ANALYSIS AND TOXICOLOGICAL EVALUATION OF DUSTS FROM RECYCLING AND THERMAL DECOMPOSITION OF NANOCOMPOSITES AND STRATEGIES FOR RISK MINIMIZATION - PROCYCLE

NANOPARTICLE RELEASE FROM THERMAL DECOMPOSITION OF POLYMER NANOCOMPOSITES AND THE BIOLOGICAL POTENTIAL OF THE EMISSIONS

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Objectives

- Nanoparticle behavior in combustion processes of nanocomposites
- Health effects of nanoparticle emissions from combustion processes of nanocomposites materials

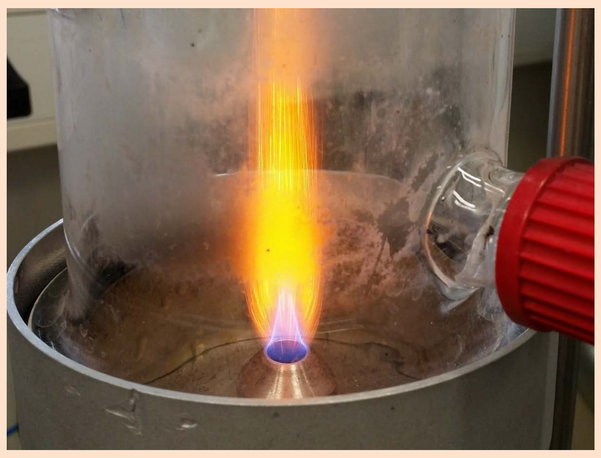
Challenges

- Combustion of Nanomaterials (NM) and Nanocomposites
- Nanoparticle detection
- Realistic exposure of human lung cells towards the combustion aerosols
- Dose determination at the Air-Liquid-Interface of human lung cells
- Dose-Response relationships from combustion aerosols in ALI exposed human lung cells

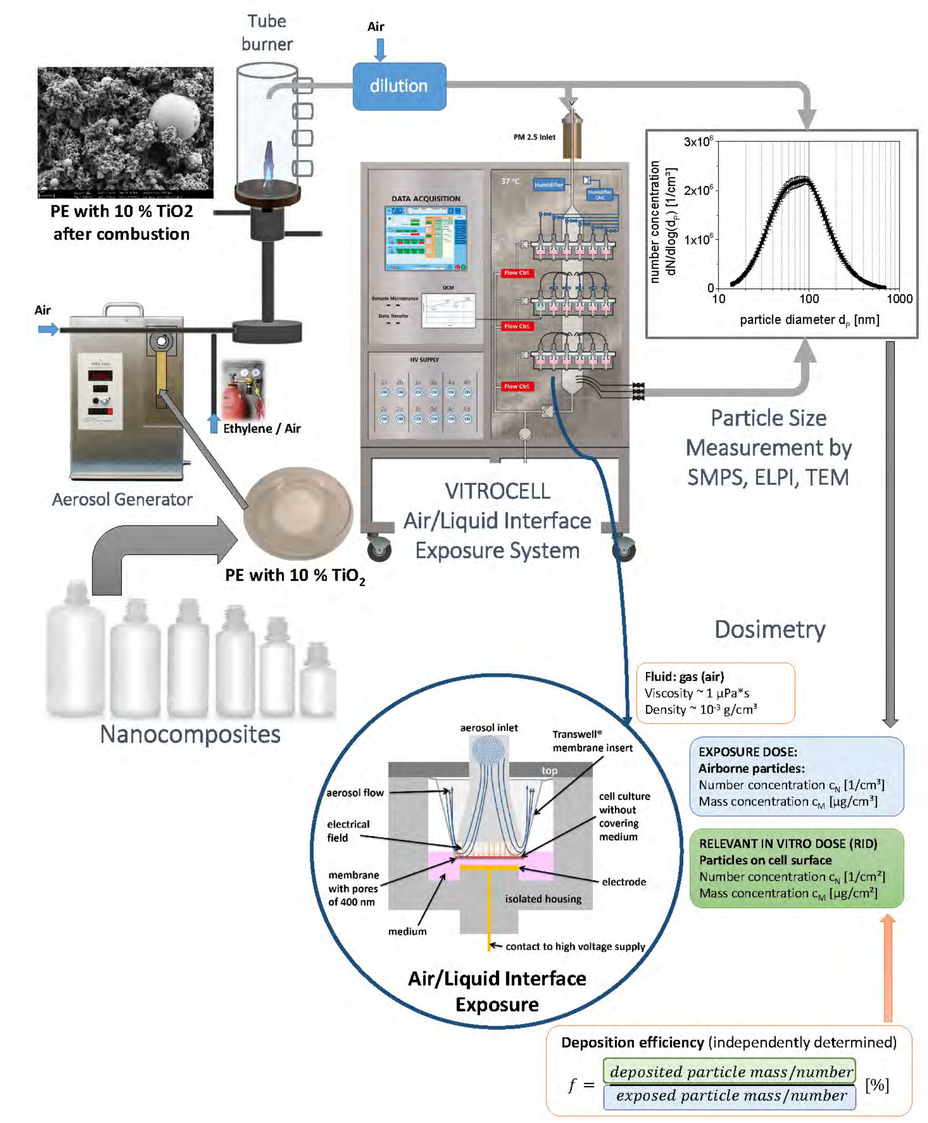
Combustion of nanocomposites emits high numbers of ultrafine particles

Tube burner

- Laminar premixed Ethylene / Air flame
- Stoichiometry: 0.8 < l < 1.2
- Adiabatic flame temperature: ~ 2100 °C
- Addition of suspensions or dusts possible
  - Nano metal oxides
  - ground nano-enabled thermoplastics
  - carbon fibres
- Sampling at different heights above the burner
- Adaption of a dilution stage allows the installation of various measurement systems

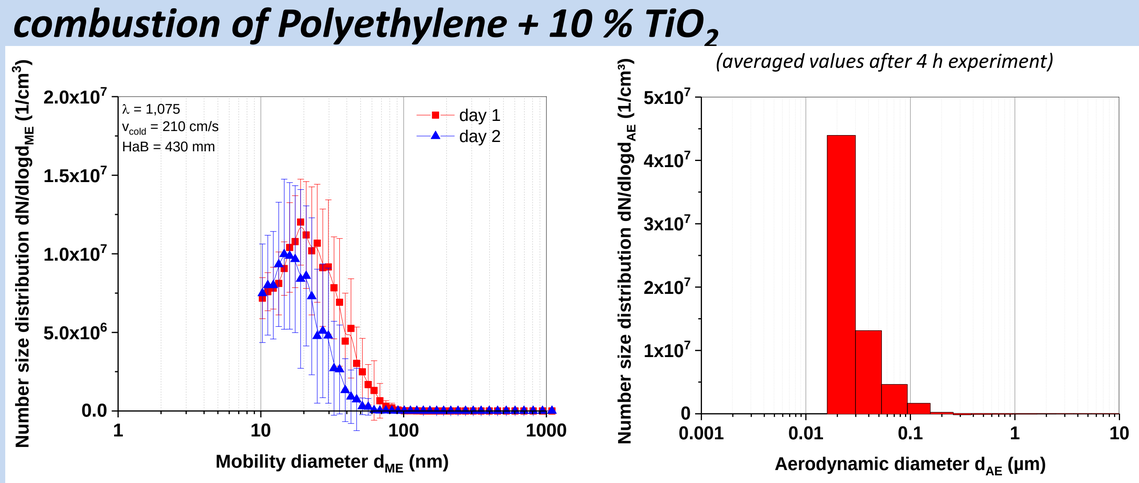


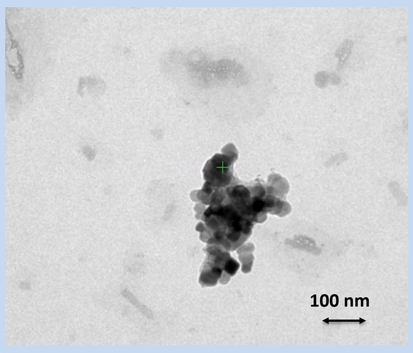
Experimental setup

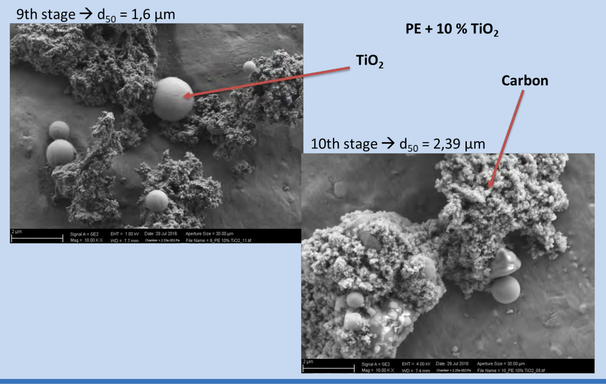


Combustion aerosols of nano-enabled thermoplastics induce DNA strand breaks in A549 cells

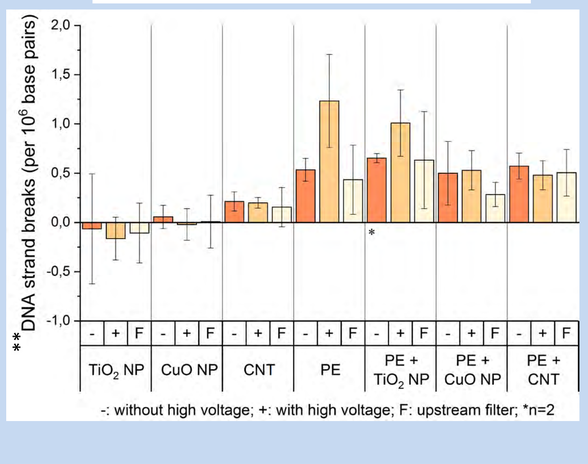
Size distributions (left: SMPS, right: ELPI) of particles from the combustion of Polyethylene + 10 % TiO_2



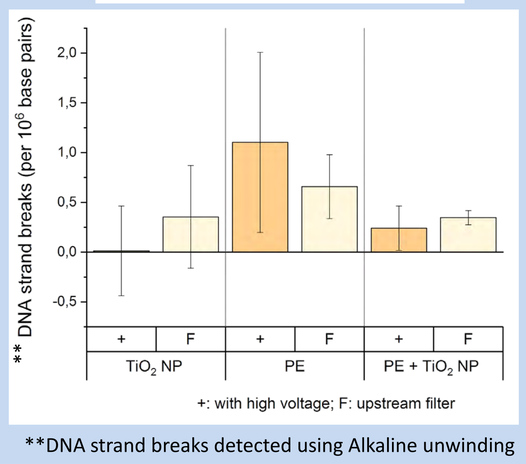




Human carcinogenic lung cell line A549



Human 3D lung tissue *MucilAir™*



**DNA strand breaks detected using Alkaline unwinding

Material	Mass conc. via ELPI [µg/m³]	Diffusional dose [ng/cm²]	Electrostatic enhanced dose [ng/cm²]
PE	505 ± 8	54 ± 1	268 ± 4
TiO_2	137 ± 20	15 ± 2	73 ± 11
CuO	256 ± 151	27 ± 16	136 ± 80
CNT (+ gum arabicum)	44 ± 7	5 ± 1	23 ± 4
PE + TiO_2	527 ± 317	56 ± 34	280 ± 168
PE + CuO	235 ± 18	25 ± 2	125 ± 10
PE + CNTs	106 ± 16	11 ± 2	54 ± 8

References
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Dilger et al., Archives of Toxicology 90 (2016), 3029
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Abbreviations
CNT: carbon nanotubes
DNA: deoxyribonucleic acid
ELPI: electrostatic low pressure impactor
NP: nanoparticles
PE: polyethylene
SMPS: scanning mobility particle sizer
TEM: transmission electron microscopy

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