

Experimental Study

Risk Assessment for coating applications

PD Dr.-Ing. habil. Michael Stintz

TU Dresden

Enabling Responsible Innovations of Nanotechnologies

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Future growing market

self cleaning coatings

bactericide coatings

photo-catalytic active coatings

highly scratch resistant coatings

special optic effect paints

UV-protective coatings

Source: Michael Bross, German Paint Industry Association (VdL)



Objective: Particle release from nanoparticle containing coatings

Strategy: Simulation of typical handling by ordinary customer,
f.e. abrasion by sandy shoes on parquet coating

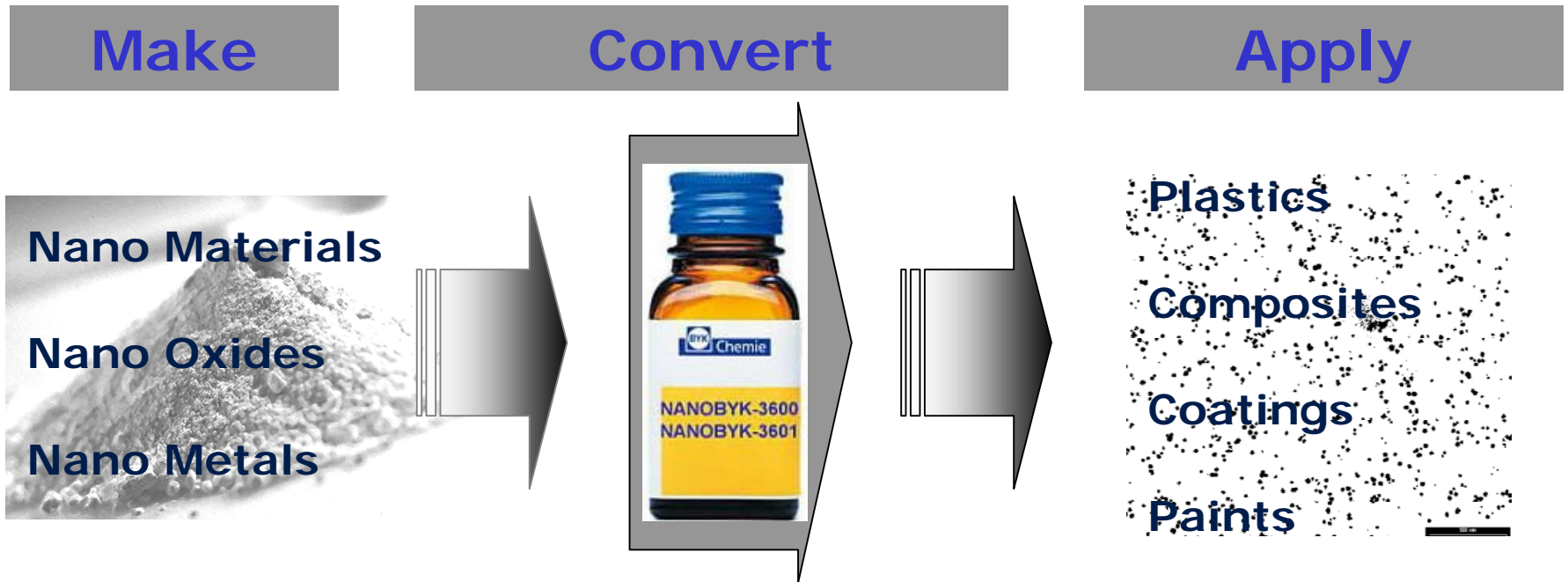
Challenges:

- Reproducibility of particle generation (and particle suspension from powder to air)
- Normalization (material amount, air volume, particle size range)
- Sensitivity of nanoparticle concentration measurement, time stability, nanoparticle background

Establishment of treatment method, standardization of measuring methods

Researcher: TUD Process Engineering (Particle Characterization Lab)

Sponsor: German Paint Industry Association (VdL) 



1. NANOBYK's help to convert nanomaterials in products
 - Easy access to Nanotechnology
 - „Ready-to-Use“
2. NANOBYK's can easily be added to paints and coatings
 - No need for disperse/handle powders ≈ safer access (Toxicology)

Source: Dr. Thomas Sawitowski, BYK Nanotechnology

Tested Coatings:

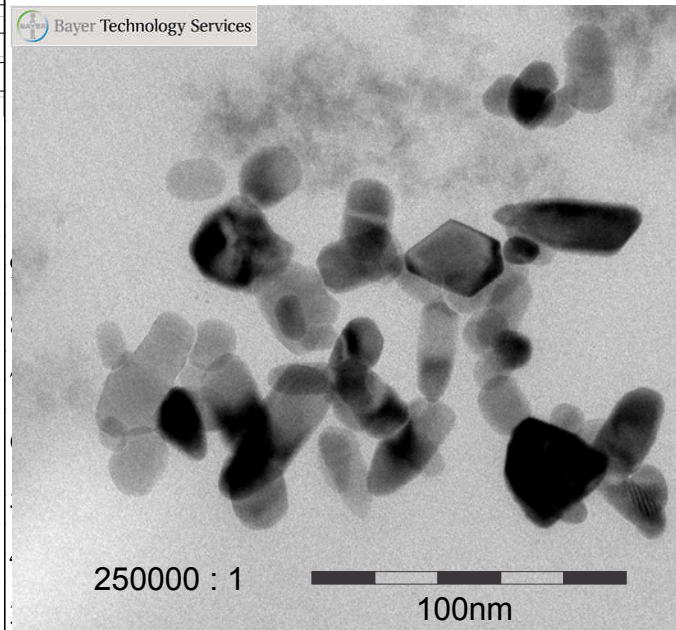
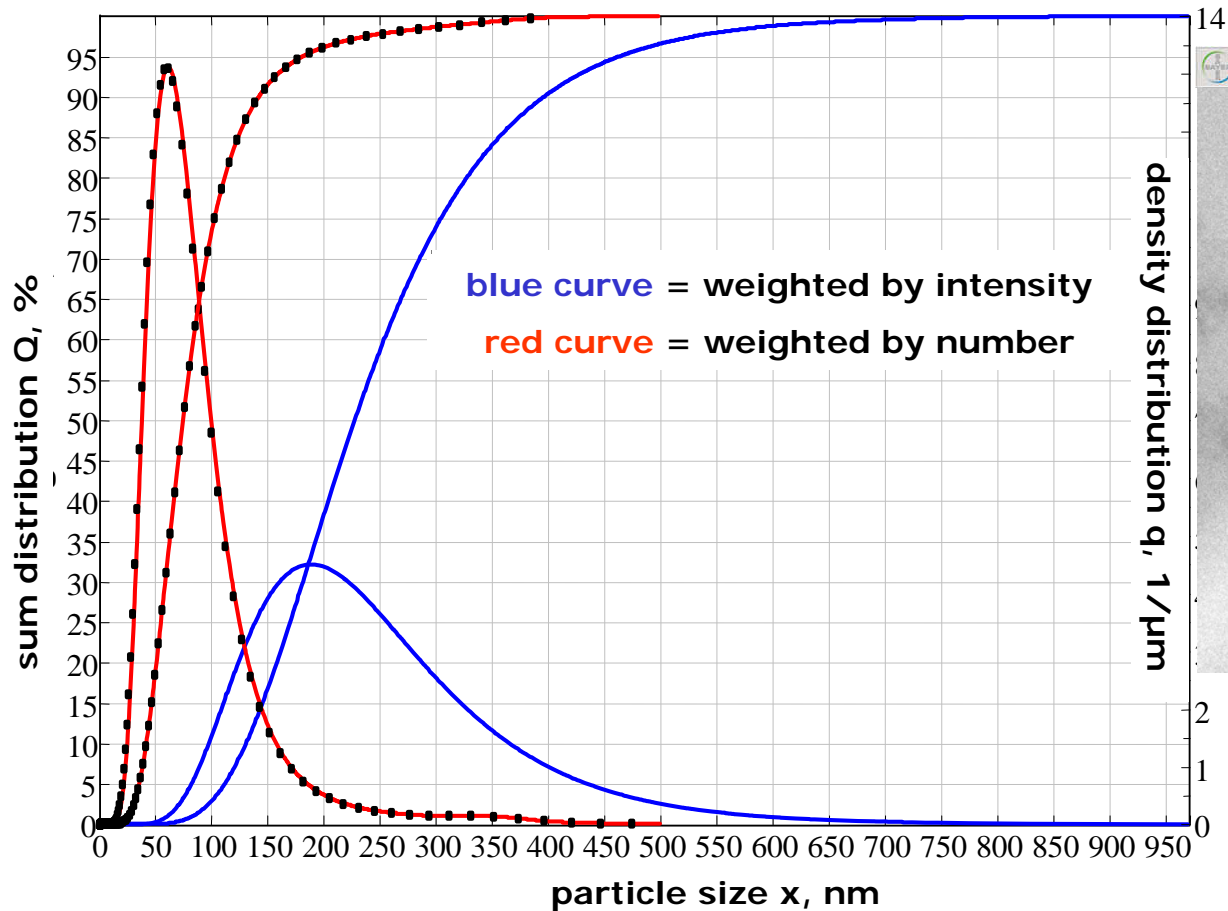
- architectural coating
(white pigmented styrene acrylate copolymer dispersion)
- parquet coating
(UV curable clearcoat)
- furniture coating
(two-pack polyurethane)



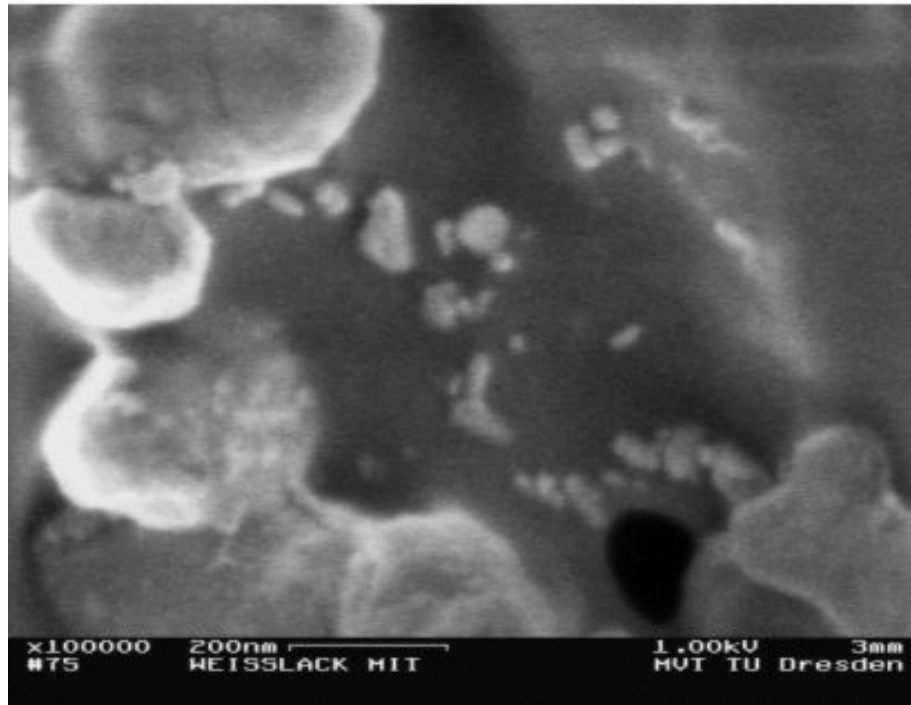
Substrates: wood and metal

ZnO-nanoparticle component of the furniture coating

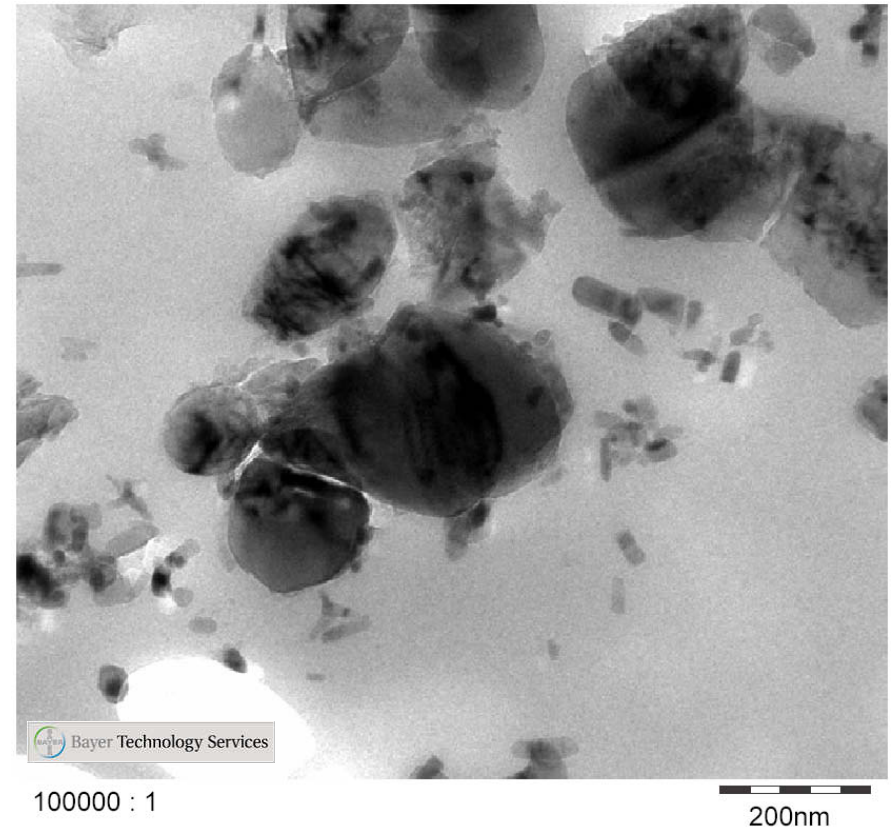
Photon Cross-Correlation Spectroscopy in liquid suspensions



Architectural coating 20 nm zinc oxide and pigment particles



SEM after Cryo-Preparation



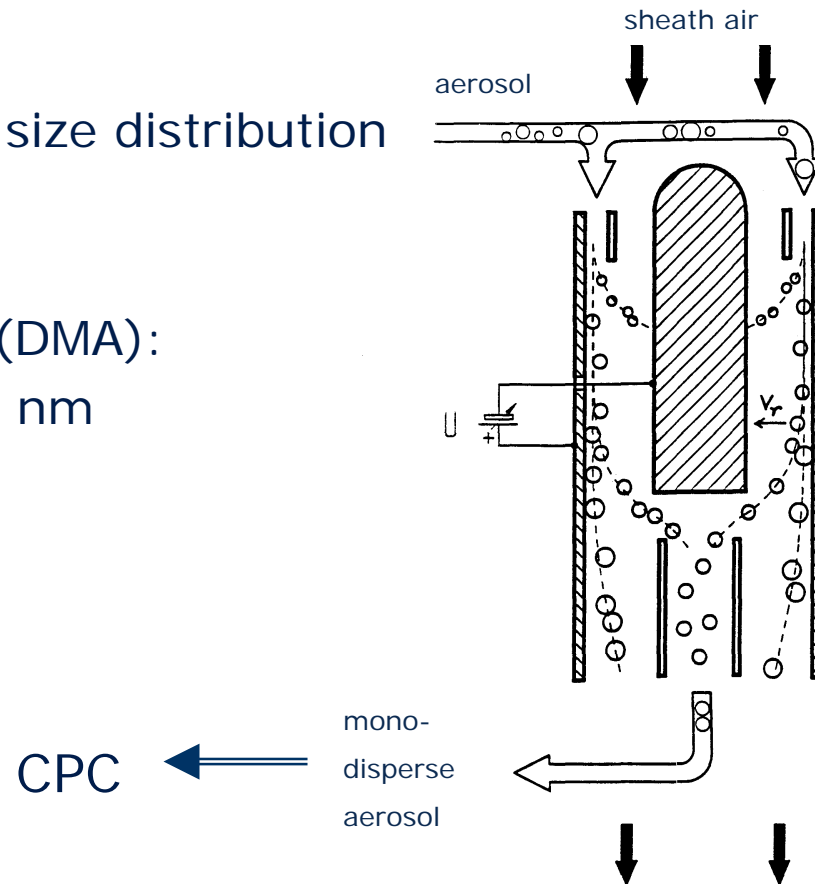
TEM

Sequential Mobility Particle Sizer (SMPS)

Number concentrations of the size distribution

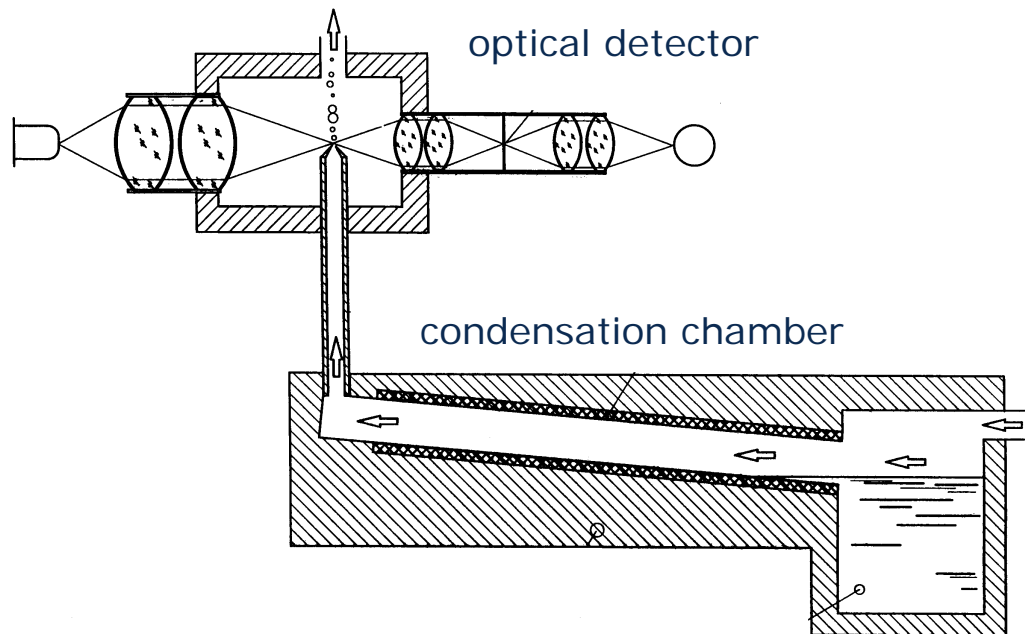
Differential Mobility Analyzer (DMA):

- Size Classification 16 - 626 nm
- Of 0,01 - 10.000 p/cm³
- In 0,3 l/min



ZnO-nanoparticles are 1000-times smaller than a human hair (0,05 mm)

Condensation Particle Counter (CPC)



- total concentration
- 7 nm - > 10 μm
- 0,01 - 10.000 p/cm³
- 0,3 l/min

Mass of a 20 nm ZnO-sphere: $2,35 \cdot 10^{-17}$ g

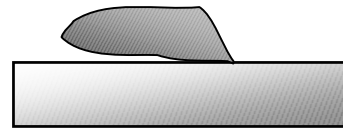
NO GRAVIMETRIC measurement applicable!

Abrasion test under
particle free
atmosphere

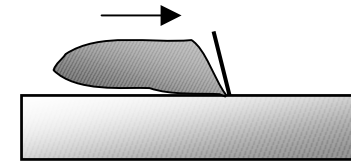
Taber Abraser for
stressing
samples



Detection of aerosol particle emission with SMPS
Additional, microscopic investigations



abrasion grain on coating



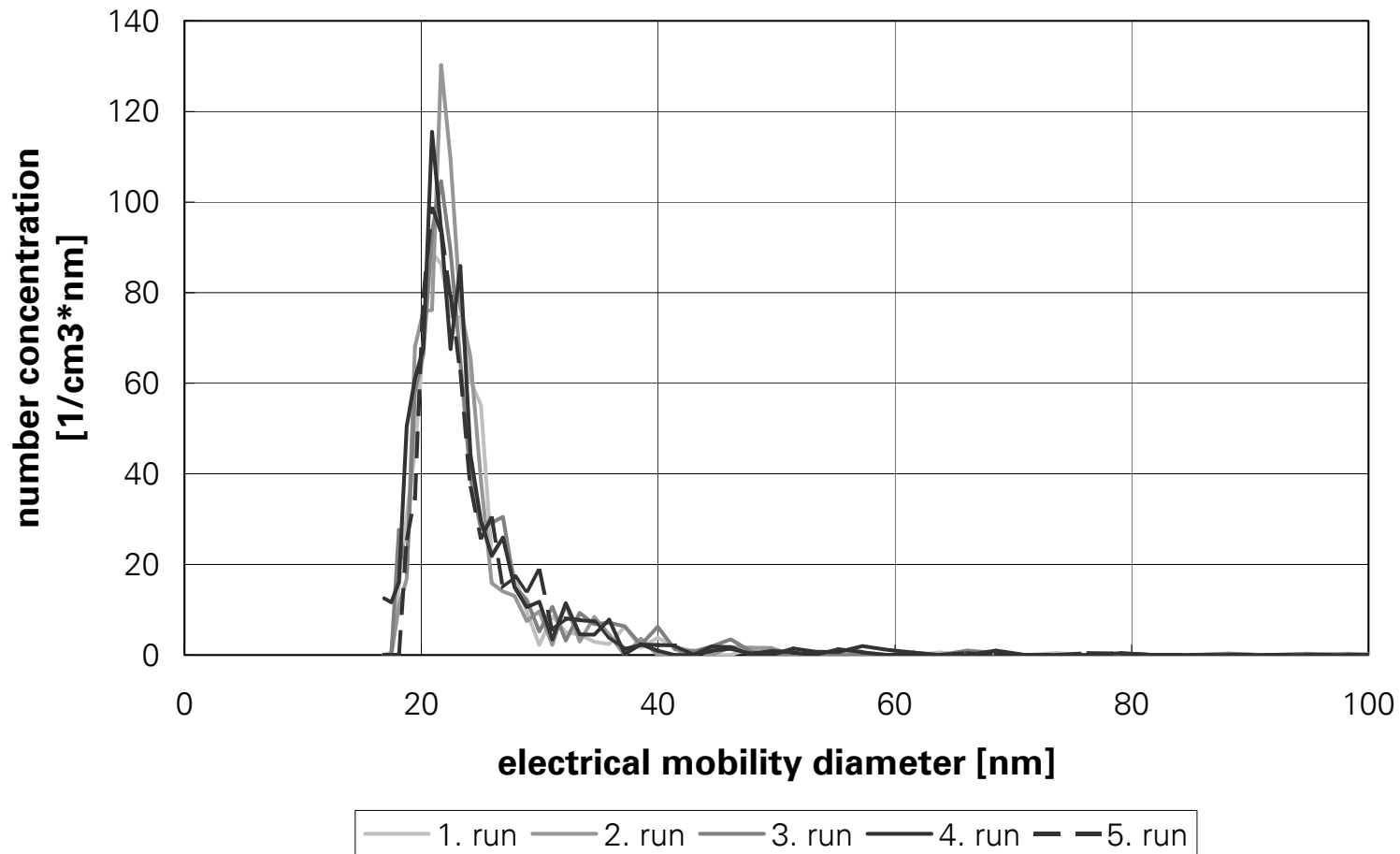
stress comparable with scratching move



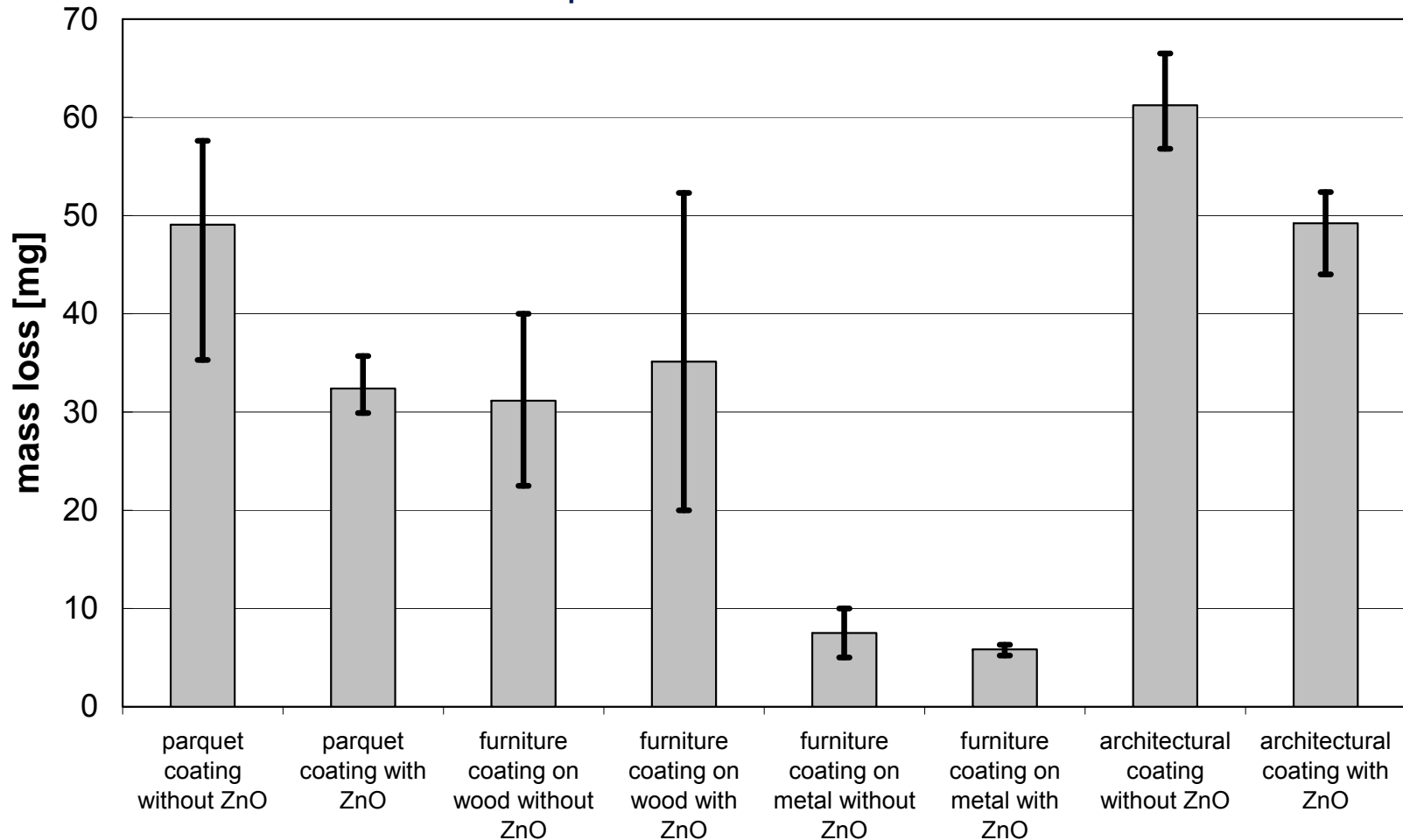
architectural coating after the process with two scratches



SMPS - measurement of test aerosol from classified 20 nm salt particles, sprayed into the abrasion zone (650 p/cm^3)

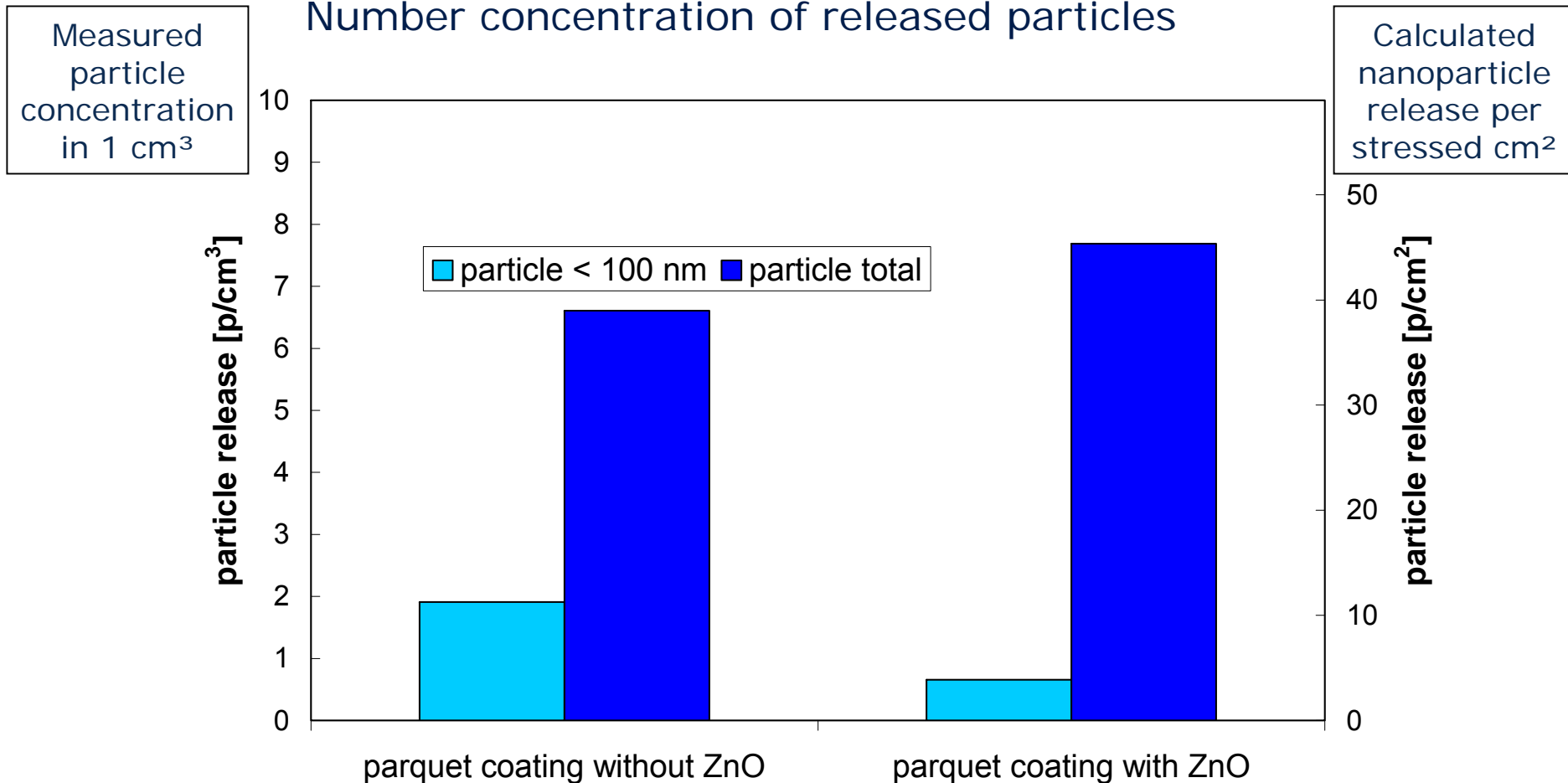


Mass loss of one sample after 300 rotations over 30 cm²

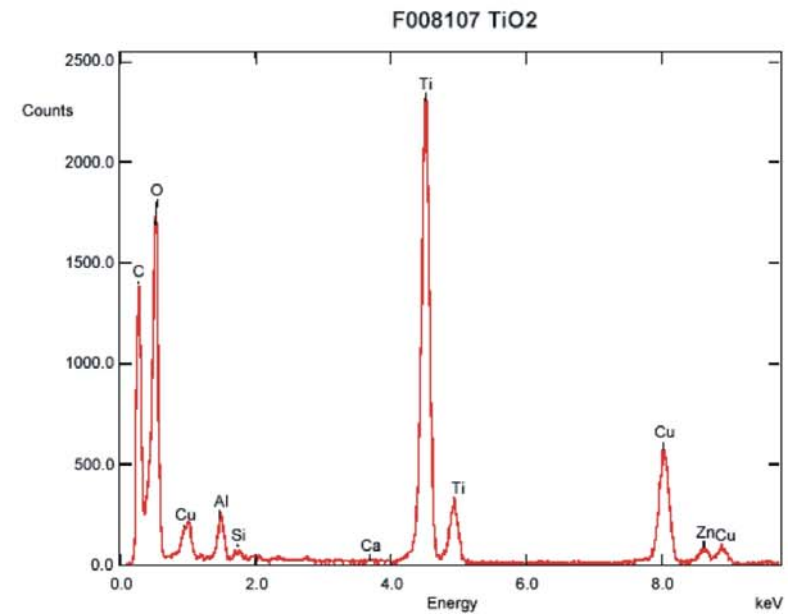
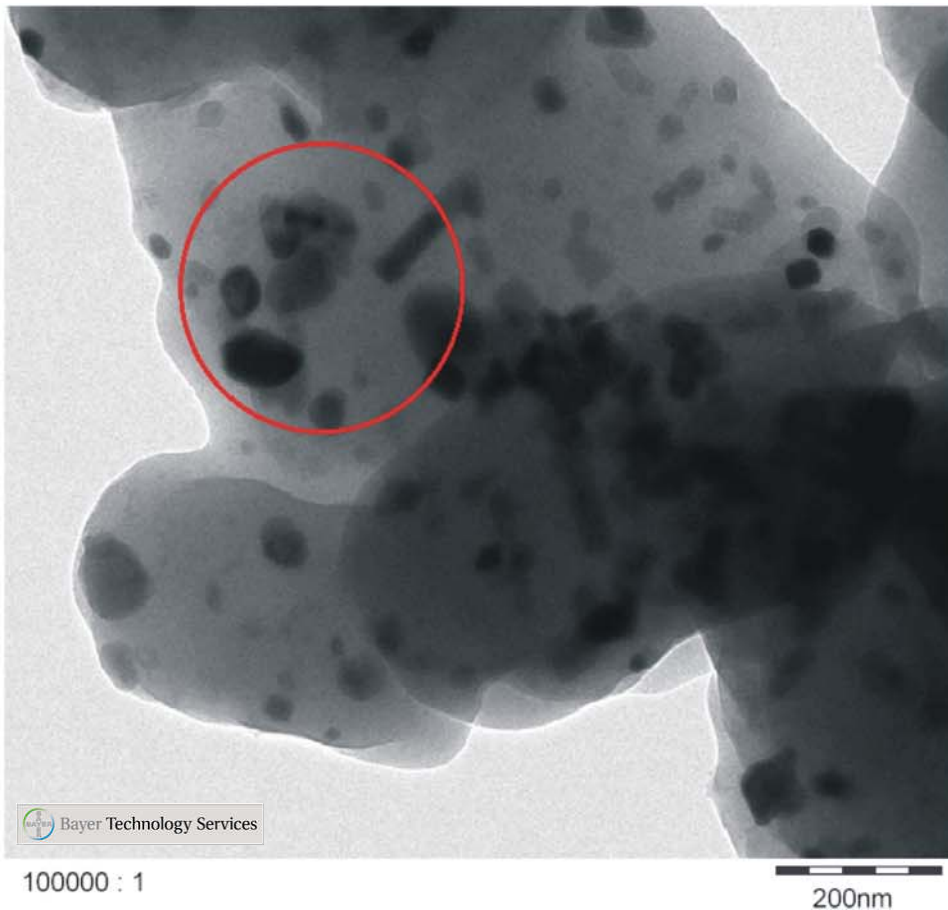


Typical mass of 1 cm² complete coating: 45 mg

Number concentration of released particles



- particle concentration < 100 nm too low for statistical certainty
- dosage of 20 nm ZnO should not increase the particle release < 100 nm



TEM- and EDX-investigations of the generated abrasive wear with **embedded** nanoparticles (20 nm zinc oxide)

- Clean room aerosol measurement technique for quantification of potential nanoparticle release as number concentration (currently under standardization in ISO/TC 24/SC 4)
- Abrasion process comparable to domestic use
- Particle release depends on substrate and coating, no significant correlation to nanoparticle content
- Particle release < 100 nm within uncertainty of measuring method
- Particle < 100 nm embedded in abrasive wear

- Publication of the results (incl. method design and evaluation)
- Input of methodological results in standardization project of ISO/TC 229 WD 12025 " General Framework for Determining Nanoparticle Content in Nanomaterials by Generation of Aerosols"
- Next step: abrasion stress comparable to professional grinding
- Life Cycle Approach (seasoned or weathered paints)
- Further investigations with more coatings and nanoparticles