WORKING FOR A HEALTHIER FUTURE

AN EXPOSURE ASSESSMENT STRATEGY APPLIED TO CASE STUDIES WITHIN THE GUIDENANO & NANOMICEX PROJECTS

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Case Studies

Project		Case Study	Partners
Name	Aim		
GUIDEnano (ongoing)	Assessment & mitigation of nano-enabled product risks on human & environmental health	Handling MWCNT during extrusion of MWCNT-containing polymers	ITENE & LATI
Nanomicex (31.3.2014)	Mitigation of risk & control of exposure in nanotechnology based inks & pigments	Synthesis of nano-TiO_2/$CoAl_2O_4$ pigments by flame pyrolysis	ITENE & Torrecid

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Sampling Strategies

- *Harmonised Tiered Approach to Measure & Assess the Potential Exposure to Airborne Emissions of Engineered Nano-Objects & their Agglomerates and Aggregates at Workplaces*, Pub^{n} No. 55. OECD, 2015.
- *Nanoparticle Emission Assessment Technique (NEAT) for the Identification and Measurement of Potential Inhalation Exposure to Engineered Nanomaterials as Part B: Results from 12 field studies*. Methner et al. J Occup Env Hygiene 2010.
- *Current Intelligence Bulletin 65:Occupational Exposure to Carbon Nanotubes and Nanofibers*. Pub^{n} No. 2013–145. NIOSH, 2013.

Uses a tiered approach where moving to a higher tier is solely based on exposure-related decision rules

Tiered Exposure Assessment Approach

Tier one

To develop and prioritise exposure scenarios.

Tier two

To identify sources of ENM emissions by measurements and estimate the potential for exposure.

Tier three

To quantify and characterise exposure as a size resolved airborne concentration and/or a personal exposure

IOM

Data Analyses

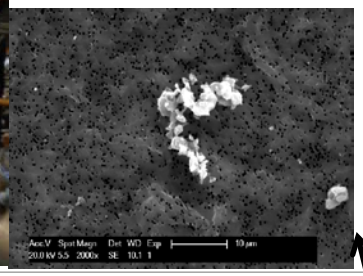
Decision logic developed to allow analysis of all results e.g. multi-metric, various instruments, limited speciation (by filter samples)

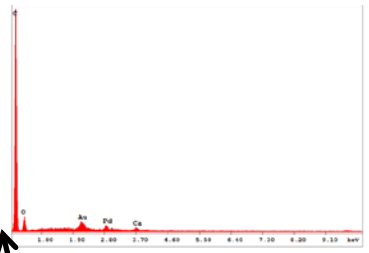
- *Workplace air measurements & likelihood of exposure to manufactured nano-objects, agglomerates, & aggregates.* Brouwer et al., J Nanopart Res,2013.
- *Occupational Exposure to Nano-Objects & their Agglomerates & Aggregates across various Life Cycle Stages; A Broad-Scale Exposure Study.* Bekker et al., Ann Occup Hyg, 2015.

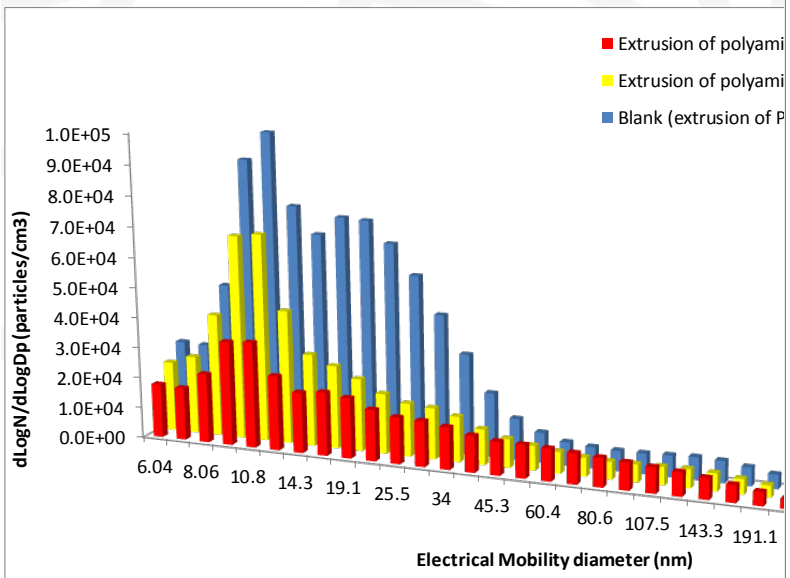
Basis for Interpretation of Results

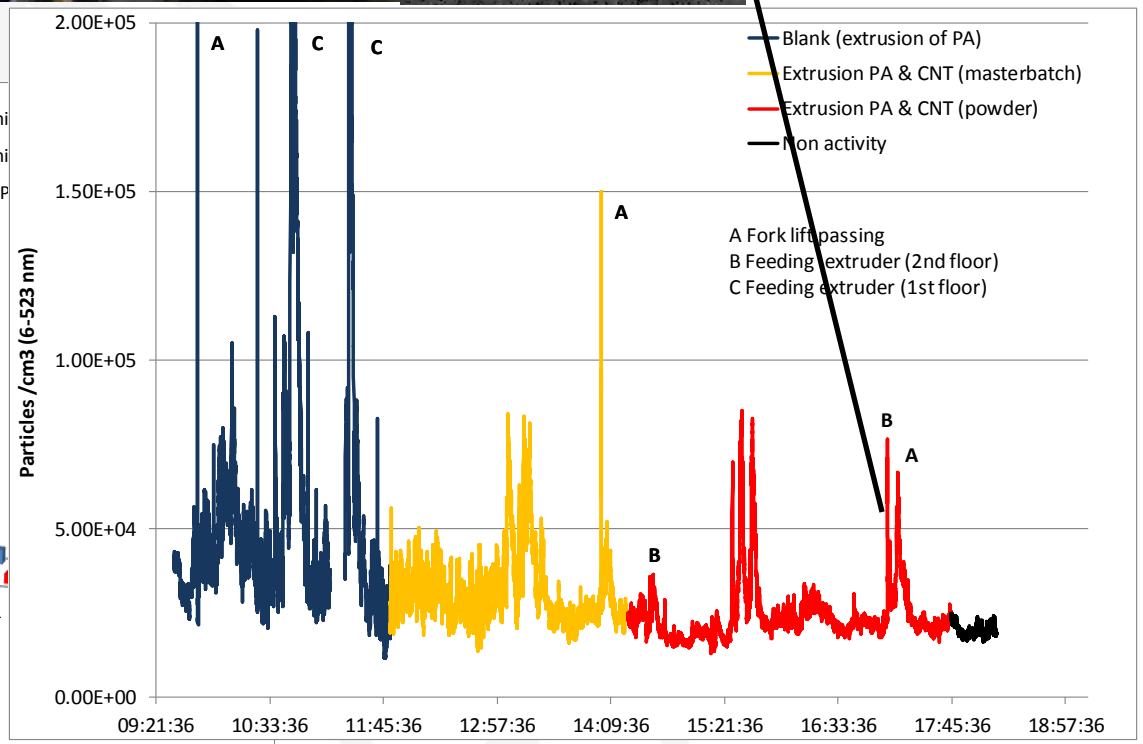
SEM/EDX results ENM identified in		Measured airborne concentrations	Other NP sources	Overall likelihood of exposure
activity samples	Backgr'd samples	Comparison of Act^{y} with Bgd as A/B &/or expert opinion		
Yes	No	Significant, A/B≥2	No	Likely
Yes	Yes	Less significant, 1.05<A/B<2	Yes	Possible/not excluded
Yes	No	Less significant, 1.05<A/B<2	No	
No	No	Non-significant, 1.05≤A/B	No	Unlikely
		Significant, A/B≥2	Yes	

Extrusion of MWCNT in polyamide





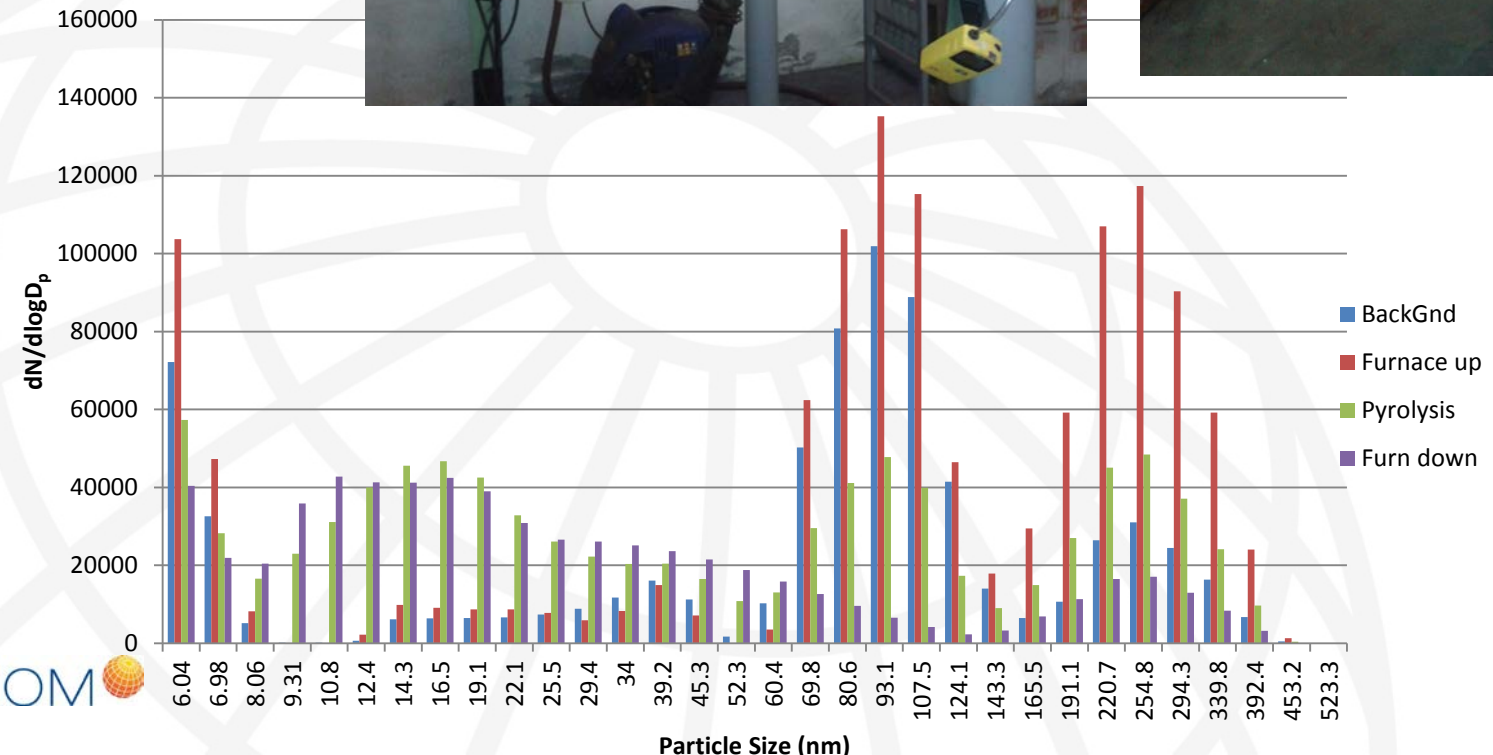




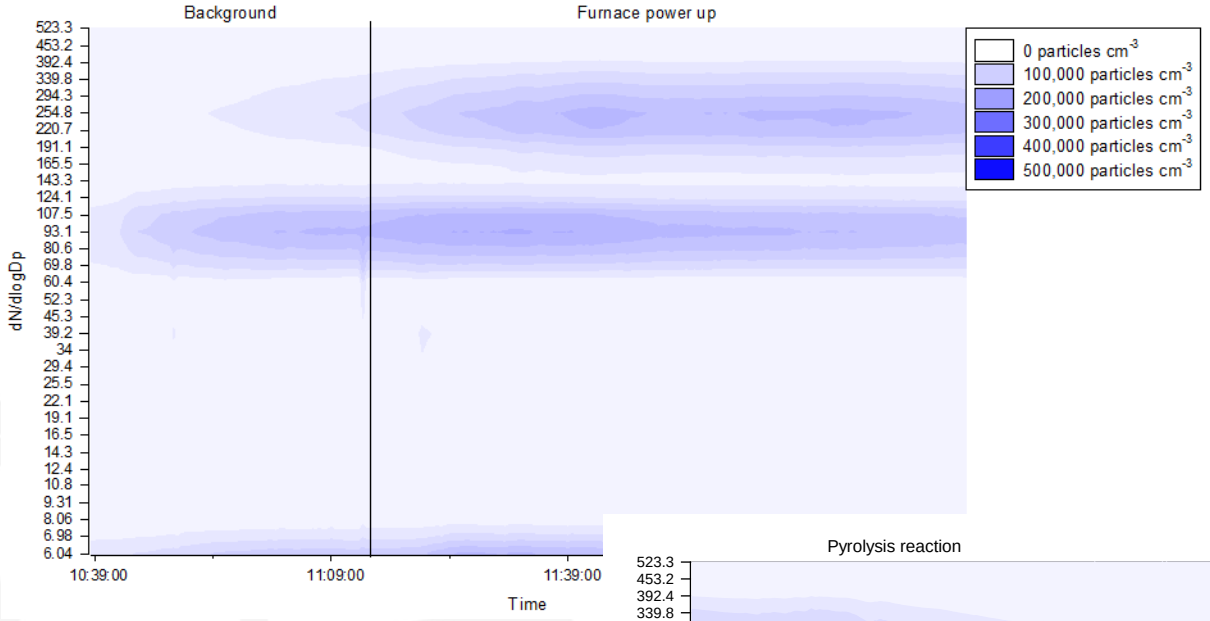
Extrusion of MWCNT in polyamide

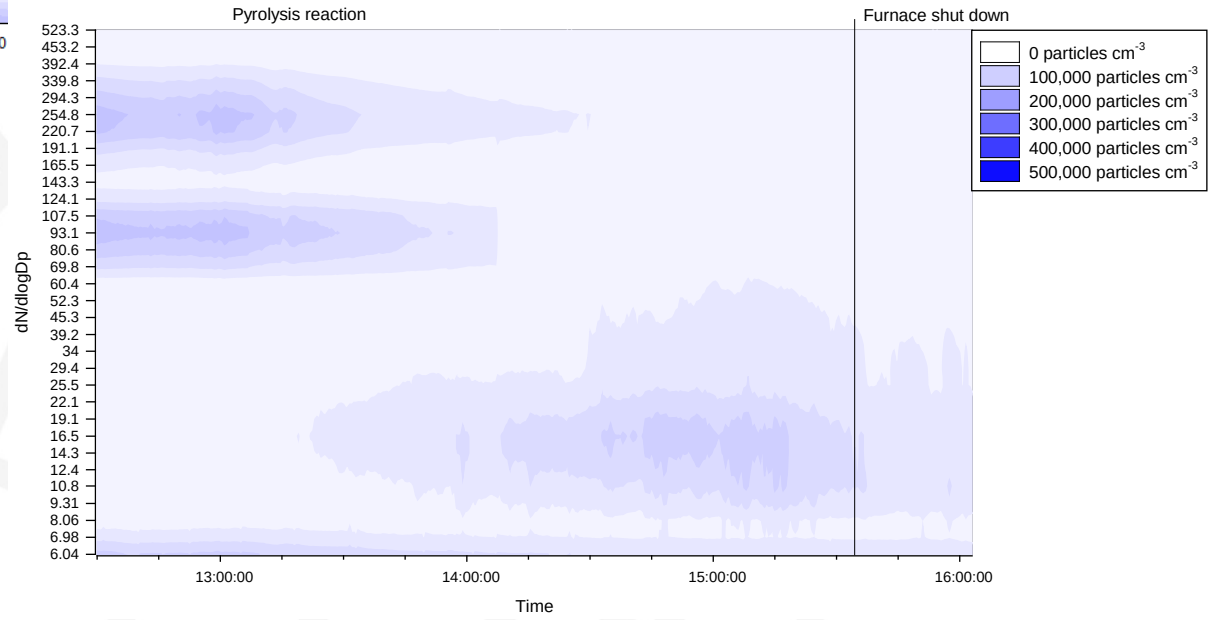
Exposure Scenario (ES)	SEM	EDX	Real time measurements		Ratio of Act^{y}:Bgd	Overall Likelihood
			Instrument	GM (GSD) for Airborne Conc		
ES1 Extrusion Product: Polyamide (PA) NM: None Duration: 137 mins Amount: 178 kg PA Control: LEV	No CNT ID-ed	Cl, Si, Ca, Na, Present No C	FMPS (N, 5-523 nm)	44,839 (1.68)	NA	NA
			APS (N, 0.5 -20 µm)	151 (1.05)	NA	
			EC (personal, µg m^{-3})	< LOD	NA	
			Respirable dust (personal, µg m^{-3})	44.5 (NA)	NA	
ES2 Extrusion of CNT-enabled product NM: CNT (pellet) Product: Polyamide Duration: 149 mins Amount: 158 kg PA & 50 kg CNT Control: LEV	No CNT ID-ed	Cl, Si, Ca, Na, present No C	FMPS (5-523 nm)	30,116 (1.34)	0.67	Unlikely
			APS (0.5 -20 µm)	109 (1.2)	0.72	
			EC (personal, µg m^{-3})	< LOD	NA	
			Respirable dust (personal, µg m^{-3})	46.7 (22.1)	1.05	
ES3 Extrusion of powdered CNT-enabled product NM: CNT (powder) Product: Polyamide Duration: 205 mins Amount: 191 kg PA & 7.5 kg CNT Control: LEV	Few CNT agglom's ID-ed	C present	FMPS (5-523 nm)	23,045 (1.09)	0.51	Unlikely - only exposure to agglom's
			APS (0.5 -20 µm)	135 (1.4)	0.89	
			EC (personal, µg/m^{3})	11.2 (1.4)	NA	
			Respirable dust (personal, µg/m^{3})	56.1 (9.2)	1.26	

Nano-TiO_2 synthesis by flame pyrolysis



Nano-TiO_2 synthesis by flame pyrolysis (Cont)





Nano-TiO_2 synthesis by flame pyrolysis

Exposure Scenario (ES)	SEM	EDX	Real time measurements		Ratio of Activity:blank	Overall Likelihood
			Instrument	GM (GSD) for Concentration		
ES1 Background **Product: None** **NM: None** **Duration: 36 mins** **Amount: N/A** **Control: considerable containment, LEV & GV**	Inorganic & soot agglomerates identified	Ti & many inorganic elements and C present	FMPS (N, 5-523 nm)	42,148 (1.32)	NA	NA
			APS (N, 0.5 -20 µm)	78 (1.09)	NA	
			CPC ($NCoAl_2O_4$,10-1000 nm)	41249	NA	
ES2 Furnace up **NM: combustion products** **Product: None** **Duration: 75 mins** **Amount: unknown** **Control: considerable containment, LEV & GV**	Inorganic & soot agglomerates identified	Ti & many inorganic elements and C present	FMPS (5-523 nm)	75,703 (1.08)	1.8	Possible/not excluded
			APS (0.5 -20 µm)	47 (1.18)	0.60	
			CPC ($NCoAl_2O_4$,10-1000 nm)	42767	1.04	
ES3 Pyrolysis **NM: TiO_2** **Product: nano-TiO_2 pigment** **Duration: 182 mins** **Amount: ~3 kg** **Control: considerable containment, LEV & GV**	Inorganic & soot agglomerates identified	Ti & many inorganic elements and C present	FMPS (5-523 nm)	54,888 (1.15)	1.30	Possible/not excluded
			APS (0.5 -20 µm)	30 (1.33)	0.38	
			CPC ($NNCoAl_2O_4$,10-1000 nm)	31990	0.78	

Conclusions

- Taking filter samples for SEM or TEM analysis is key to identifying the nano-particles as ENM generated by the activity - but this can be tricky!
- Collection of contextual information is essential for
  - identifying all sources of nano-particles
  - assigning a concentration of airborne ENM to the activity

  - but this can be tricky!
- Important to use a harmonised approach

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