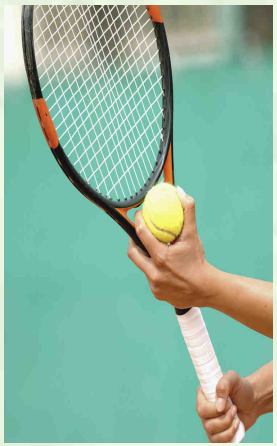
Measurement of nanoparticle removal by abrasion

A. Guiot, L. Golanski and F. Tardif
CEA Grenoble



Scope and objective

- Nanotoxicology will take decades to identify not dangerous nanoparticles

- Application of the principle of precaution: reducing the Risk

Risk = Hazard (unknown) x Exposure

➔ Necessity to reduce the Exposure to nanoparticles

. In labs and workshops (workers)

. From the nanoproducts (consumers)

- Necessity to qualify the nanoproducts in terms of absence of single nanoparticles release in usage and at end of life

➔ New standard?

Scope and objective (cont')

- **Necessity to design new methods to measure the nanofiller release from bulk or coatings of the nanoproducts under different solicitations : mechanical, thermal, UV, etc.**

  . Optimization of nanofiller "hooking"
  . Qualification for market introduction

- **This work : release-ability of nanoparticles by friction**

  . Adaptation of an existing standard for abrasion: ASTM C1353-07 TABER method

Summary

- ✓ Experimental setup and method
- ✓ Qualification of the method
- ✓ Fists results
- ✓ Conclusion

Experimental setup and method

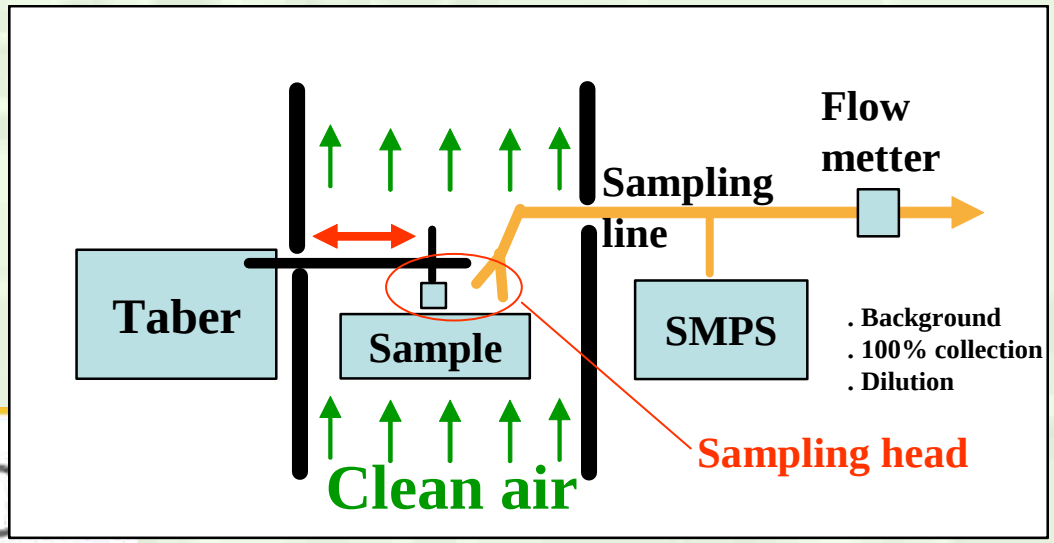
Using a Taber tool

Sample:
. Up: 30 x 30 mm
. Down: 100 x 30 mm

L: 100 mm,
f: 60 cycles/min

Same sample material for up and bottom parts

General setup



Experimental setup and method

- **Measurement (use of a SMPS and a CPC)**

. SMPS Grimm model 5.5-300

Flow rate: 0.3 L/min

. CPC Grimm 5.403 Flow rate: 1.5 L/min

- **Calculation of the theoretical Low Limit of Detections (if collection flow = measurement flow)**

. SMPS 0.3 L/min during 4 min, 44 channels
Hypothesis: average events > 1 particle/channel
➔ Abrasion > 1200 particle during the 4 min

. CPC 1.5 L/min, integration time 4 min
Hypothesis: 10 events in 4 min
➔ Abrasion > 10 particles during the 4 min

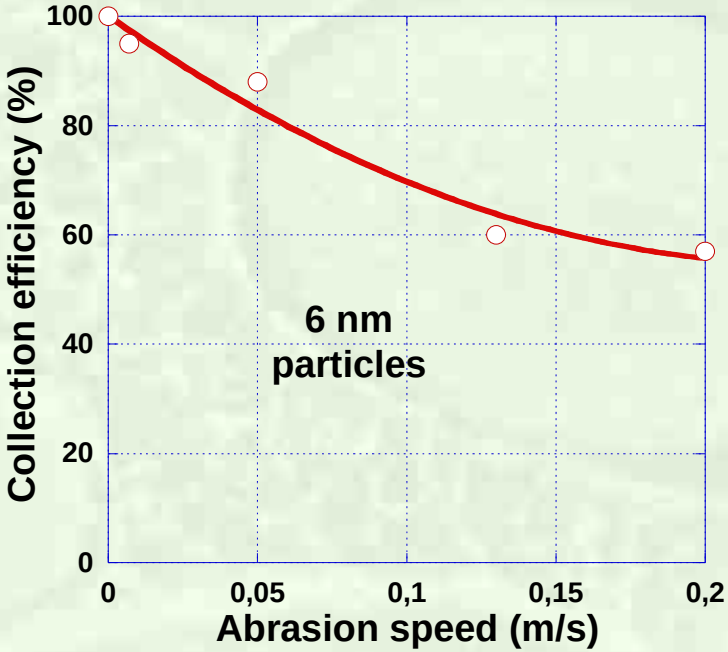
Qualifications

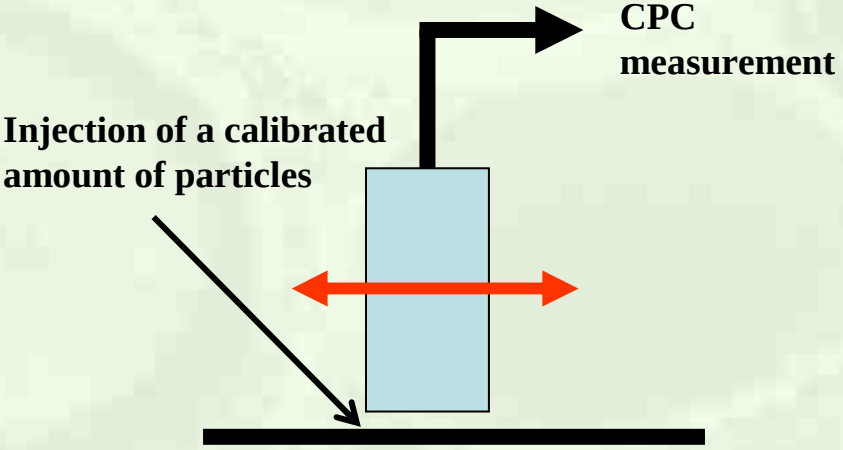
. Background particle levels (CPC):

. No movement (background level) < 5 part/cm^3 @ 6 nm

. Movement without friction <5 part/cm^3 @ 6 nm

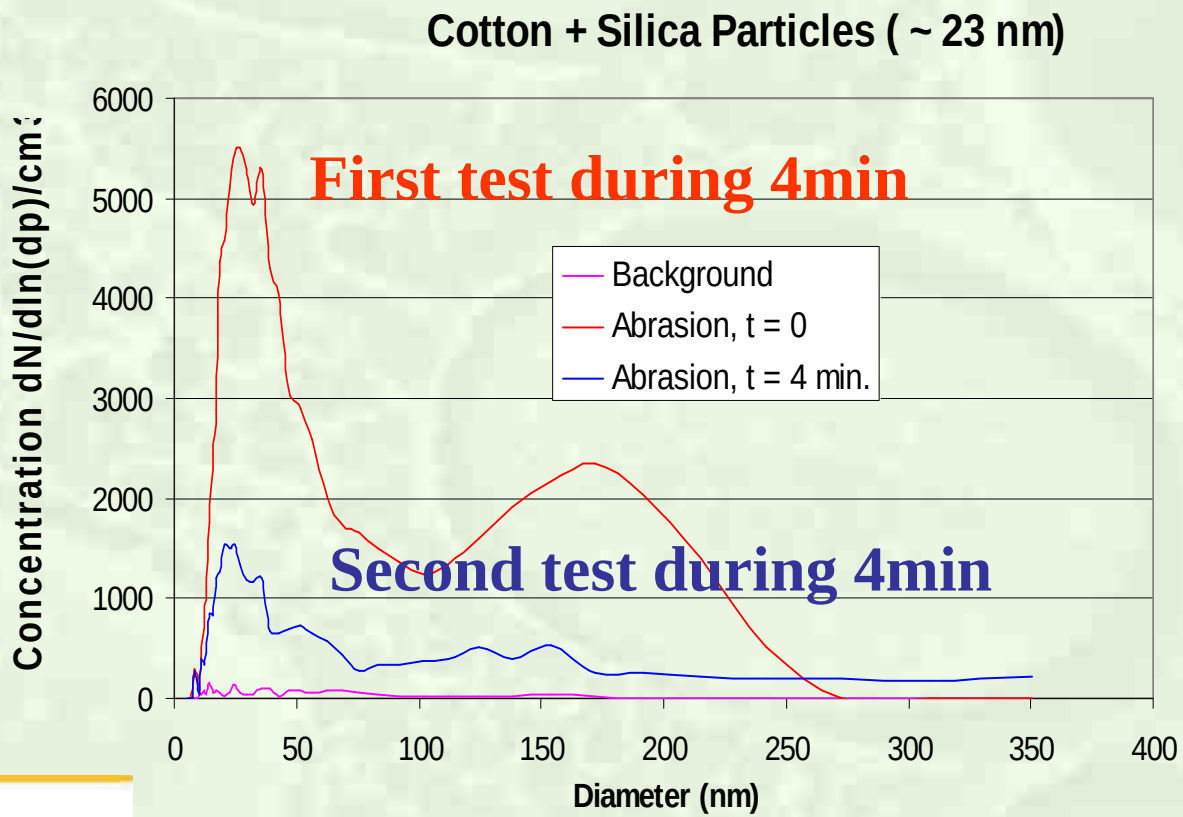
. Collection efficiency





Qualification

✓ **Behavior of nano SiO_2 release when deposited on a cotton fabric**

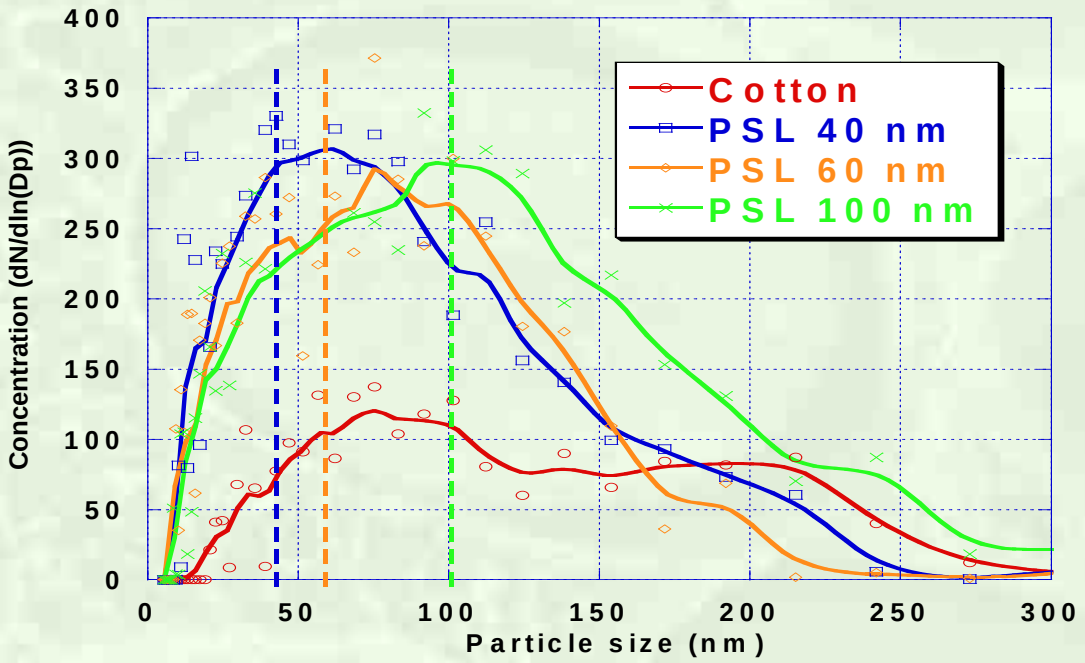


Necessity to use new samples at each measurement

Qualifications

First validations

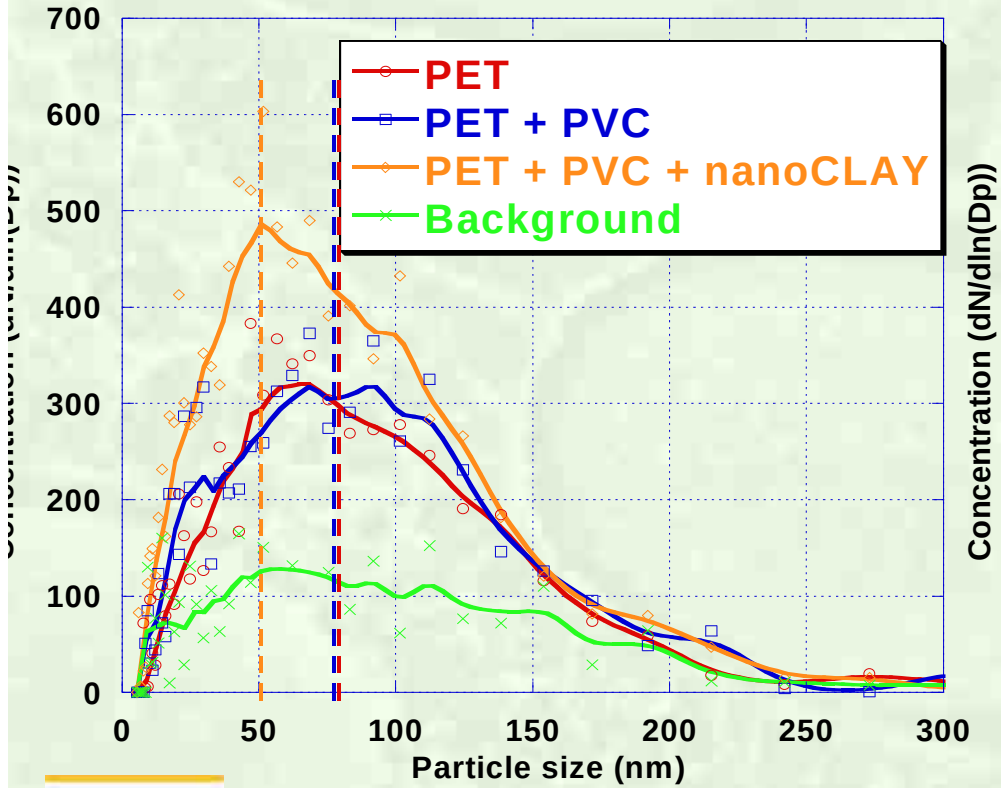
. Verification of the particle size accuracy: use of calibrated PSL nanoparticles deposited on cotton fabric

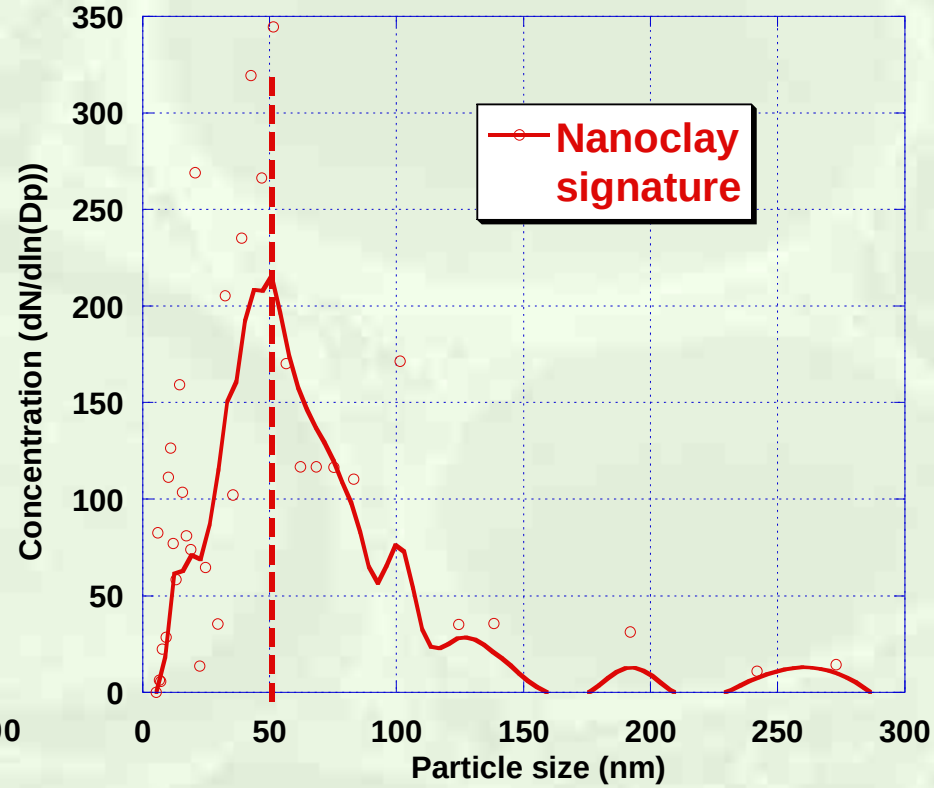


First results

✓ Nanoclay in PET fabric

(collaboration with IFTH Lyon / Project Nenatex)





First results

✓ **Tests in progress on commercial products:**

. Sun cream (on leather)
. Antibacterial spray containing nano Ag
. Socks containing nano Ag
. Paints containing nano TiO_2
. Etc.

First results: very low release of nanoparticles from nanoproducts with abrasion test using Taber method!

Conclusion

- ✓ A method to measure the release of nanoparticles has been setup and qualified
- ✓ First results : very low levels of nanoparticle release from actual nano products using abrasion by Taber method
- ✓ This method has been proposed to CEN as a potential standard

Basics of the method

➢ **Requirements necessary for an effective measuring method to qualify the release of nanoparticle**

. Design of a method removing all parasitic particles (background)

=> Ultra pure air (filtered air) close to the sample and qualification

. Collect of the whole released nanoparticles to get an absolute method (Ex. measurement of the number of released particles/min)

=> Design of an effective collecting device and qualification

. Minimization of the flow collecting the released nanoparticles to enhance the low limit of detection

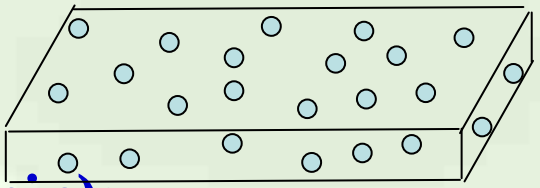
=> Using a collect flow close to the flow of the particle counter

Qualifications

➢ First validations

. Theoretical performances in terms of fraction of minimum particles to be removed

Ex. typical nanomaterial containing 5% of 50 nm nanofiller,
➔ surface concentration: 8 10^{10} particles.



- First prototype (dilution flow: 200 L/min):

SMPS: 200/0.3 15 = 10 000 ppb

CPC: 200/1.5 0.1 = 13 ppb

- Improved prototype (2nd generation)

SMPS = 1200 / $8^{E}10$ = 15 ppb

CPC = 10 / $8^{E}10$ = 0.1 ppb

Factor 1000 improvement