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healthy all life long

INNOVATIVE TEM-BASED APPLICATIONS FOR CHARACTERIZATION OF NANOPARTICLES IN FOOD IN A REGULATORY CONTEXT

EM-unit

SD Chemical and physical health risks

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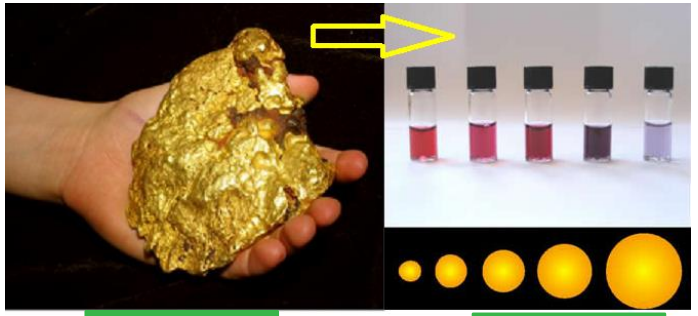
December 18, 2020 – Research in Food Safety

Introduction

- Rapid development of nanotechnology → **innovation** in many industrial sectors
  - agricultural production,
  - animal feed and treatment,
  - food additives and food processing,
  - food contact materials,
  - cosmetics,
  - textiles,
  - medical devices,
  - sensory applications,
  - biocides,
  - …
- May pose a **risk to human health and the environment** → due to specific NM properties and potential widespread use and exposure.
  - NM size, VSSA and DOS is different from bulk
  - NM carry chemicals including metals and hydrocarbons.
  - Into body through the lungs, skin and digestive system
  - Concern that once nanoparticles are in the bloodstream, they are able to cross the blood-brain barrier.

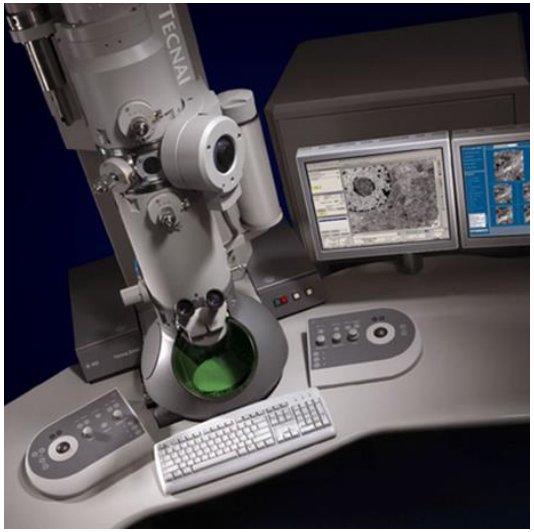


- In the EU, safe use of NM applications is ensured by **specific legislation and dedicated (non-binding) recommendations and guidances**

Electron microscopy unit activities

- We characterize in a regulatory context the **physico-chemical properties of engineered NM** by TEM,

- We make images of particles at **nanometer scale**.
  ➔ assess the size, morphology, agglomeration state, elemental composition and crystallinity of the particles.



- Focus on NM in the food chain, cosmetics, medical devices and environment.

- **NRL** for characterization of engineered nanomaterials in the food chain and food contact materials, and appointed as representative Belgian laboratory in the ‘Nano in Food’ project for the EC.

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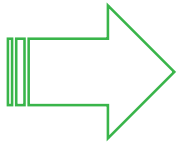
Methodologies

Old Instrument

Physical NM characterization

New Instrument

Physical NM characterization
+ Chemical NM characterization



Physical NM characterization
+ Chemical NM characterization
+ Fully automated

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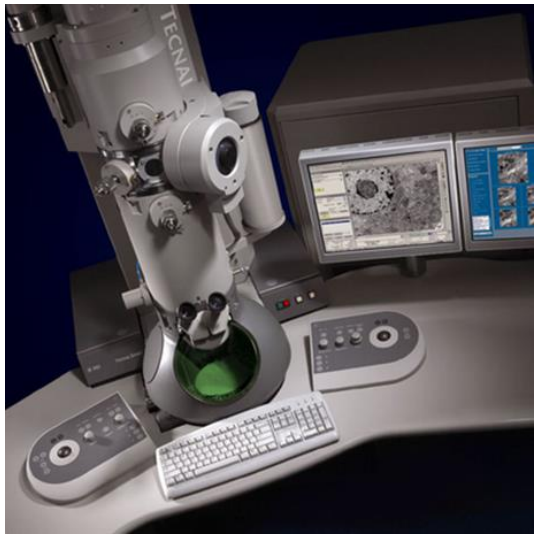
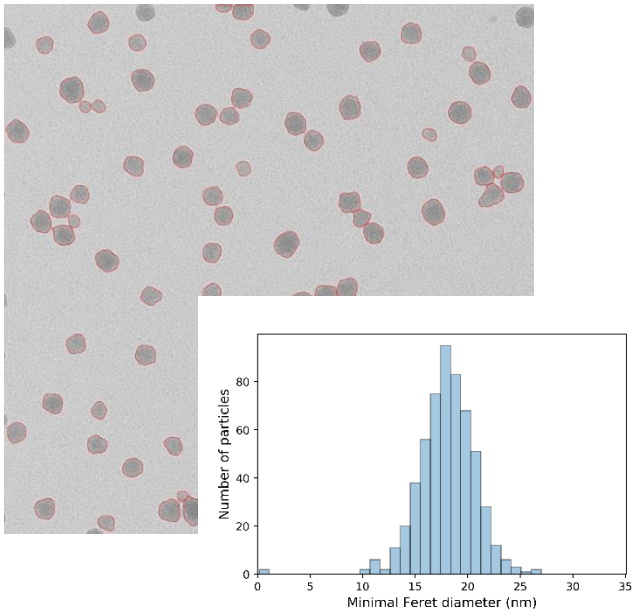
Conventional TEM: Physical NM characterization

Methodology

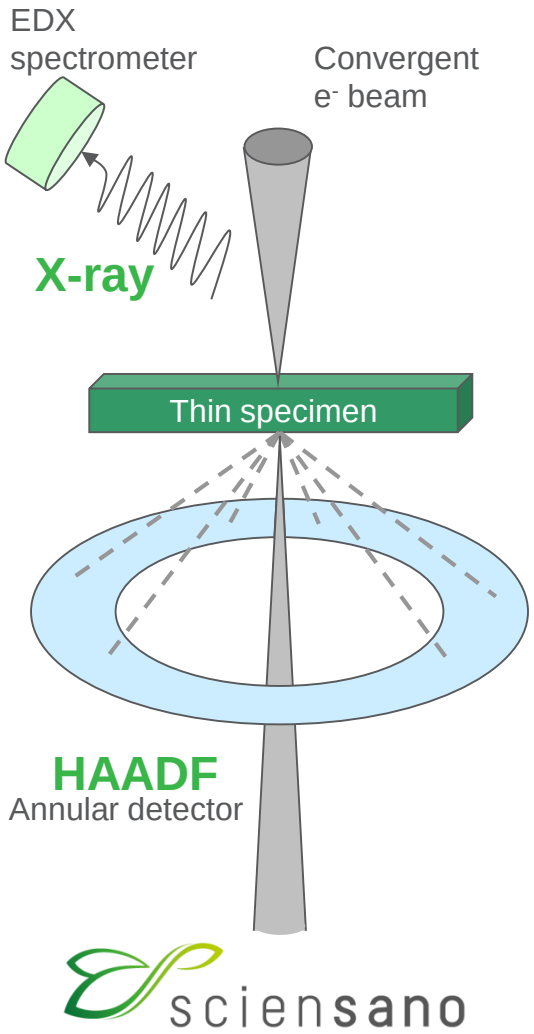
Sample preparation → **TEM imaging** → **Image analysis** → **Size distribution** → **Median value**

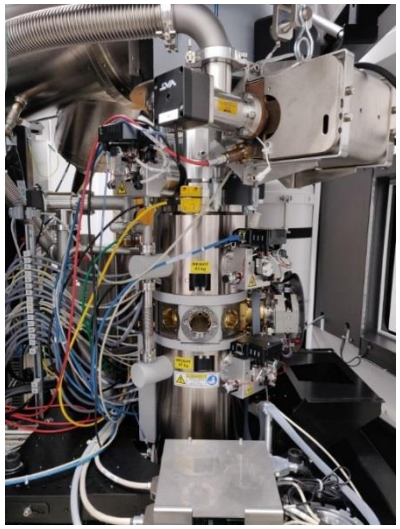


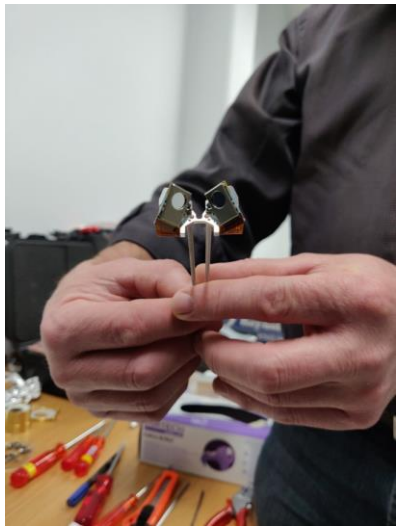


Developed for implementation of EC Recommendation on the definition of a nanomaterial (2011/696/EU)

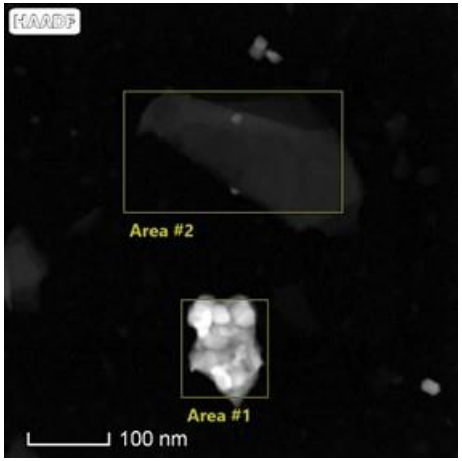
Analytical TEM:
Physical + Chemical NM characterization



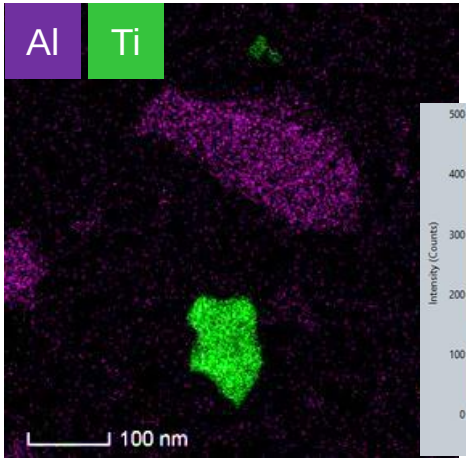




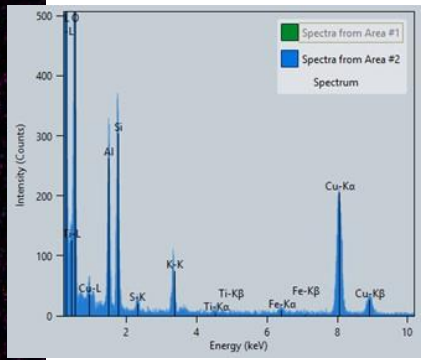
HAADF-STEM image



Elemental maps



Characteristic X-rays



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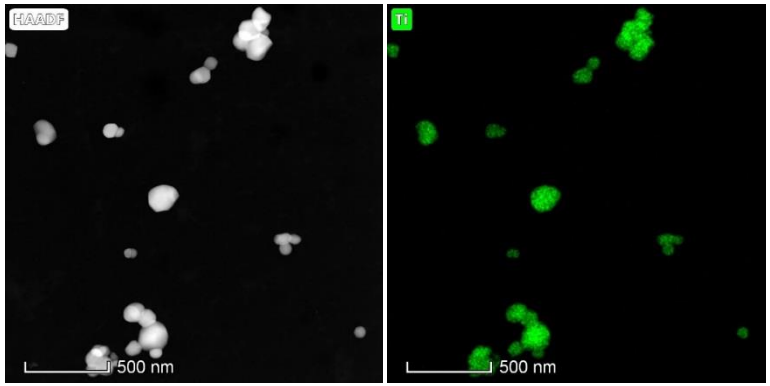
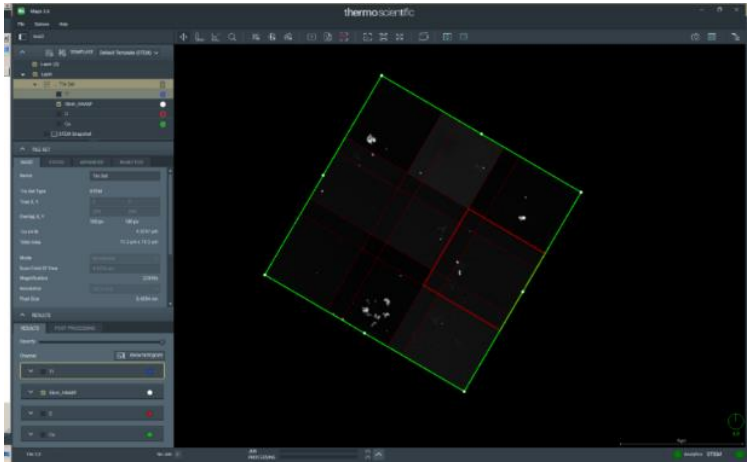
Automated TEM

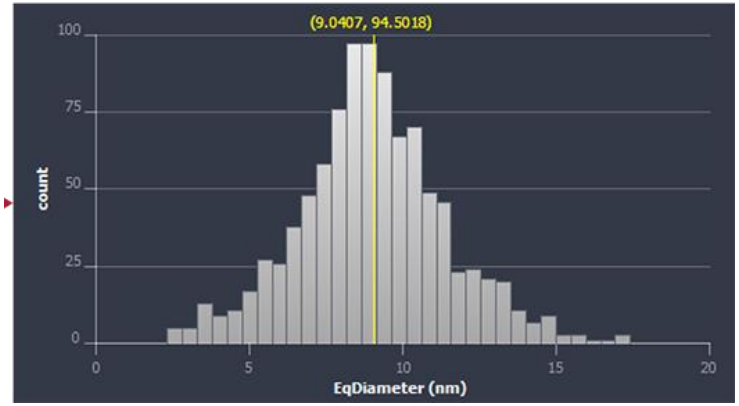
VELOX: STEM images and EDX maps recording



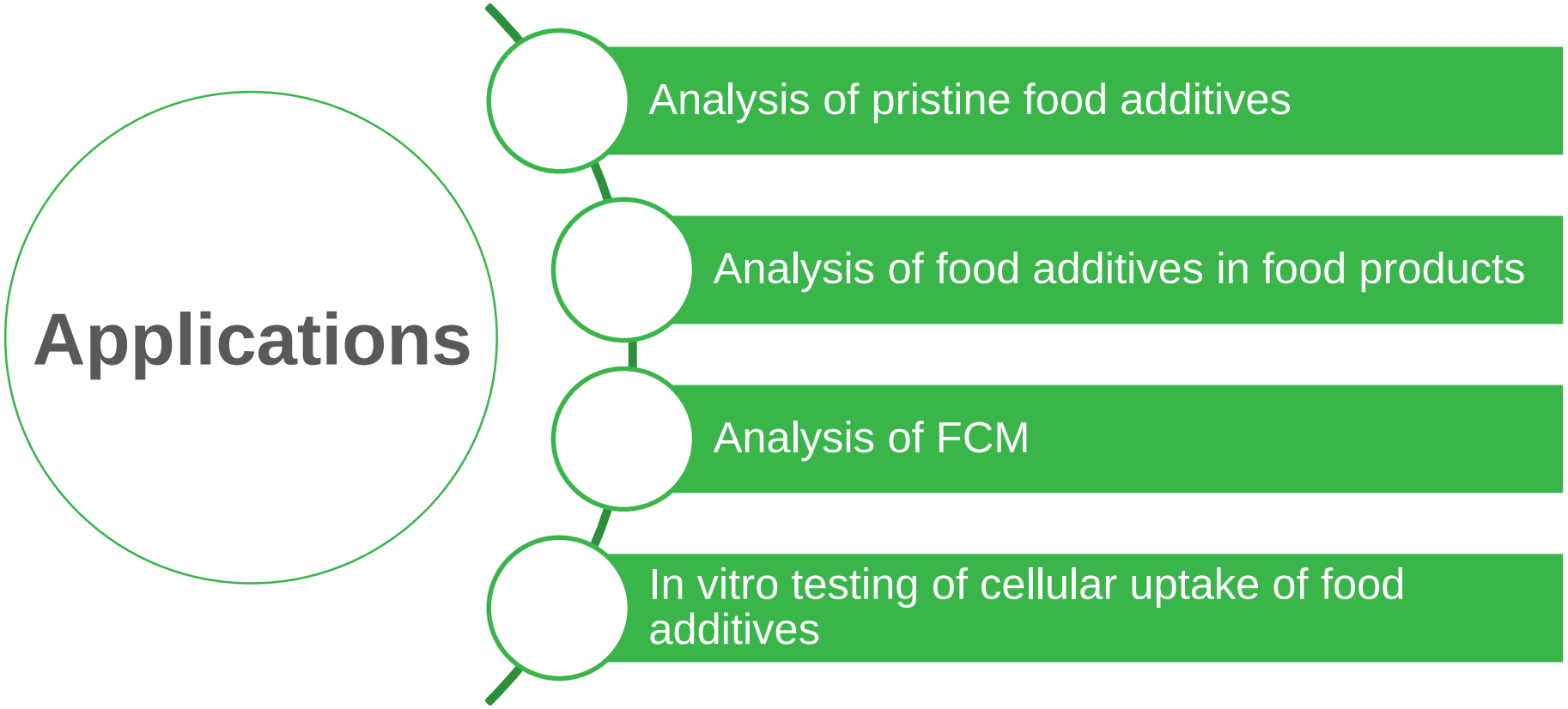
MAPS: Automated grid scanning



AVIZO: online particle measurement



Applications



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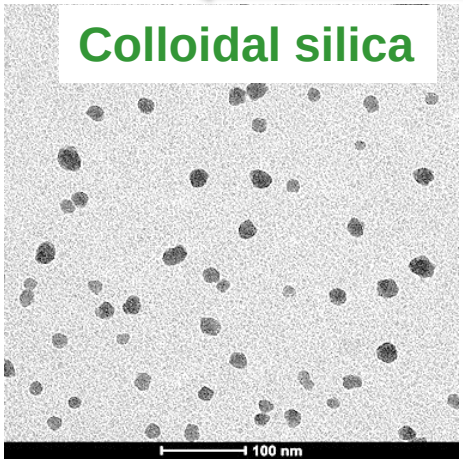
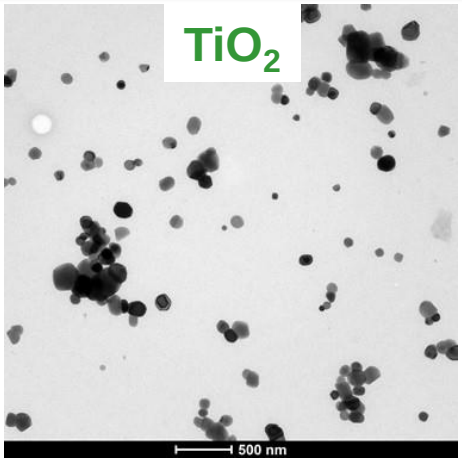
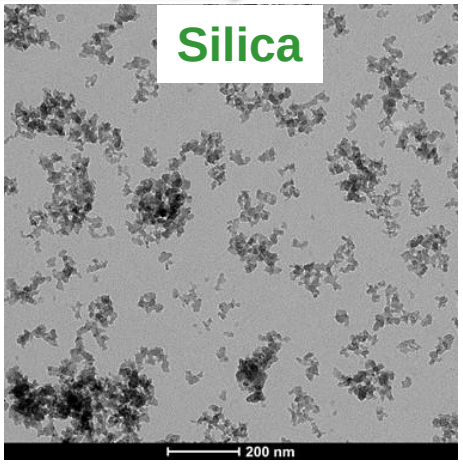
Physical characterization of pristine NM

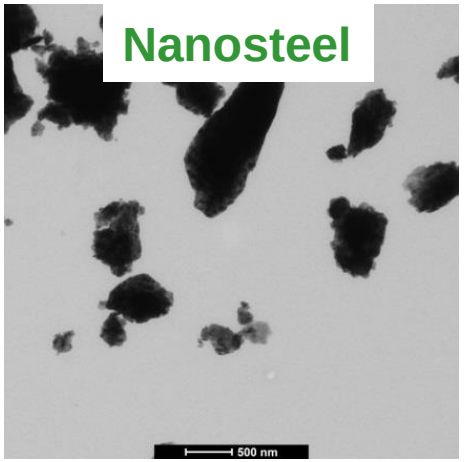
Near-spherical

Platelets



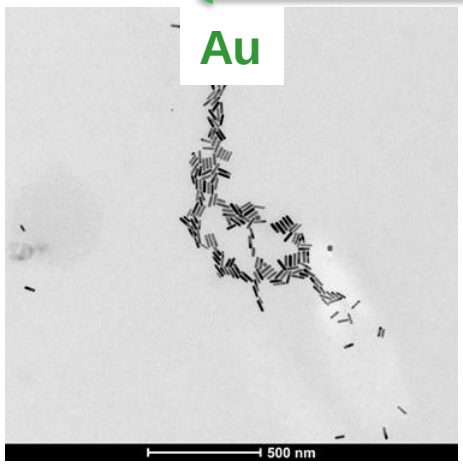


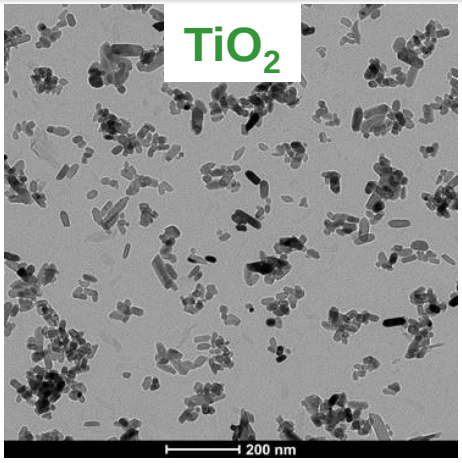


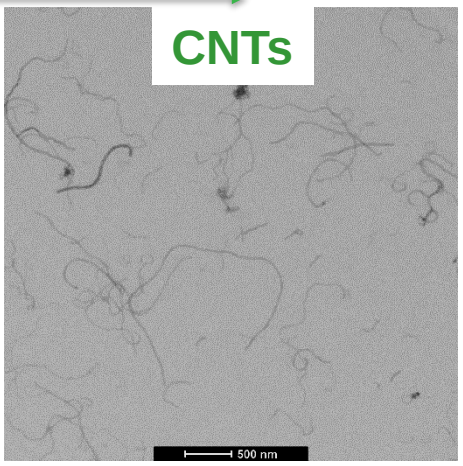


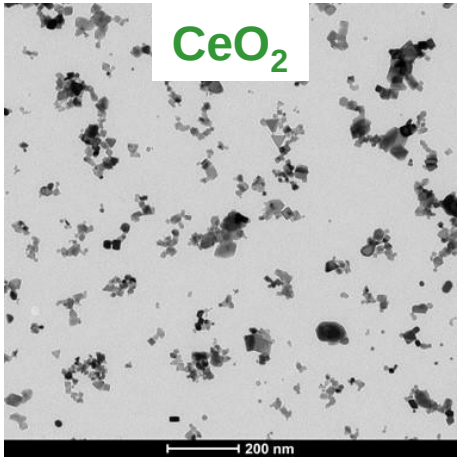
Rod-like

Irregular

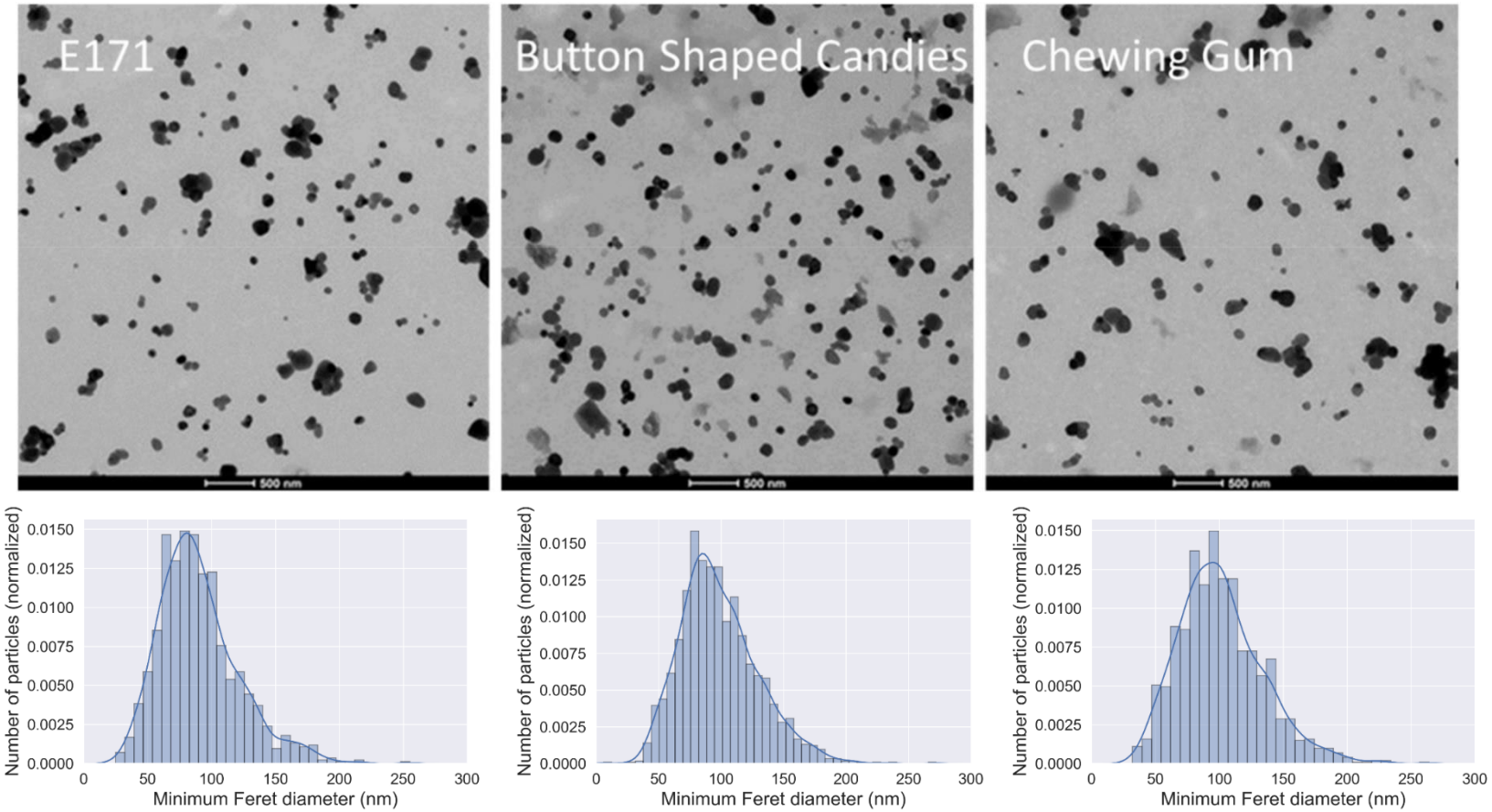








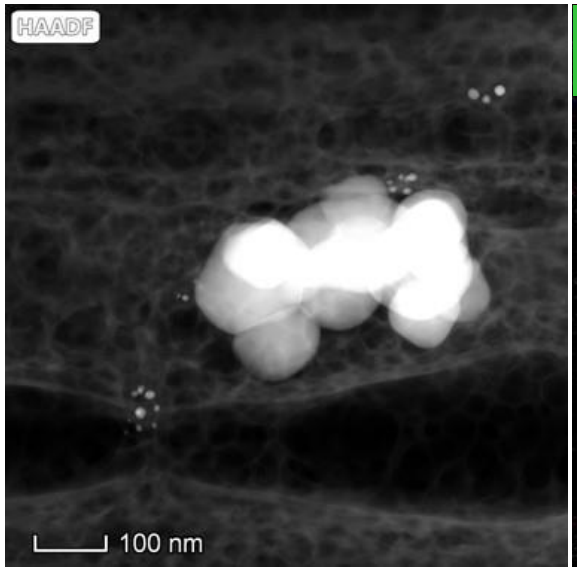
Particles in a food matrix - simple models

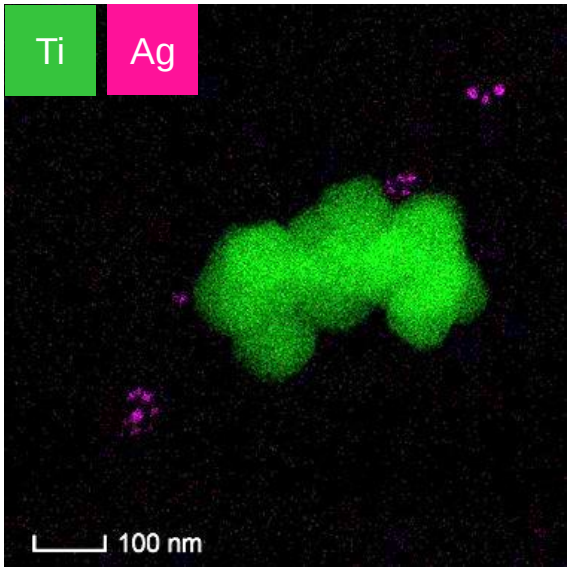


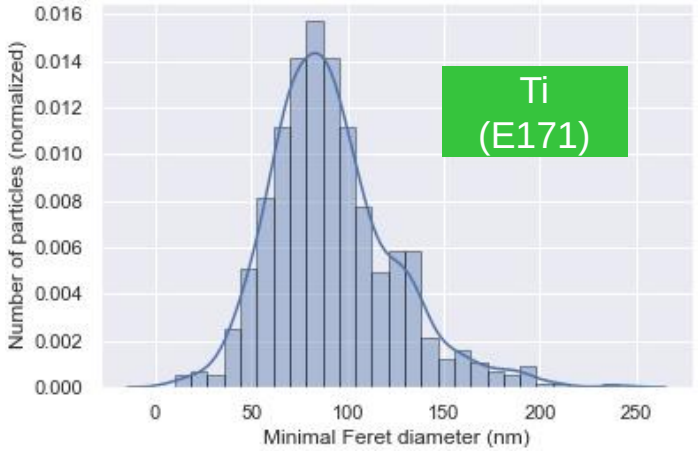
- ➔ **Optimised sample prep**
- ➔ **Limited matrix interference ➔ EDX not really necessary**
- ➔ **Characterization results are published:** **Geiss et al. 2020:** Particle size analysis of pristine food-grade titanium dioxide and E 171 in confectionery products: Interlaboratory testing of a single-particle inductively coupled plasma mass spectrometry screening method and confirmation with transmission electron microscopy

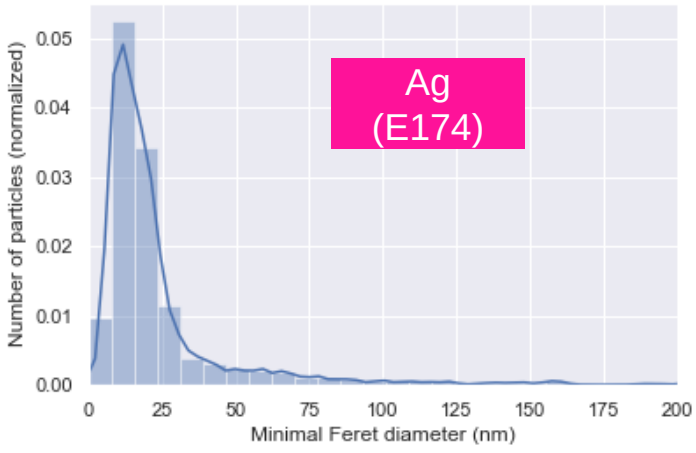
Particles in a food matrix: complex models

Food additives E171 and E174 in a food product



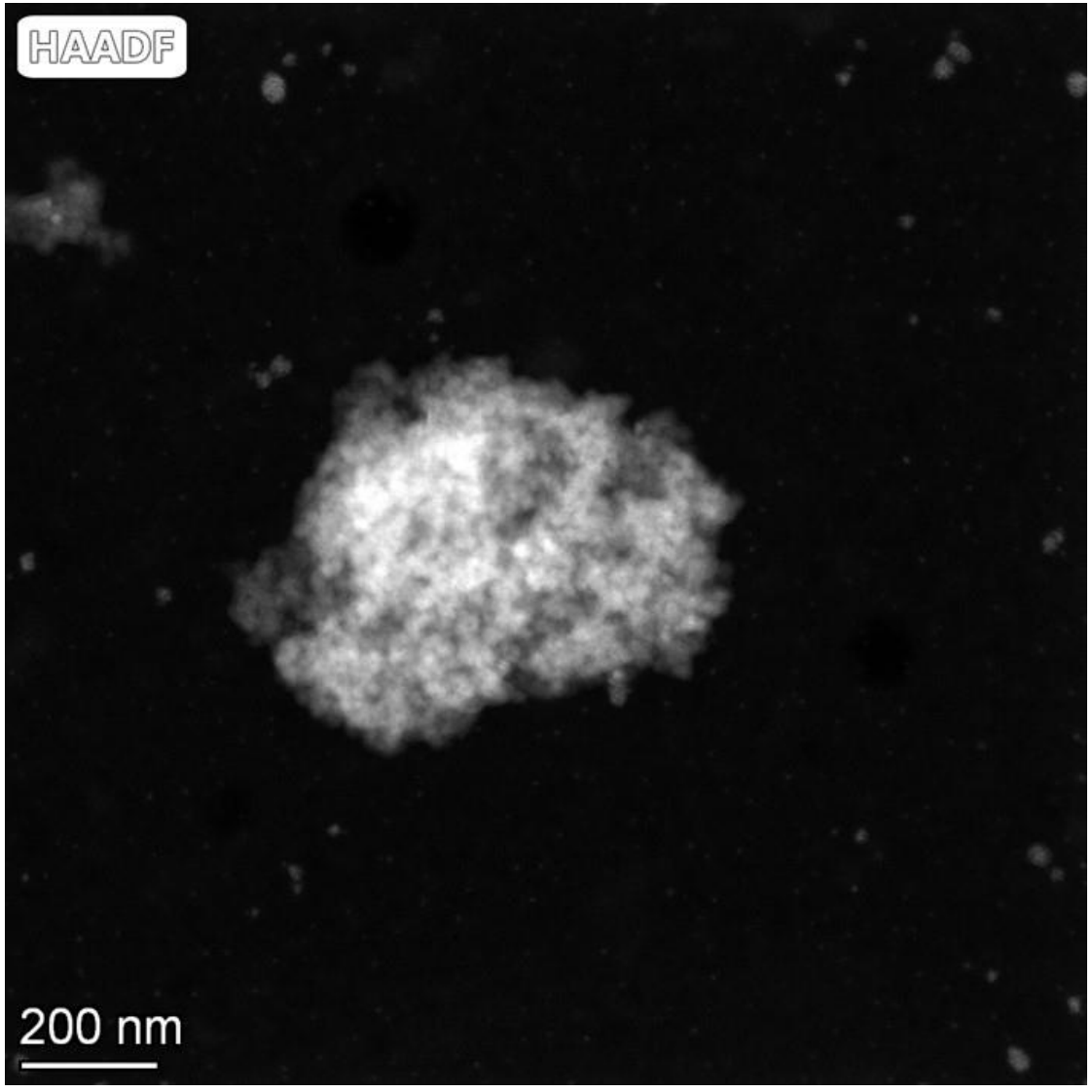


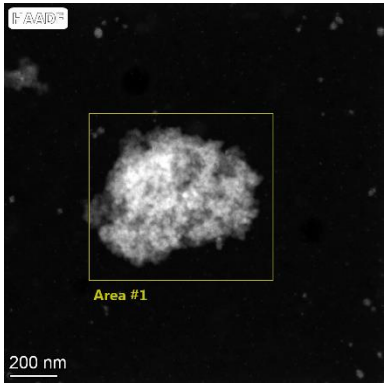


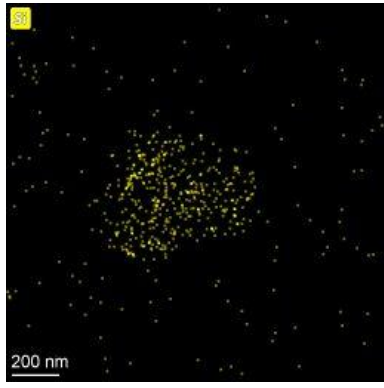


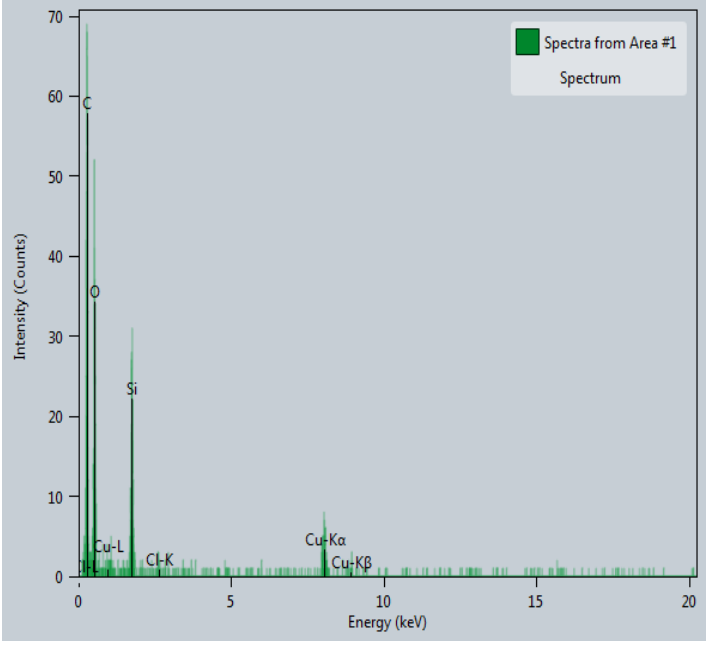
Particles in a food matrix: complex models

Food additive E551 (silica) in food products





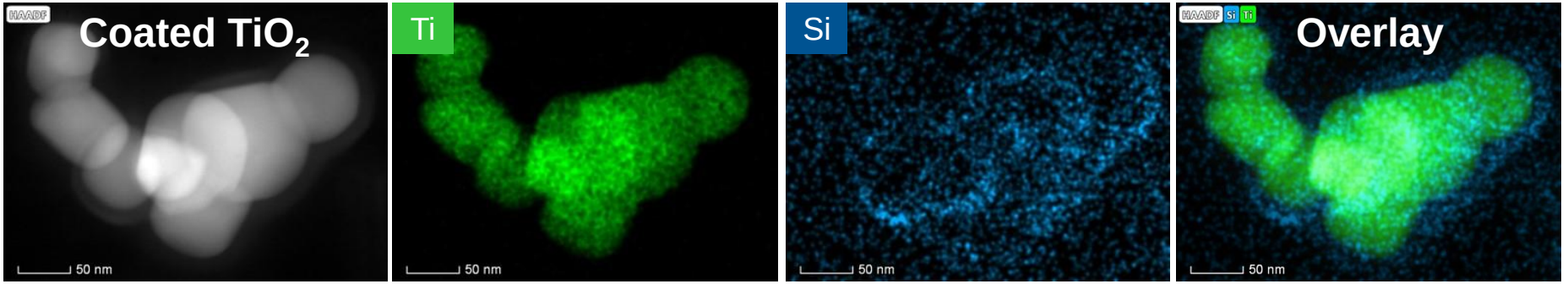




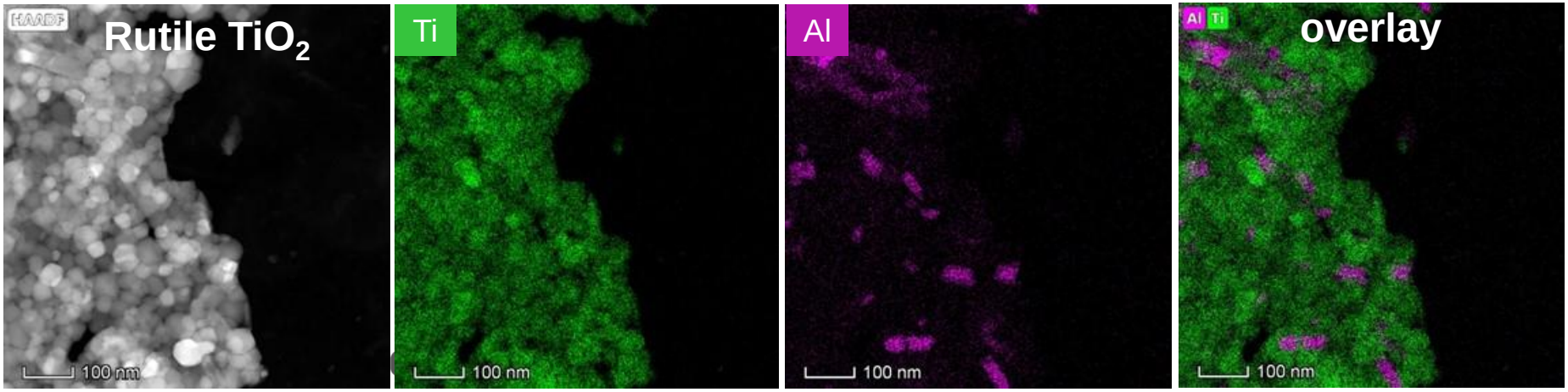
Analysis of coatings and impurities

Food additive E171

Visualization + composition of coatings

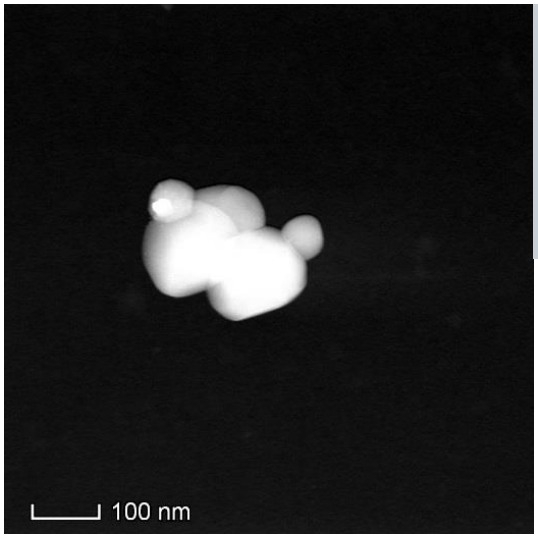


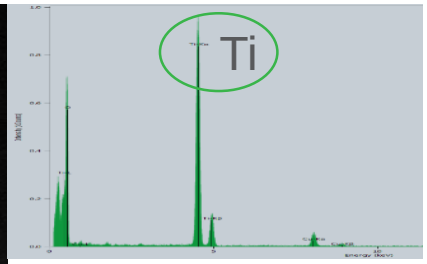
Visualization + composition of impurities

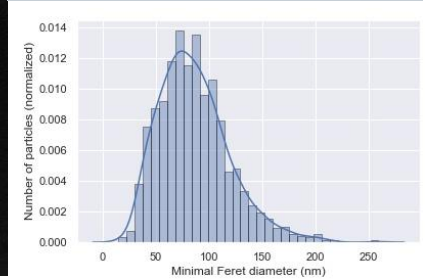


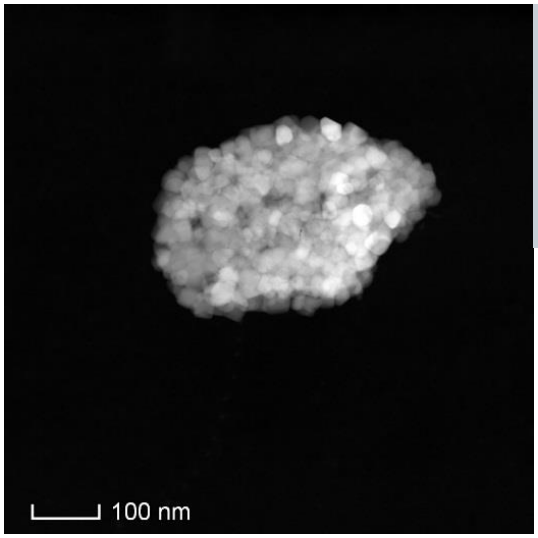
Food – cosmetics: Phase determination - crystallography

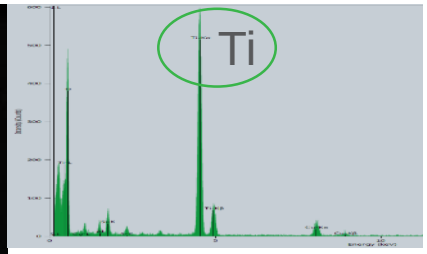
Anatase TiO_2 vs pearlescent pigments

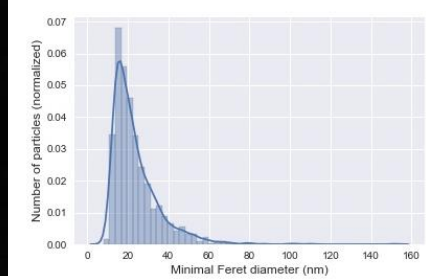




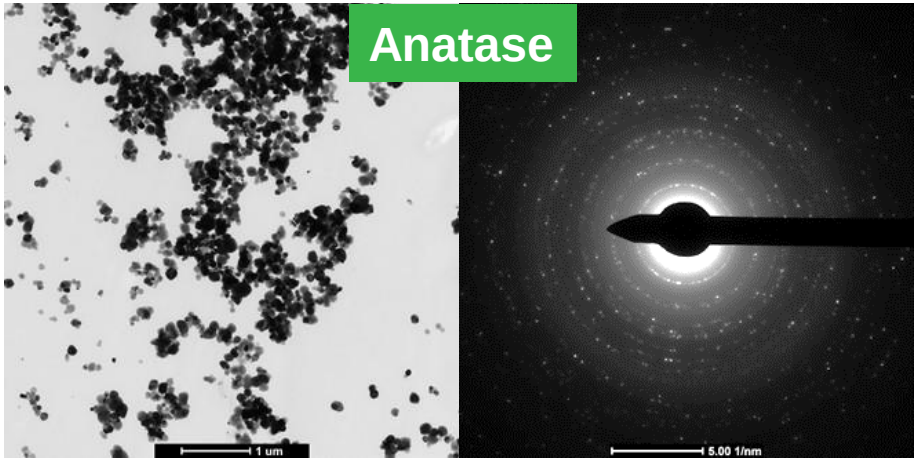




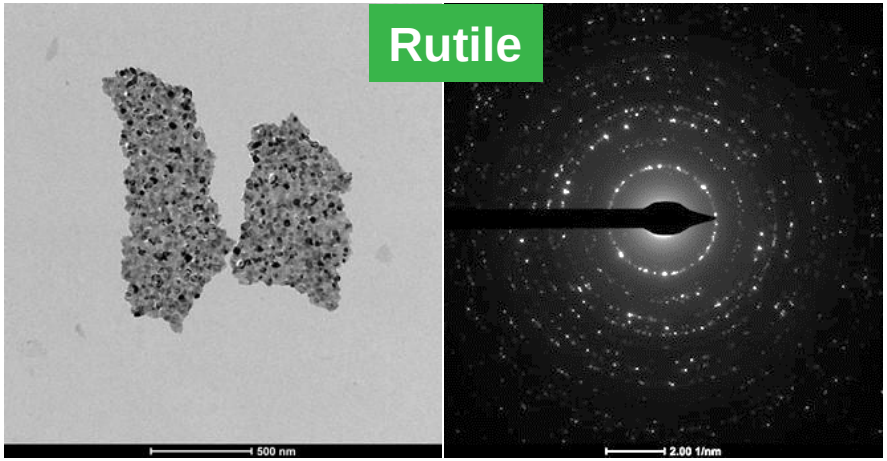




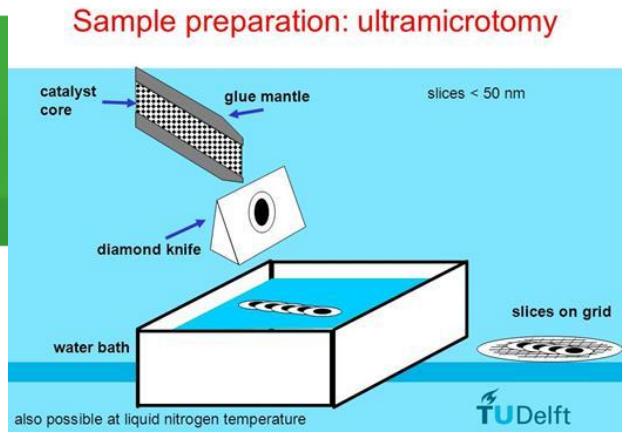
Anatase



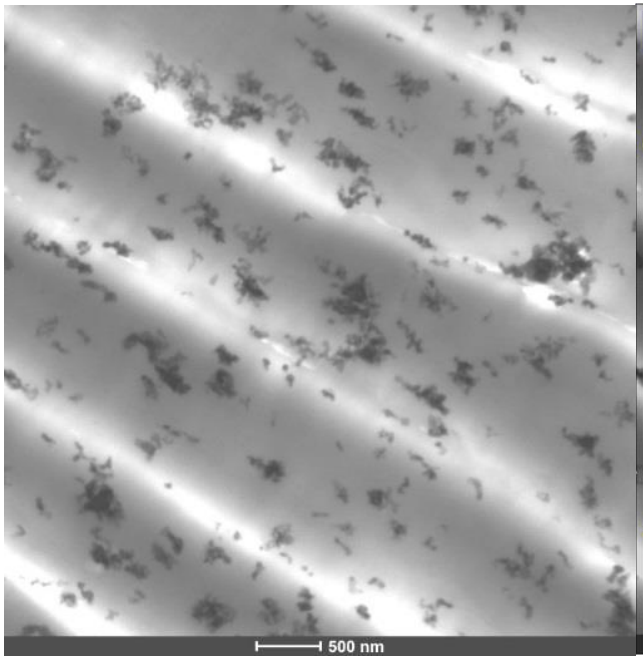
Rutile

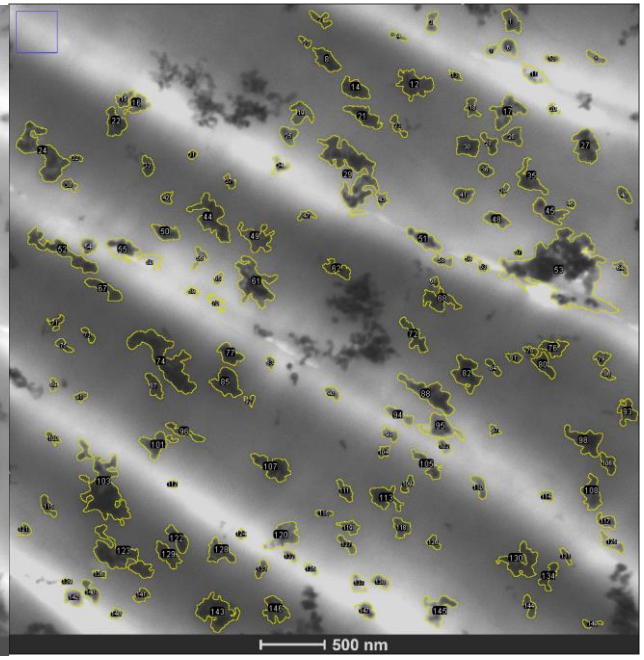


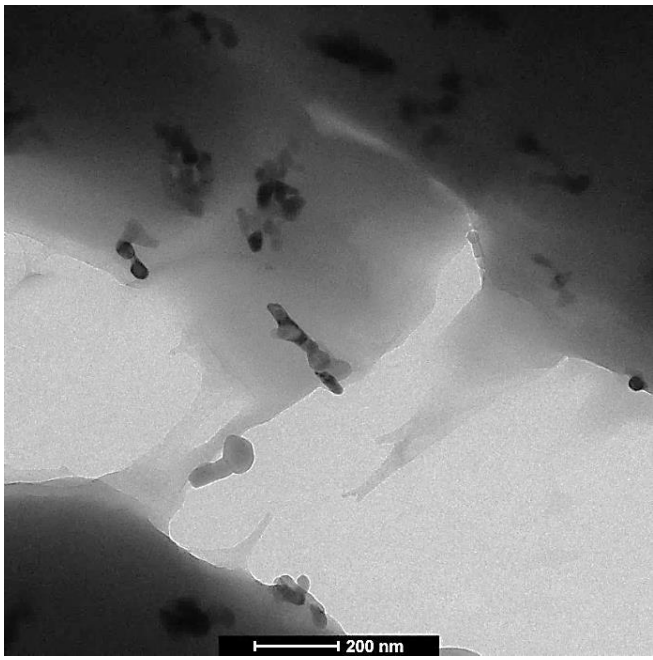
Sections:
Food contact materials



Detection of Fe_2O_3 in PE

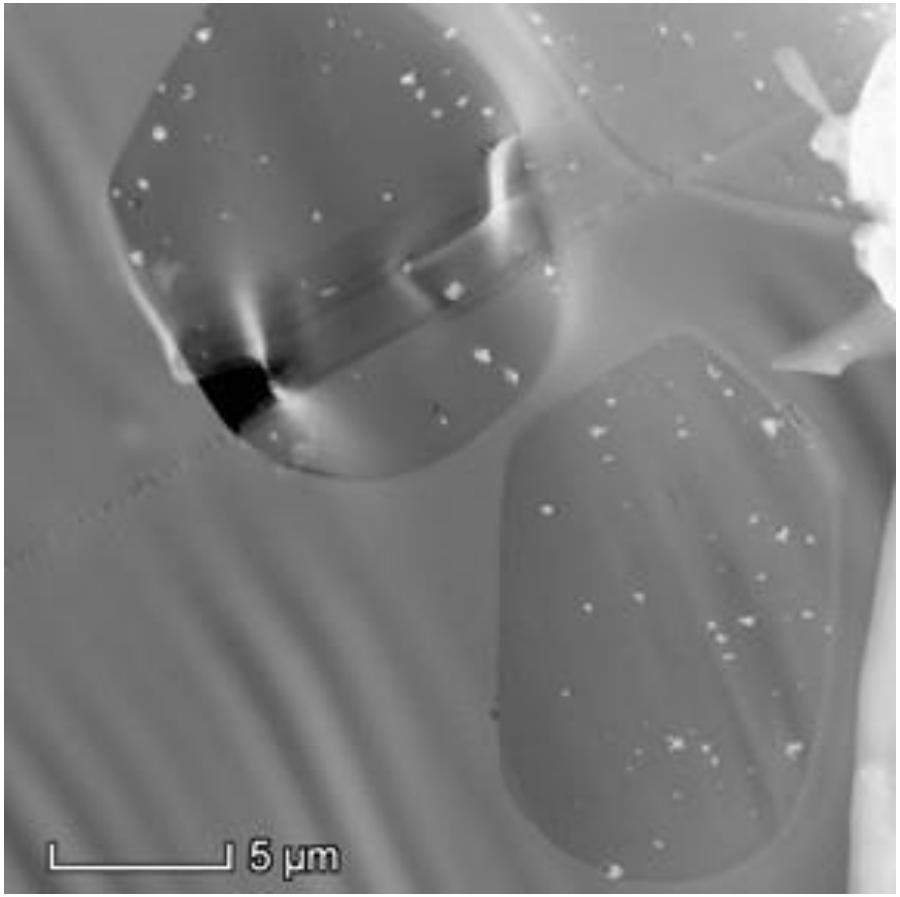






- Sections have a thickness of about 80-150nm
- Aggregates are easily detected
- Constituent particle detection is more difficult but not impossible

Detection of nanoparticles in fibers



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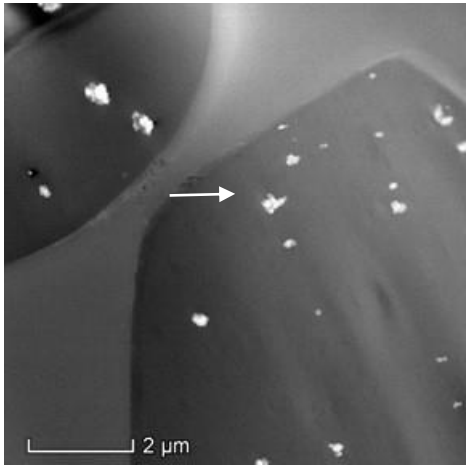
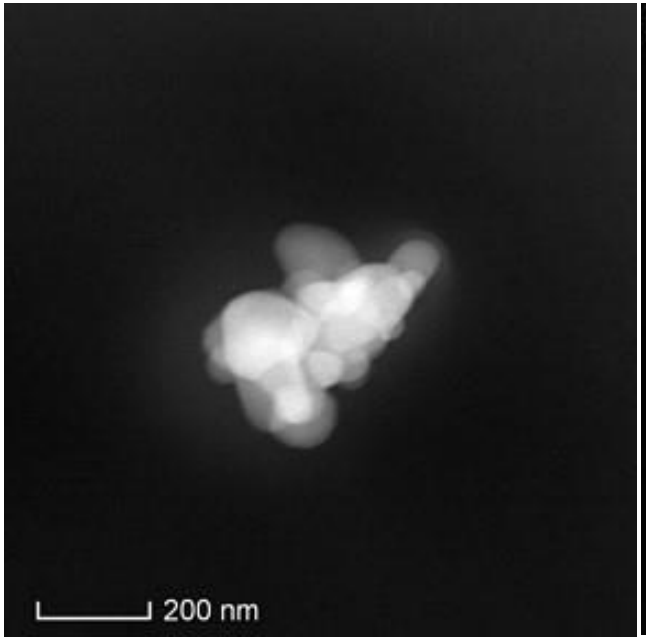
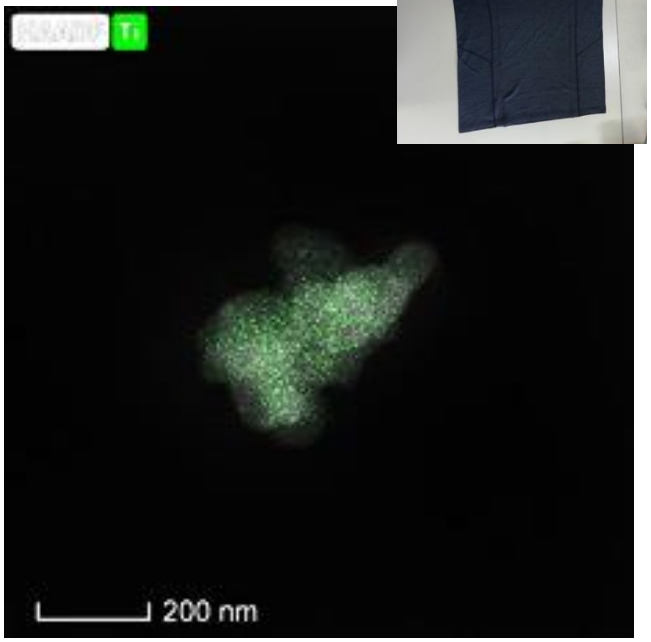
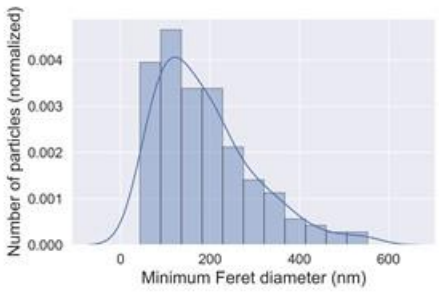
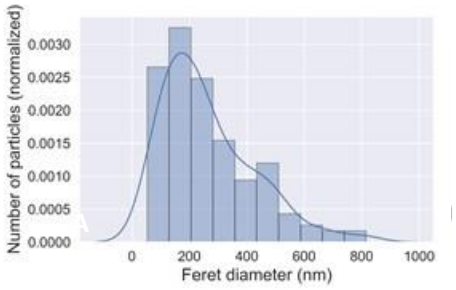
Detection of nanoparticles in fibers

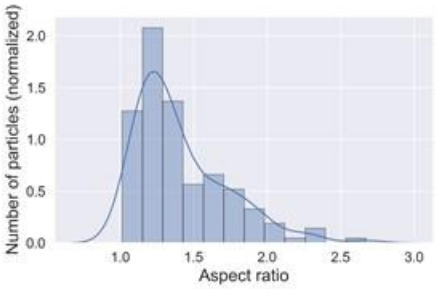


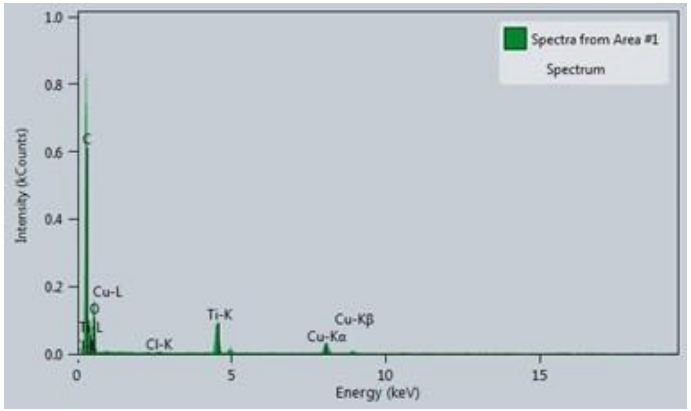




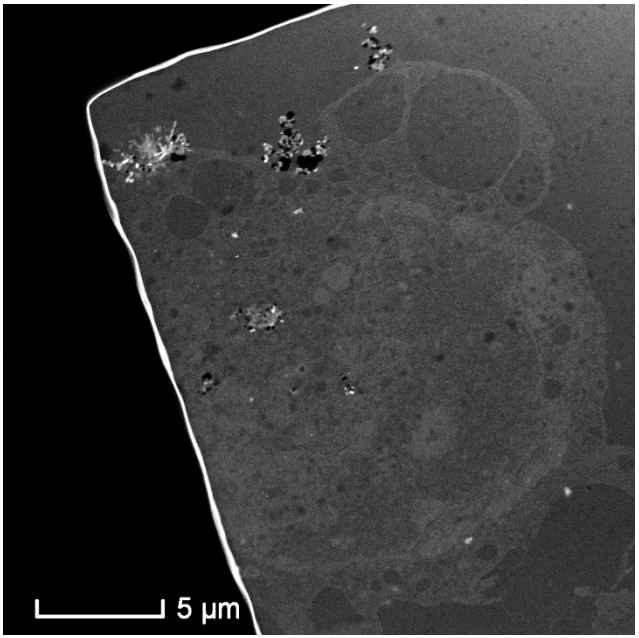


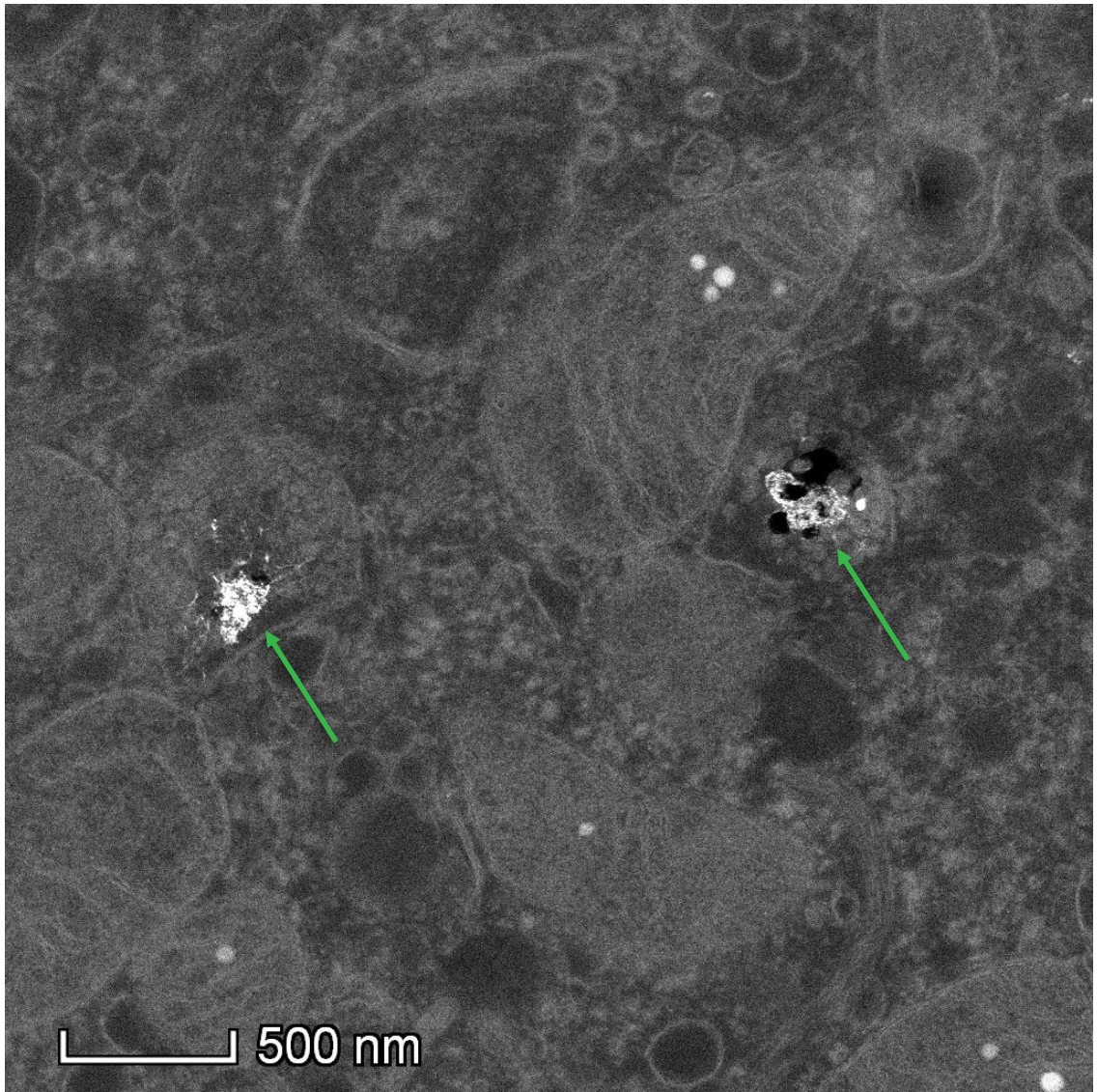






Sections: Localisation of transformed silver nanoparticles in cells





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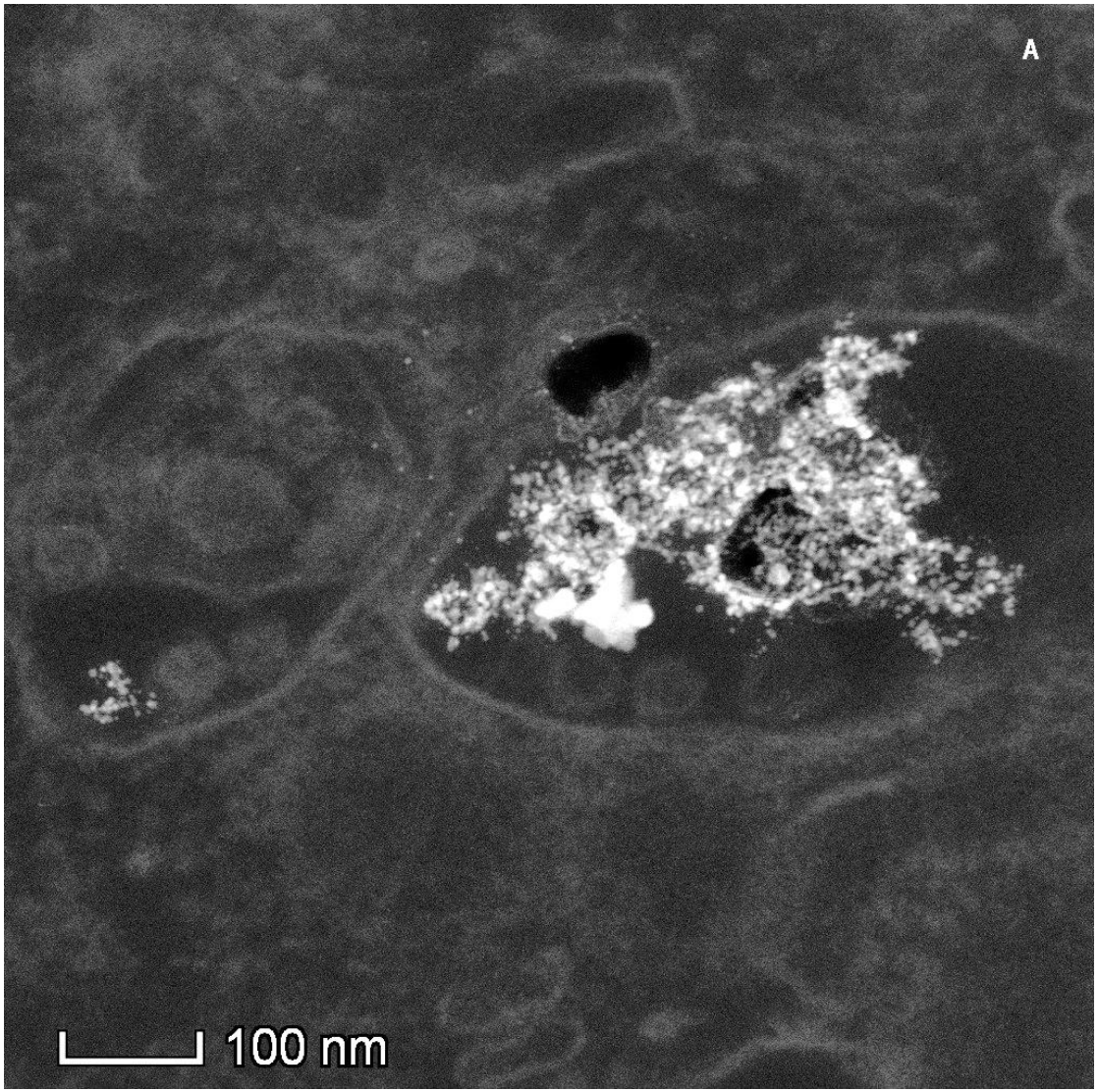
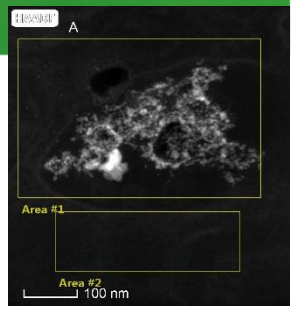
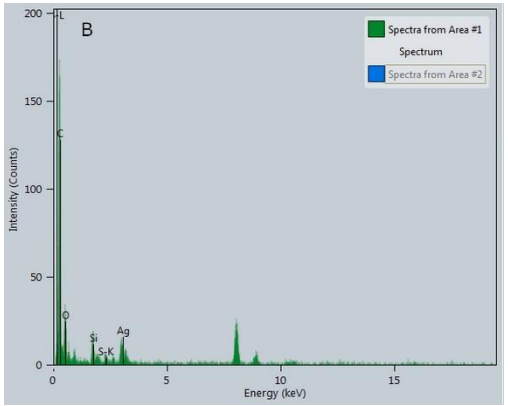
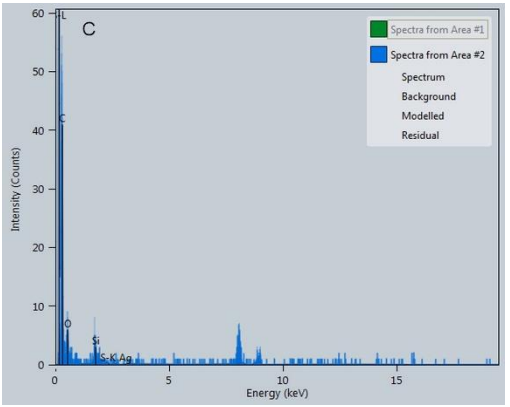
Sections: Localisation of transformed silver nanoparticles in cells

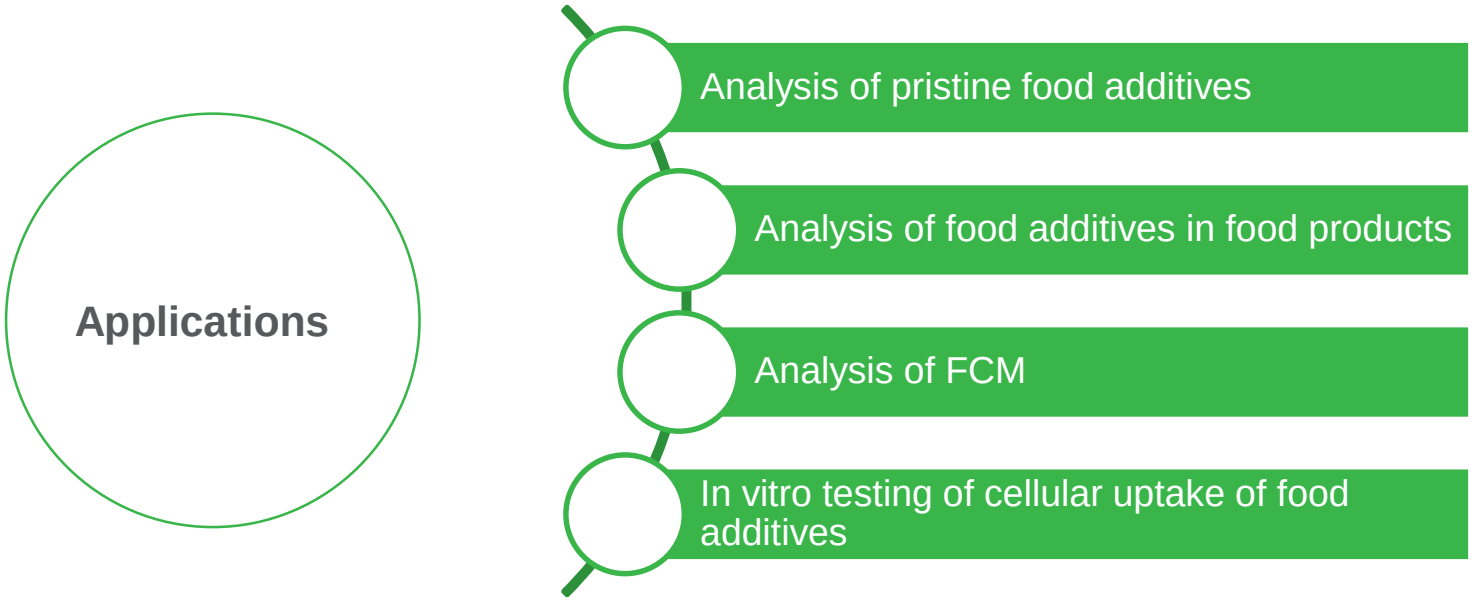








Conclusion



- Our methodologies are essential for our stakeholders and external clients to implement nano-specific regulations and legislation
- EFSA, ECHA, JRC, Nanoregister, FPS, DG4, FAVV, FAGG, Belgian and European companies and research institutions
- The methodologies are directly applicable in several sectors

Webinar Workshop

Scope:

- Provide **training on the physicochemical characterization** of nano-sized particles in food additives and in food products
- Focus on **TEM** and **single particle ICP-MS**.
- Demonstrate the **analytical capacities** of state-of-the-art methodologies to implement guidance and legislation based on **(automated) analytical TEM**.
- Method validation

Provisional date: beginning 2021

How to subscribe:

- mail to **EMgrp@sciensano.be**

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Happy Holidays!!!

from

The Electron Microscopy unit

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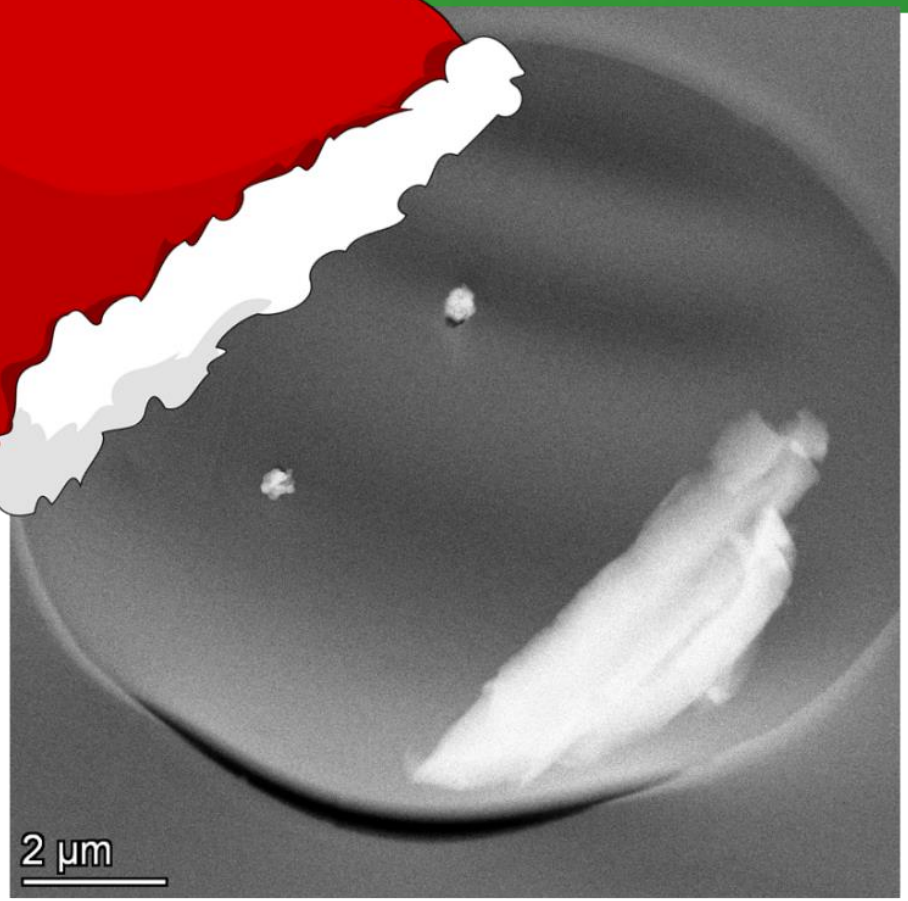

Section of a textile fiber (polyester) containing TiO_2 nanoparticles

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