

Applying safe –by-design approaches in construction

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Best Practice Guide- Risk Prevention

1. Mapping the construction sector & exposure scenarios to NOAAs
2. Risk Prevention Strategies
3. Best Practice

1. Mapping the construction sector & exposure scenarios

Life cycle step	Nano-object and application					
	nano-TiO2 depollutant mortar	nano-TiO2 self-cleaning coating	nano-SiO2 self-compacting concrete	nano-Clay(fire retardant panels	carbon nano-fibers coating laminates	nano-cellulose insulations
Nano-object manufacturing	X	X	○			
Manufacturing nano-enabled products and application	X	⊗	○	○	X	X
Use/maintenance: Machining	X	X	X	⊗	X	X
Demolition	X	X	X	⊗	X	X
Accidental fires	X	X	X	X	X	X

⊗ scenarios measured at lab/pilot/industrial scale
 ○ scenarios measured in Industrial Case studies

The results found that in general workers performing the tasks measured were not overexposed to NOAAs in the scenarios investigated; data of occupational exposure were below the limits proposed for the NOAAs by Scaffold.

2. Risk Prevention

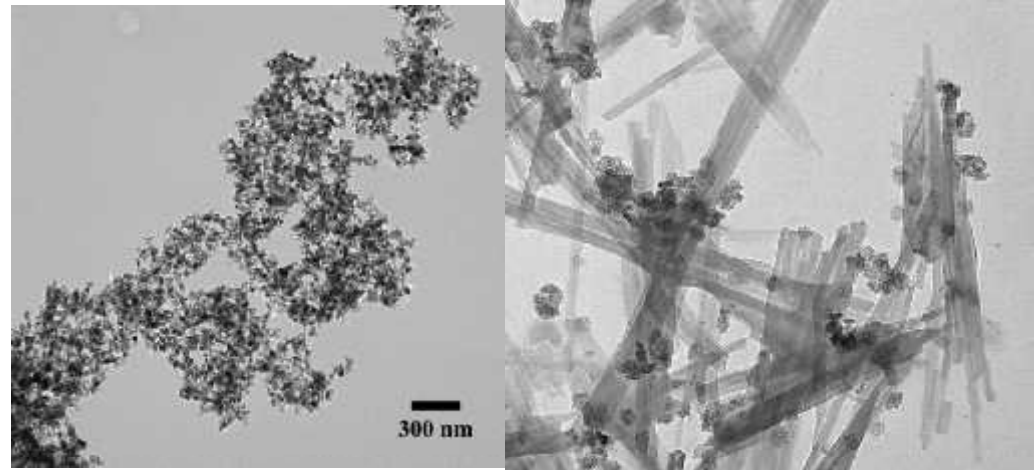
Overview of strategies used in Scaffold

	NOAA	Strategy	Potential impact on:		
			Formulation	Application	Use/Maint.
Nano-filler	n-TiO ₂	Using n-TiO ₂ supported on sepiolite	X	X	
		Getting high concentrated dispersions	X		
	n-SiO ₂	Getting high concentrated dispersions	X		
	Nanoclay	Using modified nanoclay to release smoke in case of fire			X
	Nano-fibers	Achieve good dispersions-NOAA bounded to the matrix			X
Process	Nanoclay	Reduction of energy in agitation processes	X		

n-TiO₂:

Strategy: Support of nanoparticles on microparticles

TEM micrograph of a conventional TiO₂ nanoadditive (left) and a safe-by-design nanoadditive composed of TiO₂ supported on sepiolite microfibers (right)



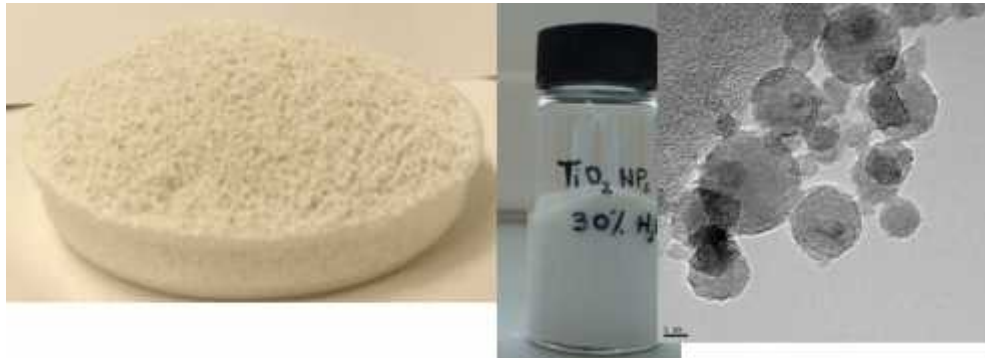
Safety impact:

Experimental data from SCAFFOLD shows that **occupational exposure** to nano-TiO₂ was **smaller** when using the additive of nano-TiO₂ supported on sepiolite than when using nano-TiO₂ powder directly.

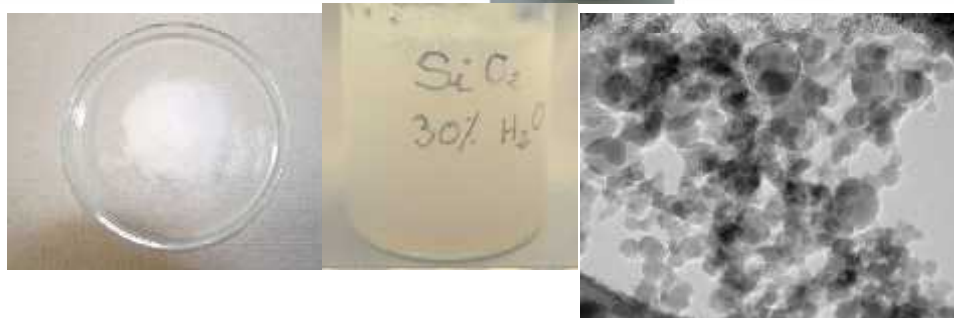
Occupational Exposure 8h-TWA to TiO ₂ (mg/m ³)		
	n-TiO ₂ /Sepiolite	n-TiO ₂
Mortar manufacturing	0.008	0.073
Mortar application	0.016	0.043

n-TiO₂/n-SiO₂:

Strategy: preparation of highly concentrated aqueous suspensions



n-TiO₂ in form of powder (left), 30%wt aqueous suspension (center) and TEM image of the nanoparticles (right)



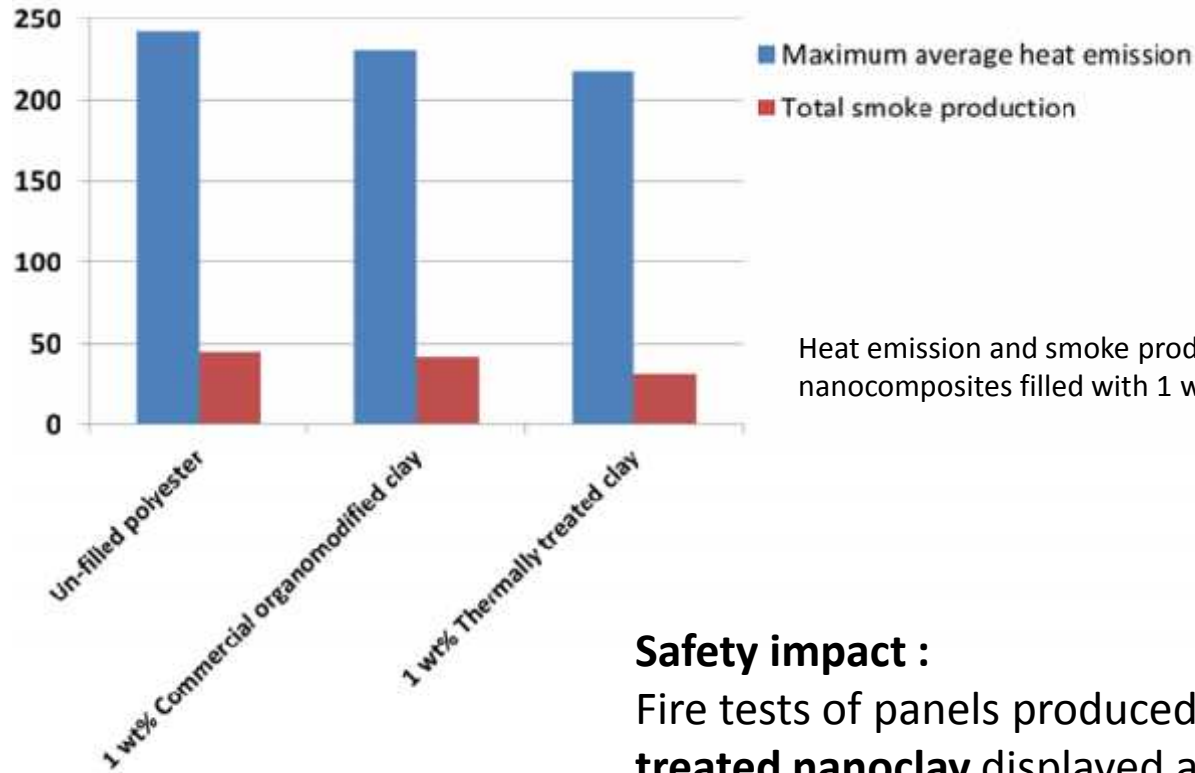
n-SiO₂ in form of powder (left), 30%wt aqueous suspension (center) and TEM picture of the nanoparticles (right).

Safety impact :

More concentrated and stable suspensions (30%wt) were synthesized in order to **reduce the volume** of commercial products and **risks associated to the manipulation** of large quantities of powders.

Nanoclay:

Strategy: Thermal modification to reduce the risk of toxic smoke emission during fire



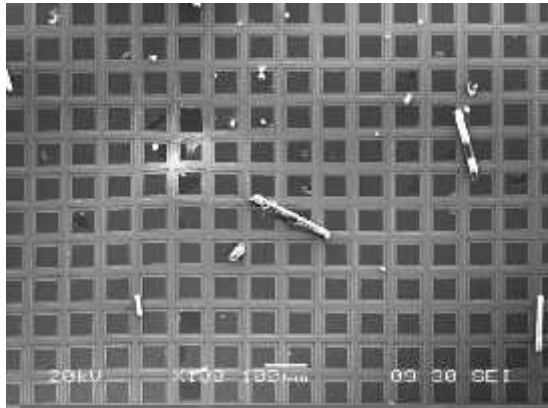
Heat emission and smoke production measurements for PS matrix and nanocomposites filled with 1 wt% of both nanoclays

Safety impact :

Fire tests of panels produced using the **thermally treated nanoclay** displayed a slightly **lower total heat emission and smoke production**, compared to the commercially-available organomodified clay

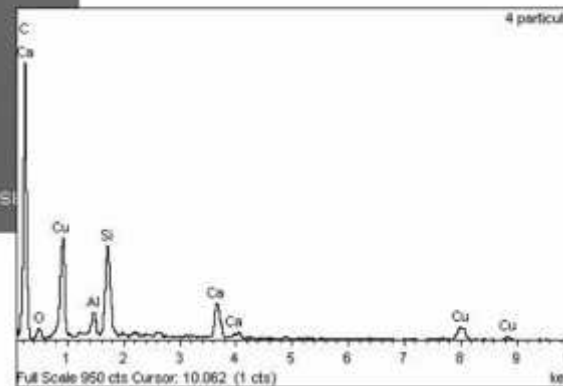
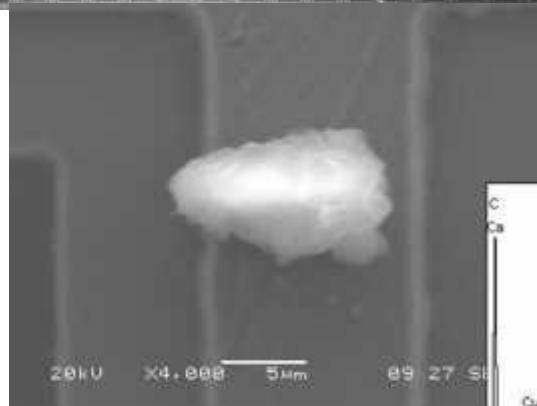
Nano-fibers:

Strategy: improvement of the dispersion and compatibilization matrix/MNMs



Safety impact :

Samples collected during machining tasks did not identified free CNF. The **improvement of the dispersion and compatibility between phases** (by using superficially modified nanofibers) may reduce the likelihood of having poorly attached agglomerates.



SEM images at the PBZ; evidence of glass fibers (picture above) and particles with C, Si, Ca, Al from polymer, glass fiber and potential CNF embedded (picture below); no free CNF identified

Nanocays:

Strategy: Designing the clay-polymer mixing process in order to minimize inhalation exposure risk



Safety impact:

Lower energy processes of mixing **to reduce potential splits**. Experimental testing showed that the energy used in the mixing process have no discernible effect on ultimate fire performance.

Thank you !

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