Assessment of the emission behavior of nanomaterial-containing waste in thermal treatment plants

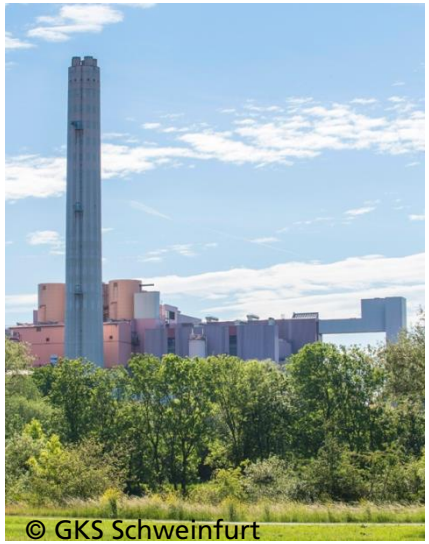
Scientific Stakeholder Meeting on Nanomaterials in the Environment

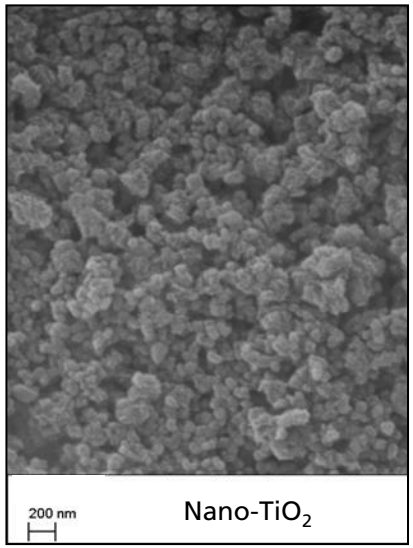
10-10-2017

UBA, Dessau

Jürgen Oischinger
Martin Meiller
Dr.-Ing. Robert Daschner

Fraunhofer UMSICHT





Umwelt Bundesamt

Fraunhofer UMSICHT

Agenda

- Introduction
- Project “Assessment of the emission behavior of nanomaterial-containing waste in thermal treatment plants” (UFOPLAN FKZ: 3712 33 327)
- Project “NanoEmission“
- Overview of other research projects
- Project “Investigations on the possible release of nanoparticles during the deposition and soil-related application of mineral waste“ (UFOPLAN FKZ 3716 34 319 0)
- Discussion / Further points of interest

Introduction

Emissionpathways of ENM during disposal

Products containing engineered nanomaterial (ENM) e.g. cosmetics, paints

Waste containing nanomaterial

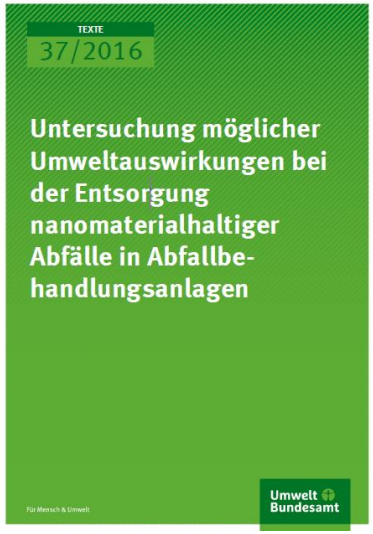
Thermal treatment plants

End-of-life

Disposal

Release by flue gas?

Fate in the bottom ash?



[BÖR16]

Fraunhofer UMSICHT

Project UFOPLAN FKZ: 3712 33 327

Examined waste streams

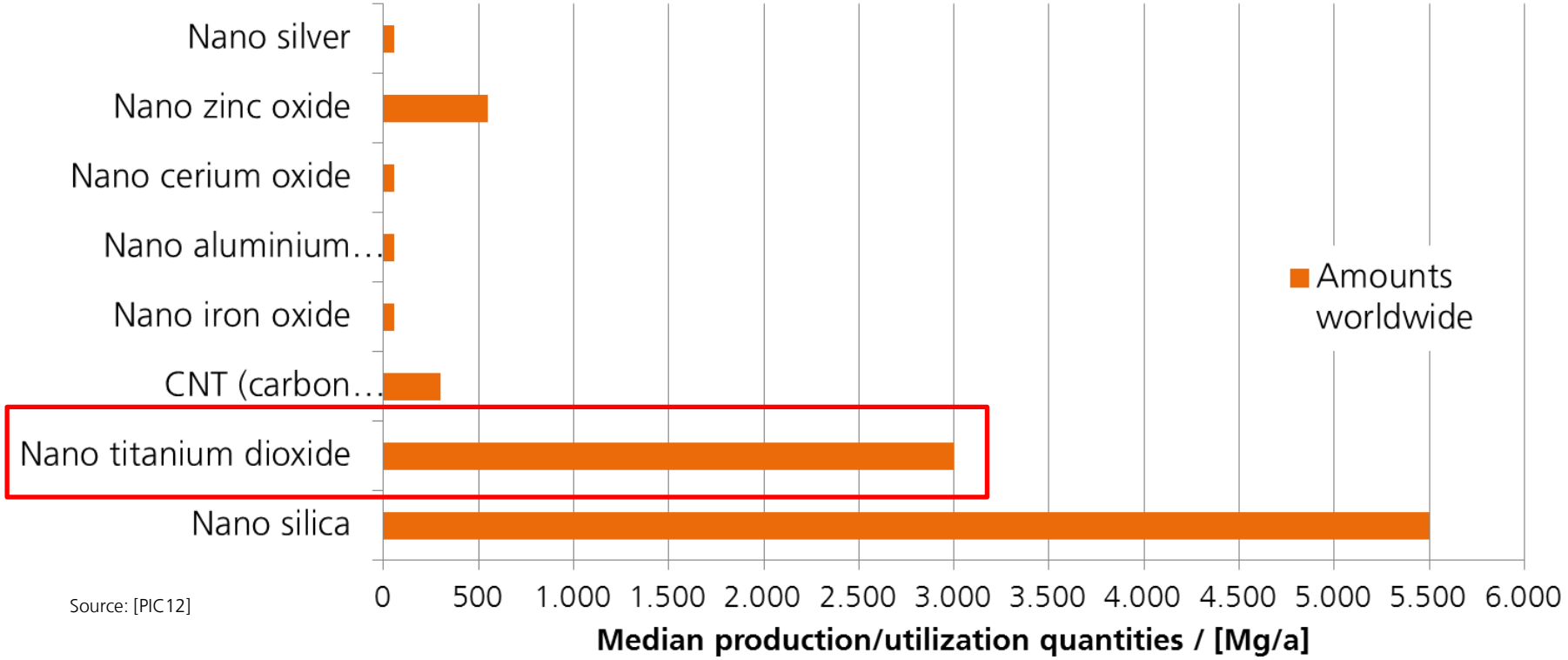
Different forms of application of ENM to different fuels	Sewage sludge	Municipal waste

Pilot plant at Fraunhofer UMSICHT	Sewage sludge incineration plant ZVK Steinhäule	Municipal waste incineration plant GKS Schweinfurt

Fraunhofer UMSICHT

Project UFOPLAN FKZ: 3712 33 327

Selection of ENM



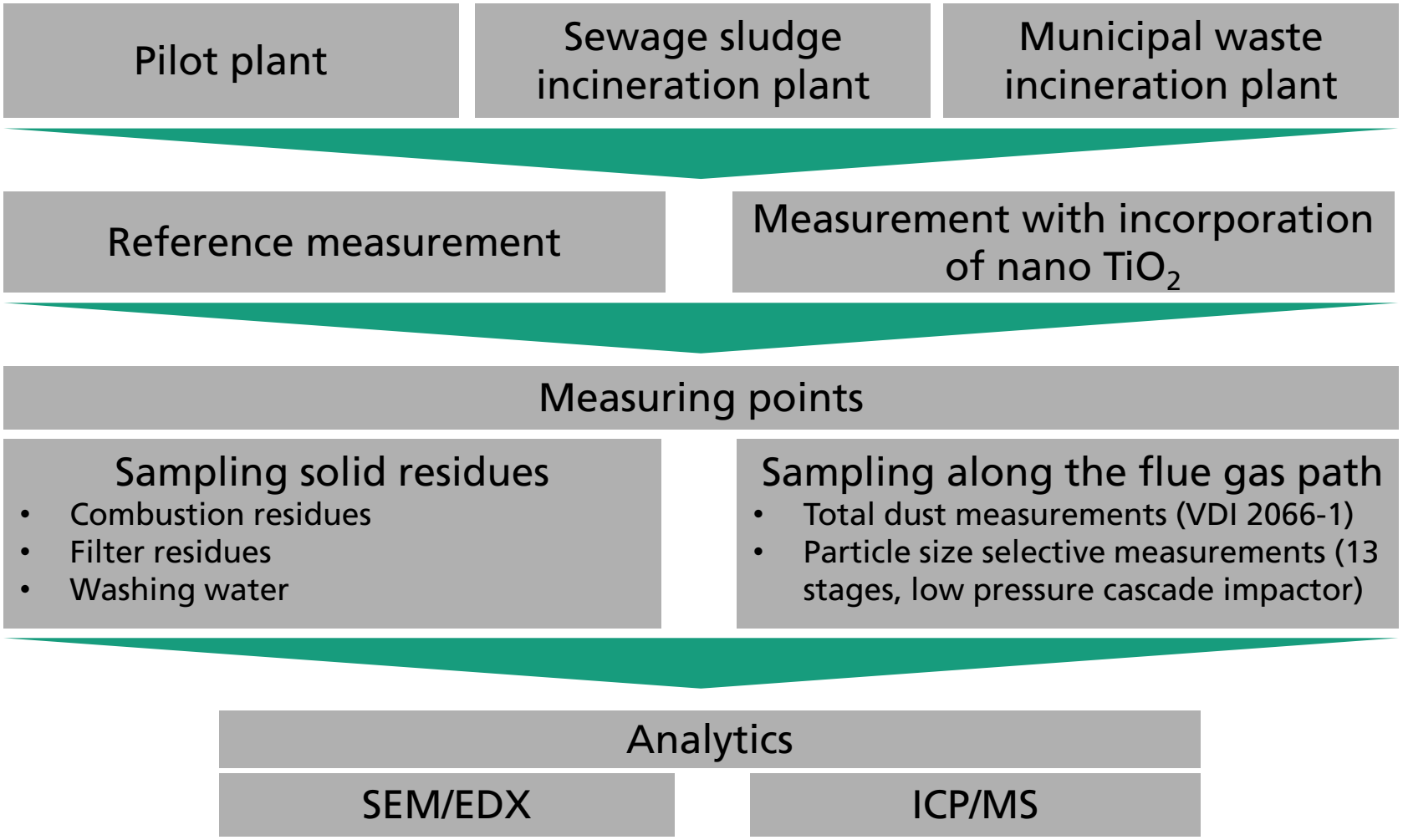
Source: [PIC12]

- Nano titanium dioxide as tracer
- Advantages: inert, chemical stable, melting point > 1800 °C
- Product: Hombicat UV 100 WP (slurry for large-scale plants experiments)

Fraunhofer UMSICHT

Project UFOPLAN FKZ: 3712 33 327

Measurement technique / analytics



Fraunhofer UMSICHT

Project UFOPLAN FKZ: 3712 33 327

Measurement instrumentation / analytics

Cascade impactor

Dekati® Low Pressure Impactor

- Operation in low pressure range
- 13 stages + filter
- Determination of particle size distribution in the range of 30 nm upto 10 µm (10 nm with filter stage)
- 3 stages in the nm scale

Fraunhofer UMSICHT

Project UFOPLAN FKZ: 3712 33 327

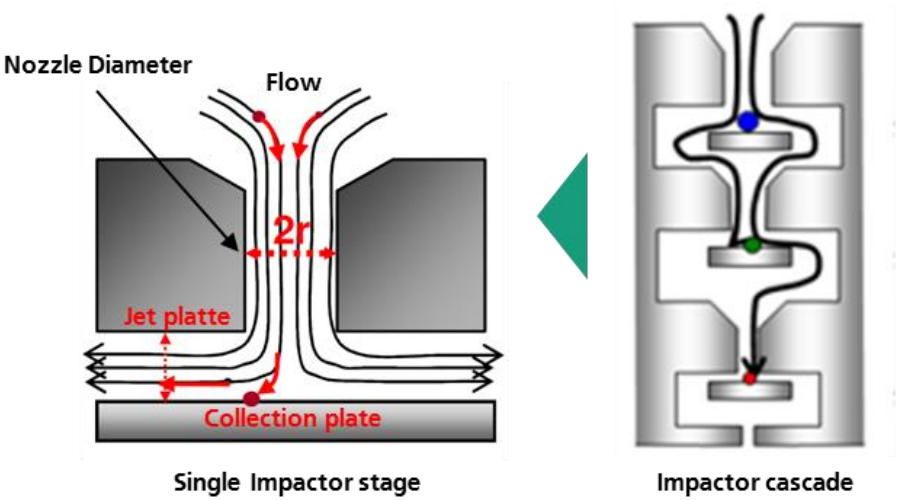
Measurement instrumentation / analytics

Cascade impactor

- Aersol passes through the nozzles with high speed and makes a sharp turn to flow between the plates
  → Particles larger than a certain size impact on the collection plate
- Nozzle diameter reduces in the impactor cascade
  → Classificaton by particle size
- Collection of aerosol on aluminium foils

  → Gravimetric analysis

  → Following: SEM/EDX or ICP/MS

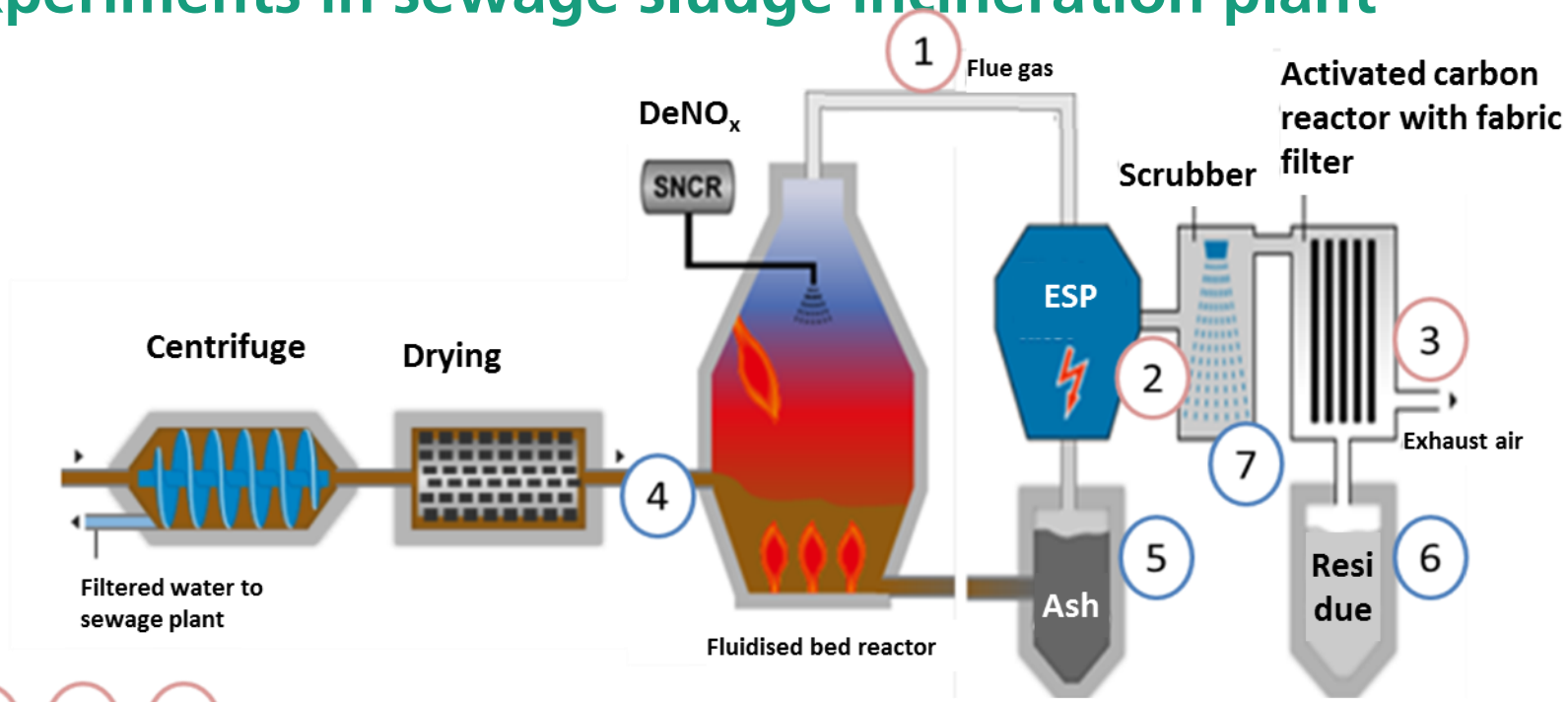


Functional principle of impactor [DEK10]

Fraunhofer UMSICHT

Project UFOPLAN FKZ: 3712 33 327

Experiments in sewage sludge incineration plant



1 2 3 Total dust- and impactor measurement (flue gas)

4 5 6 Solid sampling

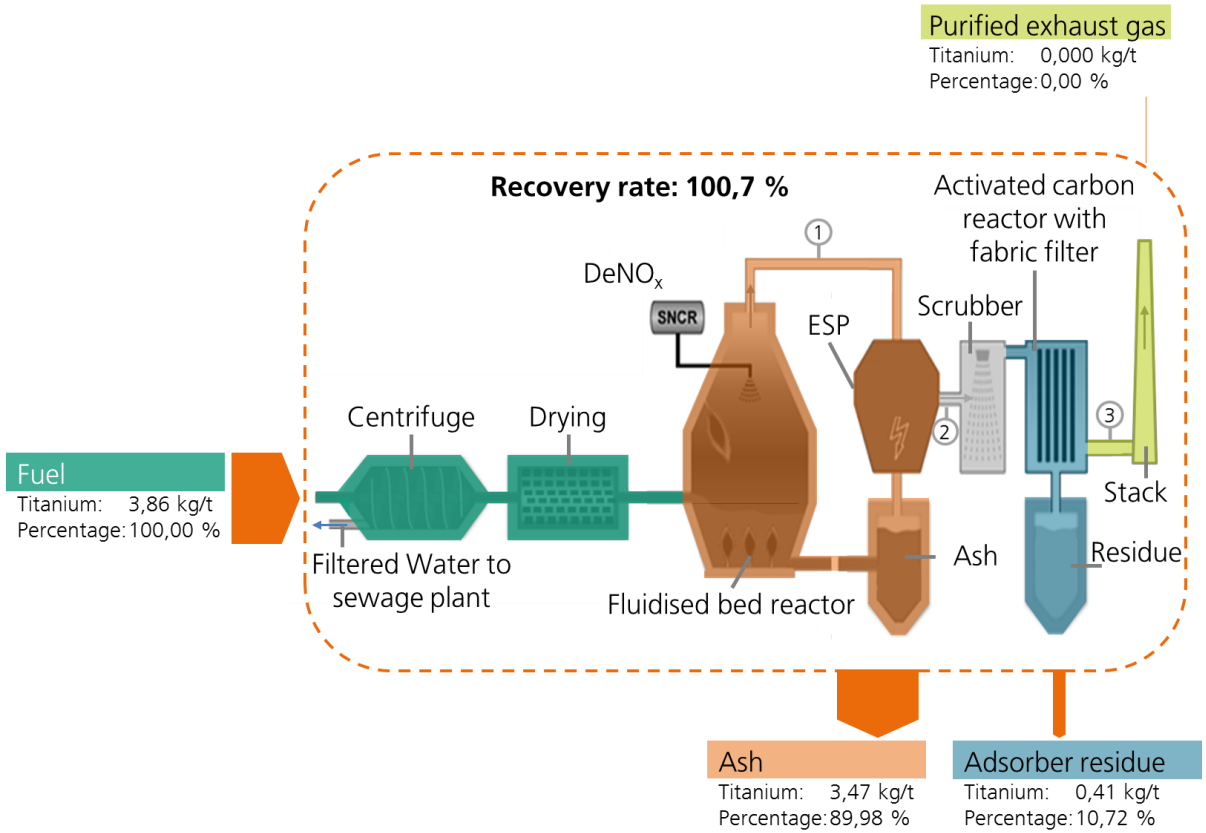
7 Wash water sampling

Source: www.klaerwerk-steinhäeule.de

Fraunhofer UMSICHT

Project UFOPLAN FKZ: 3712 33 327

Experiments in sewage sludge incineration plant



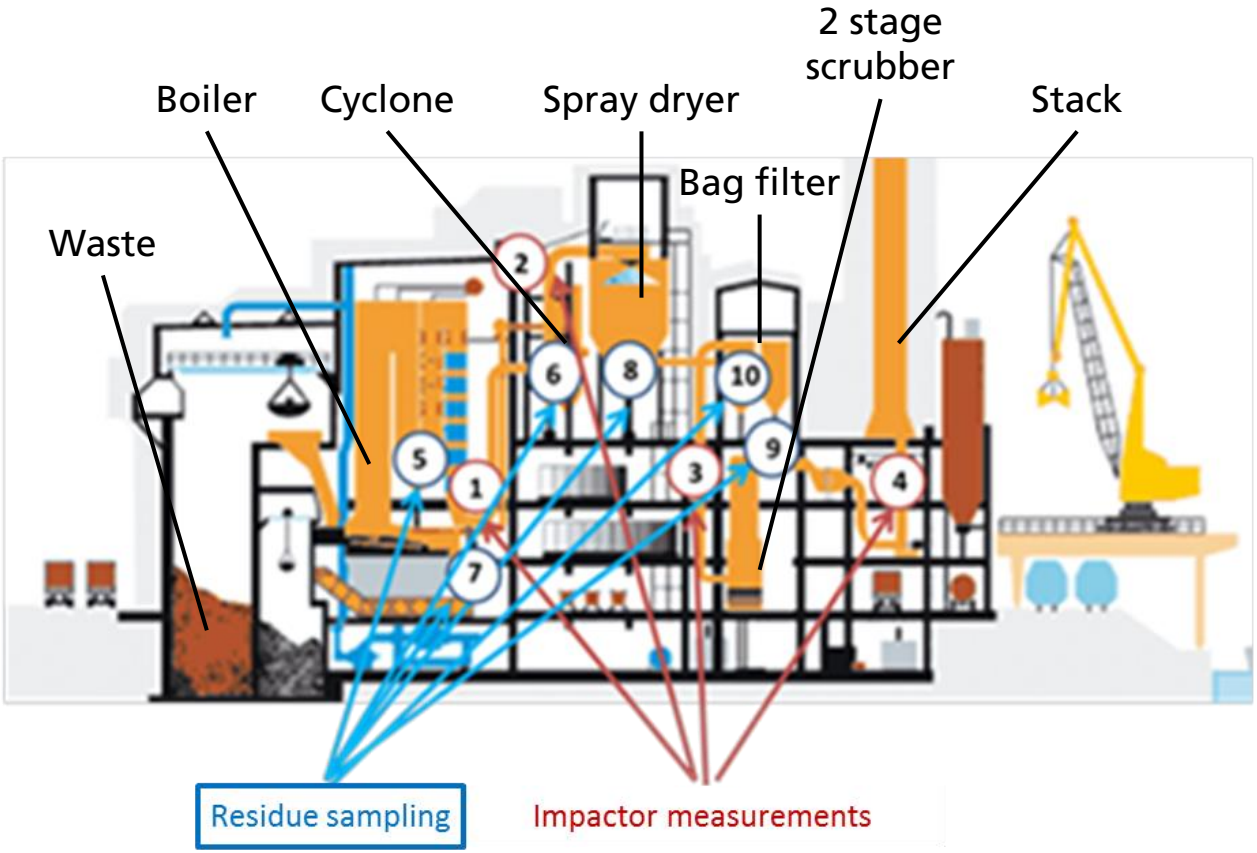
Titanium loads in the reference measuring are substracted.

- Fate of titanium: Particularly in solid combustion residues
- Emission of titanium by purified exhaust gas is hardly to be expected.

Fraunhofer UMSICHT

Project UFOPLAN FKZ: 3712 33 327

Experiments in municipal waste incineration plant

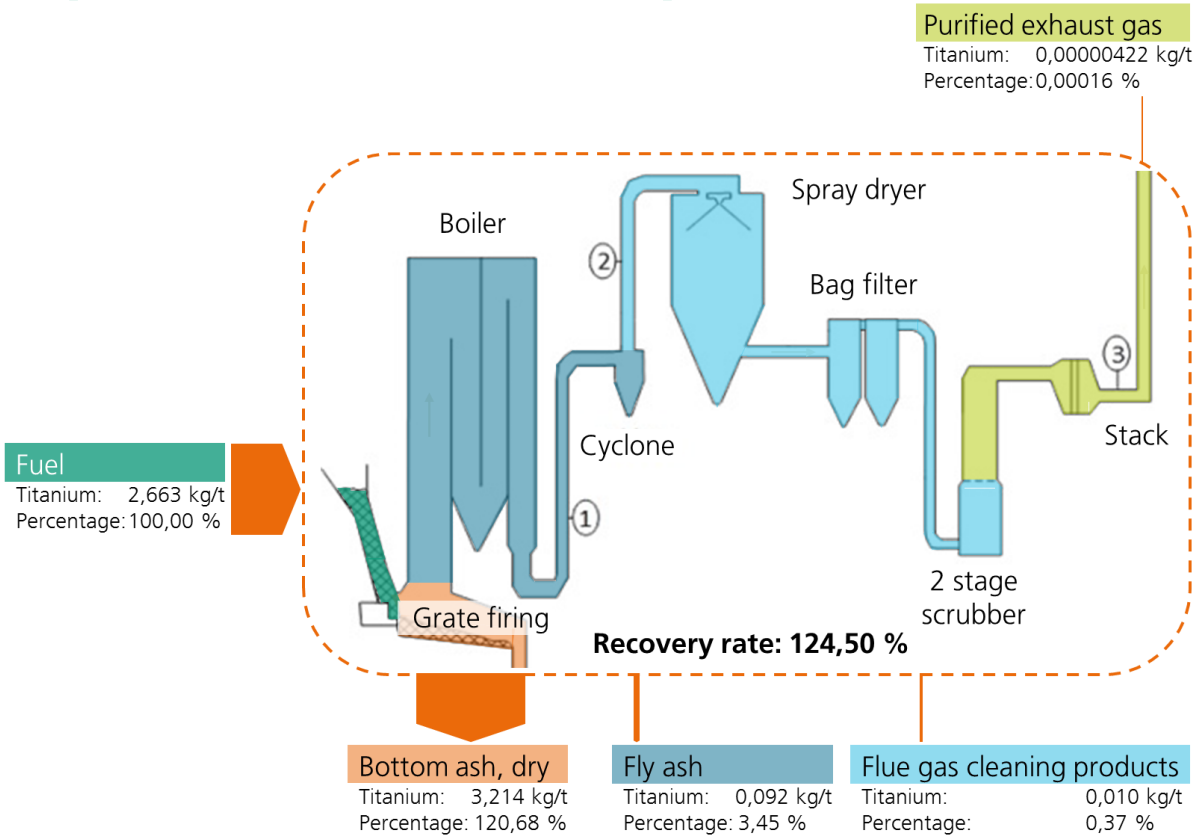


Number	Position	Sample matrix
1	After boiler	Dust
2	After cyclone	Dust
3	Before scrubber	Dust
4	Before stack	Dust
5	Boiler ash	Ash
6	Cyclone dust	Dust
7	Bottom ash	Ash
8	Spray dryer	Solid matter
9	Wash water	Water sample
10	Fabric filter	Ash

Fraunhofer UMSICHT

Project UFOPLAN FKZ: 3712 33 327

Experiments in municipal waste incineration plant



Titanium loads in the reference measuring are substracted.

- Fate of titanium: Particularly in solid combustion residues
- Emission of titanium by purified exhaust gas is hardly to be expected.

Fraunhofer UMSICHT

Project NanoEmission

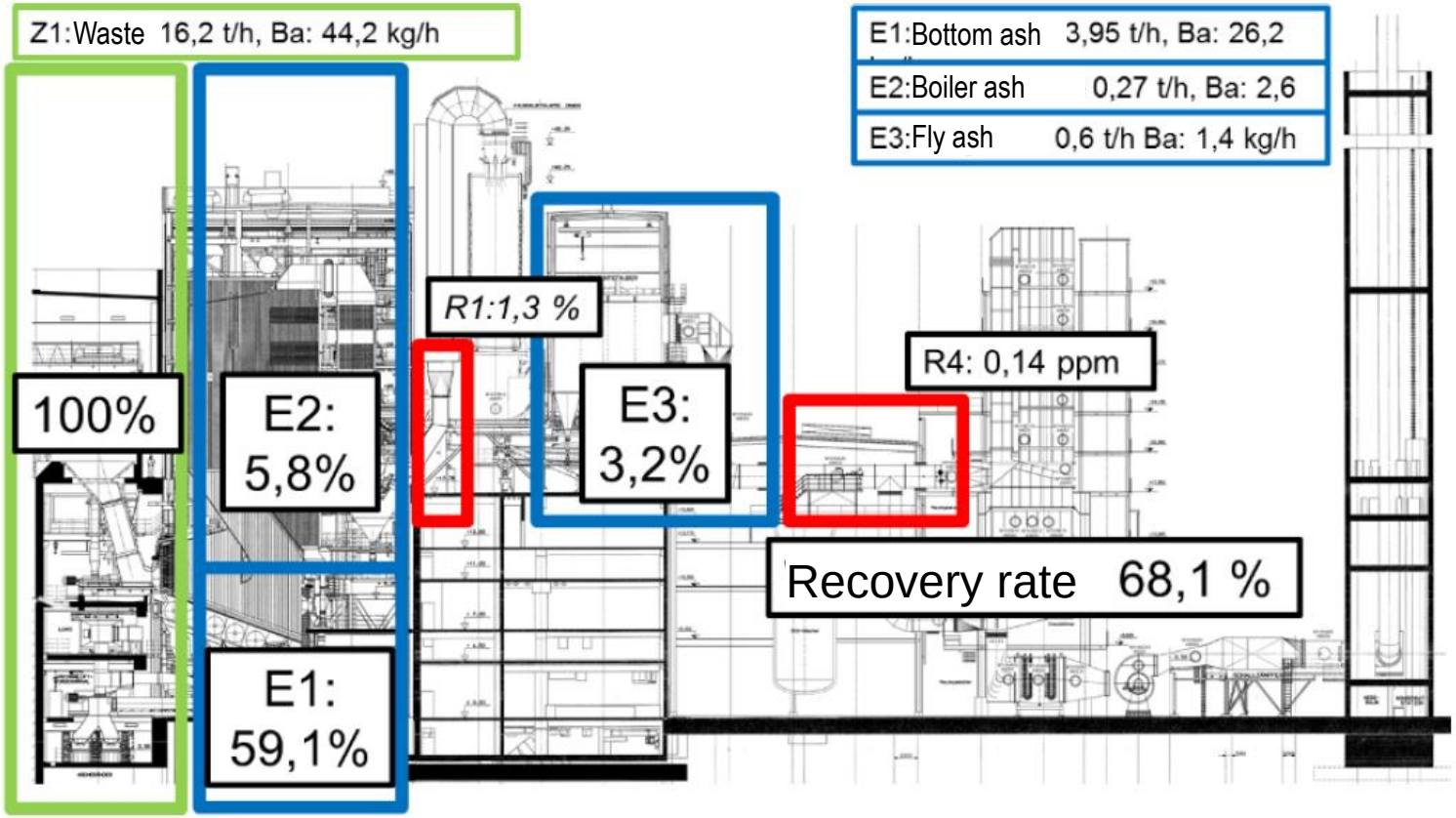
Experiments in municipal waste incineration plant

- Joint research project:
- Funded by BMBF
- Project duration: 2013 - 2016
- Objective of the project: Investigation of the emission behavior of nanoparticles in waste incineration
- Detailed investigation along the whole pathway considering the waste, combustion, filtering and a possible release of ENM as well as human toxity studies
- Experiments in pilot plants as well as in the municipal waste incineration plant MVA Weisweiller
- Bariumsulfate as tracer in the MVA Weisweiller

- Reports available: https://www.tib.eu/de/, keyword: NanoEmission

Project NanoEmission

Experiments in a municipal waste incineration plant



- Fate of barium: Particularly in solid combustion residues
- Emission of barium by purified exhaust gas is hardly to be expected.

Source: [BAR16]

Fraunhofer UMSICHT

Overview of other research projects

Experiments in thermal treatment plants

Plant/ Combustion system	Fuel / ENM	Tracer recovery rate in [%]			Tracer at stack	
		Bottom ash	Boiler ash	Precipi-tator	Concentration [µg/m³]	Percentage [%]
100 kW Boiler* Grate	Wood chips with 1% TiO_2	ca. 98		No precipitator	< 5.000 Boiler outlet	< 2***
MWIP Schweinfurt* Grate	Waste with 1% TiO_2	92	5	0,2	5	< 0,01
Sewage sludge incinerator* ZVK Neu-Ulm / Fluidised bed	Sewage sludge with 0,8 % TiO_2	ca. 50		ca. 5	< 20	< 0,01
MWIP-Solothurn** Grate	Waste with a) 10 kg CeO_2 b) 1 kg CeO_2	 32 18	 7 15	 < 0,1 0,6	 < 0,1 < 0,1	 < 0,01 < 0,01
KLEAA (KIT) Labor shaft furnace	PMMA-composite with 2 % TiO_2	99 Residue	--	--	< 0,1	< 0,01
BRENDA (KIT) 2 MW burning chamber	Coal dust with 25 g/h CeO_2 / 6,5 mg/Nm³	No grate	3	64	< 0,1	< 0,01
RVA in chemical industry/rotary kiln with afterburner chamber	Residues with 100 g/h CeO_2	No grate	10	72	< 0,1	< 0,01

* UBA-Texte 37/2016 (UFOPLAN-Projekt 3712 33 327) [BÖR16]
** Walser et. al (2012) [WAL12]
*** At boiler outlet with no further flue gas cleaning

Source: [PAU16]

Fraunhofer UMSICHT

Project UFOPLAN FKZ 3716 34 319 0

- Partner:
- Funded by UBA
- Project duration: 2016 – 2019
- Objective of the project: Investigations on the possible release of nanoparticles during the deposition and soil-related application of mineral waste (UFOPLAN FKZ 3716 34 319 0)
- Production of nanomaterial containing ashes/slags from municipal waste and sewage sludge (Fraunhofer UMSICHT)
- Leaching tests with the nanomaterial containing ashes/slags in large-scale lysimeters (Fraunhofer IME)

Discussion

Further points of interest

- Summary
  - Nano-TiO_2, nano-CeO_2, nano-$BaSO_4$ show similar behaviour during combustion in thermal treatment plants
  - Fate of examined ENM: Particularly in solid combustion residues
  - The examined incineration and flue gas treatment plants comply with the requirements of the best available techniques.

- Further points of interest:
  - How behaves a carbon tracer like CNT during combustion?
  - How behave CeO_2, $BaSO_4$ and CNT in mineral waste streams?

Assessment of the emission behavior of nanomaterial-containing waste in thermal treatment plants

Scientific Stakeholder Meeting on Nanomaterials in the Environment

Thank you!

Contact:

Jürgen Oischinger
Research assistant
Group energy from biomass und waste

Fraunhofer UMSICHT
Institute branch Sulzbach-Rosenberg
An der Maxhütte 1
92237 Sulzbach-Rosenberg
Phone: 09661-908 448
E-Mail: juergen.oischinger@umsicht.fraunhofer.de
Internet: http://www.umsicht-suro.fraunhofer.de

Thanks to:

Umwelt Bundesamt

Fraunhofer UMSICHT

Literaturverzeichnis

[BAR16] Baran, P. J.: MESSPROTOKOLL, BMBF Forschungsvorhaben, FKZ: 03X3578NanoEmission, Verbrennungsversuche unter Praxisbedingungen in der MVA Weisweiler: technische Umsetzung und Ergebnisse; Aachen: TEER RWTH Aachen, 2016.

[BÖR16] Börner, R.; Meiller, M.; Oischinger, J.; Daschner, R.: Untersuchung möglicher Umweltauswirkungen bei der Entsorgung nanomaterialhaltiger Abfälle in Abfallbehandlungsanlagen. Dessau-Roßlau: UBA, Januar 2016. Online verfügbar unter: http://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_37_2016_untersuchung_moeglicher_umweltauswirkungen_bei_der_entsorgung_nanomaterialhaltiger_abfaelle.pdf

[DEK10] Dekati, 2010] Dekati Ltd.: DLPI USER MANUAL ver. 3.62; DLPI - Deka-ti® Low Pressure. Impactor. Tampere (Finland): Dekati Ltd., 2010.

[PAU16] Paur, H.-R. et al.: Verbrennung in Sonderabfallverbrennungsanlagen IFAT Expertenworkshop Entsorgung nanohaltiger Abfälle, Juni 2016.

[PIC12] Piccinno, F. et al. (2012): Industrial production quantities and uses of ten engineered nanomaterials in Europe and the world. J of Nanopart Res 14, S. 1-11.

[WAL12] Walser, T. et al.: Persistence of engineered nanoparticles in a municipal solid-waste incineration plant; In: Nature Nanotechnology 7, S.520-524, Mai 2012.