the use, recycling and / or final treatment of nanotechnology-based products.*
*An European Integrated Project Supported by through the Seventh Framework*

*Dissemination reports from NanoHouse project are designed to highlight and present in a simplified way the main results obtained in the studies carried out during this project. These reports mainly deal with one question which is of general concern for whom is interested by the **Cycle of Nanoparticle-based Products used in House Coating**. The full results are summarized in the corresponding Technical reports.*
***All the Dissemination reports and Technical reports are publicly available from NanoHouse project website**: **http://www-nanohouse.cea.fr***

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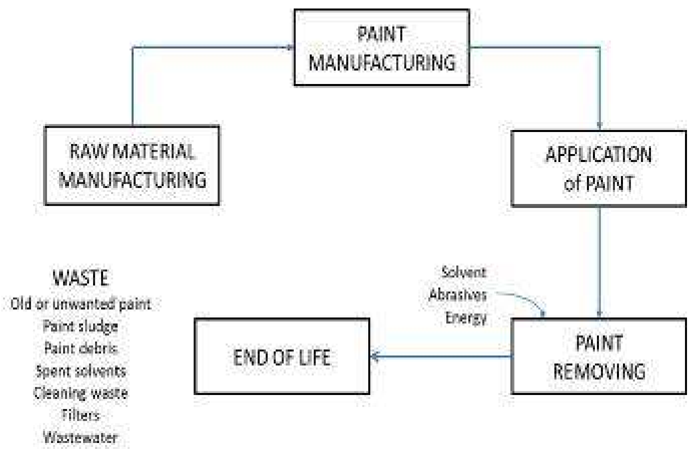
# *Why should we care about 'nanowaste'?*

*Nanowaste management issue*

'Nanowaste' refers to waste containing nanomaterials or items contaminated with nanomaterials. The increased production and use of nanomaterials and finished products that contain nanomaterials will introduce nanowaste streams into the environment.

May nanowaste be considered as hazardous waste? What are the potential risks of nanowaste at the working place? How can nanowaste be managed in a sustainable way?

To date, there are no specific regulations on, neither published statistics for nanowaste volumes. In addition, the behaviour of nanowaste in treatment plants is unknown!




*Paint product life cycle*

The wastes produced during the manufacture and use of paints have long been an environmental issue.

After a consumer has used paint from a particular purchase, any leftover paint may go into one of several disposition pathways, such as local municipal solid waste (MSW) landfill, incinerator (in liquid or dried form), as well as collection, management and disposal as hazardous waste according to household hazardous waste collection program.

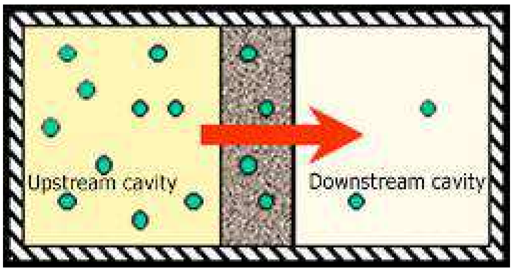
## *The quantification of generated volumes is the first step of the nanowaste management.*

# Which tests to implement for characterizing nanowaste?

*We investigated landfill behaviour of nano-based paint debris by means a leaching test usually applied for characterization of construction/inert waste and verified possible incineration of that debris by means an appropriate thermal treatment in oven/furnace*

*Paint debris example*

Nano-based paint debris were obtained by applying nano-based paint on plastic panels, and after drying in indoor ambient, applied paints were removed from panels and sieved to obtain fine granular debris (i.e. powders < 4 mm). Then sieved powder paints were used for EN ISO 12457-3:2002 leaching test normally used for characterization of granular waste.




*Diffusion experimental device*

Finally, diffusion experiments were conducted to evaluate the barrier property of geomembranes (i.e. thin (1 to 4 mm) LDPE or HDPE membranes used in landfills). LDPE membranes 100 times thinner than the actual ones used in landfills were put in contact with suspensions of nanoparticles used in paints in the upstream reservoir of a specifically designed diffusion cell. The concentration of nanoparticles in the downstream reservoir was monitored as a function of time.

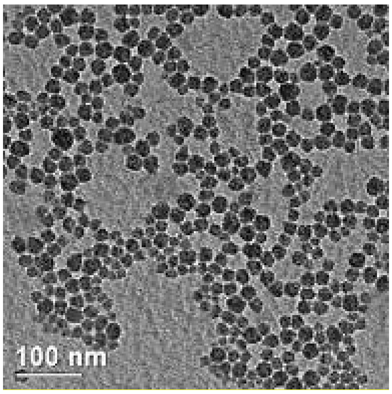
*The chamber furnace used to simulate the incineration of nanowaste (Source: SSV - Glass Research Facility – Murano, Venice)*

An experimental protocol was defined for the incineration of paints including thermal treatment in a chamber furnace with air supply and using silico-alumina crucible to carry the input material (i.e. paint debris). The paint debris were heated up to about 950 °C for 2 h to simulate typical condition in a full scale incineration plant.

With respect to re-use and final treatment solutions, an inertisation technique as vitrification was proposed and tested to transform ashes obtained from incineration into useful leac-resistant materials (e.g. glass-based material).

## Leaching tests applied to paint debris simulate a landfill scenario to provide information about the ENPs release.

# Are nanoparticles released from paint debris?



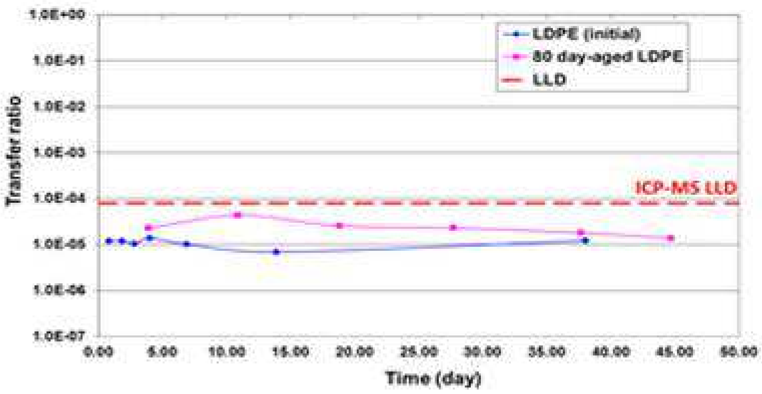
*Aggregate $SiO_2$ ENPs*

Considering leaching tests $TiO_2$ release was quantified only about 0.0001% of the total $TiO_2$ in the paint. $TiO_2$ nanoparticles seem to be attached to other organic materials, probably organic binder leached from the paint.

The release of $SiO_2$ nanoparticles was measured only about 1.48% (w/w) of the initial amount of $SiO_2$ used in paint.

Besides, electron microscope images showed that single $SiO_2$ ENP were released mostly as aggregated particles. $SiO_2$ ENP aggregation is caused either by binder properties or the functionality or the dispersing agent of paint.

Considering diffusion tests, neither the $SiO_2$ nor the $TiO_2$ nanoparticles cross the membrane after over one month of constant exposure, which corresponds to an effective efficiency of the geomembranes over 12 years in real conditions. Similar results were obtained with artificially-aged membranes (80°C for 80 days).



*~10nm $SiO_2$ diffusion across 10µm-thick LDPE membranes*

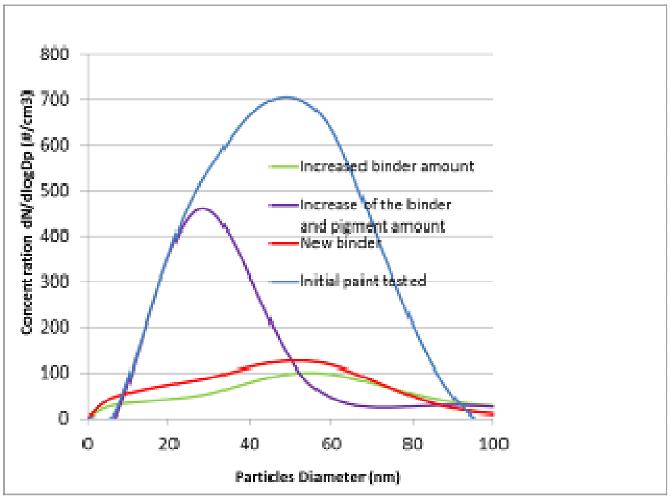

*Glass obtained from ashes*

During the incineration, we did not observe a volatilisation of nanoparticles used in paint. However, nanoparticles were observed in solid residues / ashes eventually handled and disposed in landfills or final deposit. Nanoparticles containing solid residues were finally stabilised by means a vitrification process, starting from a mixture of 60 wt% ash and 40wt% cullet glass, in order to obtain an inert glass-based product similar to calcium oxide used to produce insulating building materials similar to mineral wool glass and expanded clay.

**These first experiments represent a significant advancement towards sustainable end of life solution of solid nanowaste.**

# *How to improve the safety of nano-based paint?*

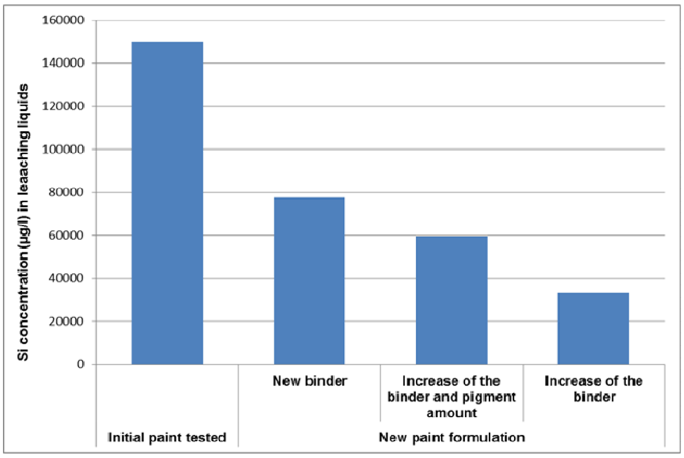
*In order to overcome the release of nanoparticles from paint debris, we tested three new formulations by changing the pigment volume concentration through increased amount of binder, pigment and also new type of binder.*




*Influence of the formulation on the size distribution*

Considering abrasion tests, by increasing the binder in new paint formulation, it is possible to reduce **strongly** the release of free and agglomerates of $SiO_2$.

Optimizing pigment into a paint formulation helps to decrease toward zero the release of SiO2 agglomerates when abrasion is performed on an aged paint.




*Concentration of Si released during the leaching test of new paint formulation*

Considering leaching tests, it was observed that amount of released Si is lesser for new formulations than the initial paint tested.

The type and the amount of **binder and pigment** influence the Si release. Si is mainly present in dissolved form in the leaching liquids collected from new paint formulation.

## *Nanoparticles release form paint debris is influenced by the binder: new formulations can reduce the ENP release.*

*NanoHouse brings together twelve partners from eight different countries. The project is supported through the 7th Framework Programme for Research and technological Development. The project has started in January 2010 and will end in June 2013.*

*NanoHouse considers the **whole product life cycle** in regard to EHS and to study the environmental behaviour and the toxicological effects of the **actually released Engineered NanoParticles ("aged" ENPs)**, and to compare them with the pristine ENPs.*

# Partners

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|---|---|
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| **Eidgenössische Materialprüfungs- und Forschungsanstalt – EMPA**<br>www.empa.ch | **CH** |
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NANOHOUSE

Dissemination report

# Nanowaste management

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These first experiments represent a significant advancement towards sustainable end of life solution of solid nanowaste.

Nanoparticles release form paint debris is influenced by the binder: new formulations can reduce the release of nanoparticles.