



Consumer exposure to silver (nanoparticles) in consumer products

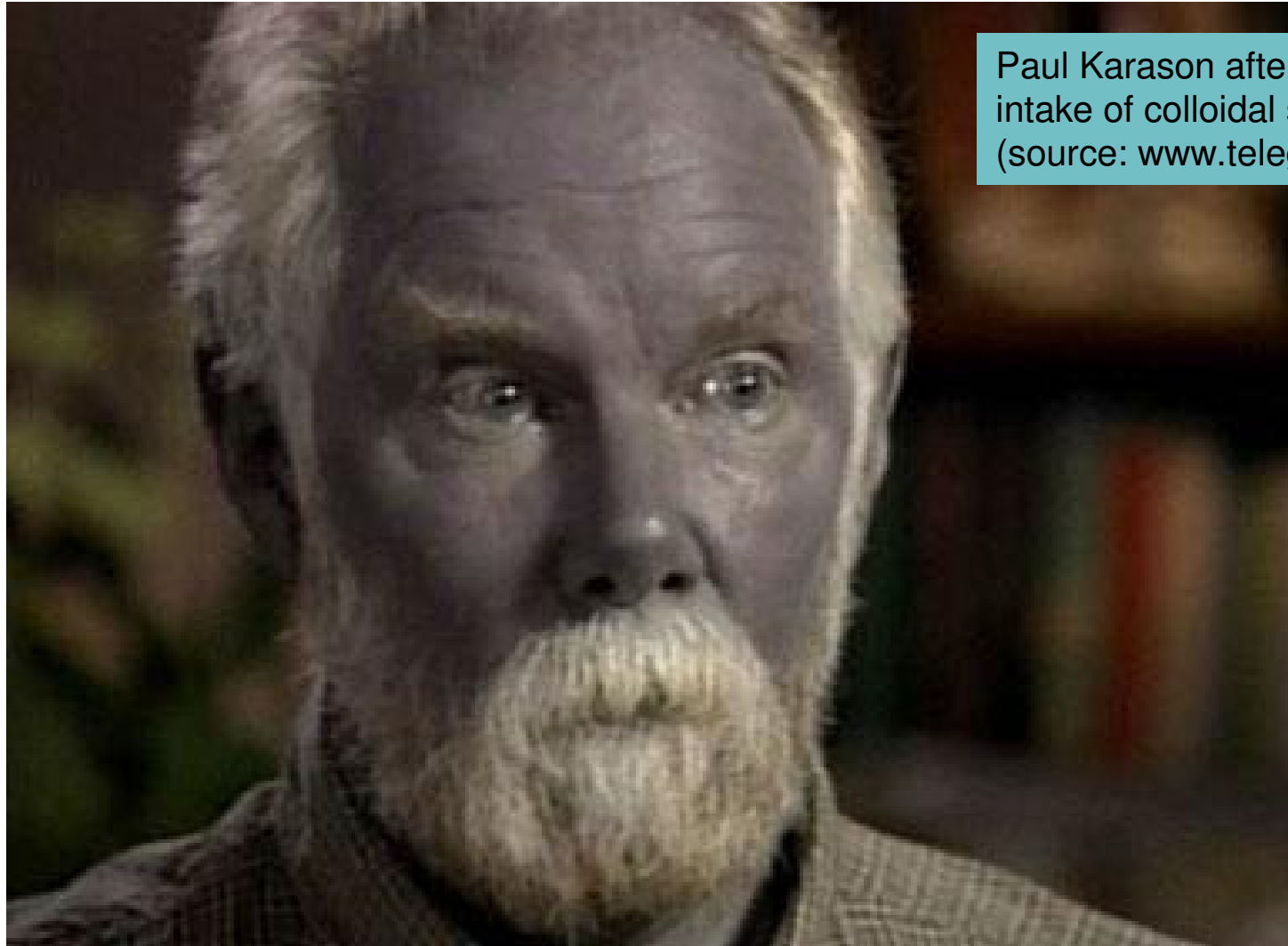
Natalie von Goetz

ETH Zurich, Institute of Chemical and Bioengineering

The “blue man”



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Paul Karason after 15 years of oral
intake of colloidal silver
(source: www.telegraph.co.uk)

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Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Natalie von Goetz, BfR-Conference on Nanosilver, Berlin, 8./9.2.2012

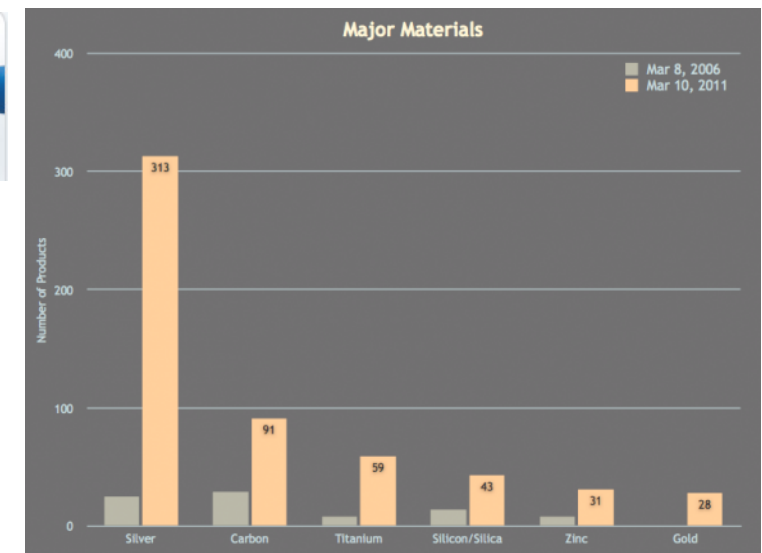
Silver in consumer products

The Nanotechproject: 313 products (24% of the inventory) use silver nanoparticles

- Medication: alternative medicine → “Blue man”, sporadic
- Medication (treatment of burns): since 50 years, routine treatment
- Textiles: since 10 years, especially functional textiles
- biocidal sprays for indoor use
- toothpaste (US, Poland), toothbrush
- facial cream (e.g. CH)
- tupperware (US, Korea)
- toys (US)



Benny Bear, 2008



www.nanotechproject.org

Silver in consumer products



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Household Sprays

Personal Care Products

Biocides: NanoSys



Antiperspirant:
Nivea Silver Protect



NanoSpray I: ETH and EMPA, 2008-2010

Shoe sprays



Foot Spray: e.g. Hansaplast
Silver Active Fußspray

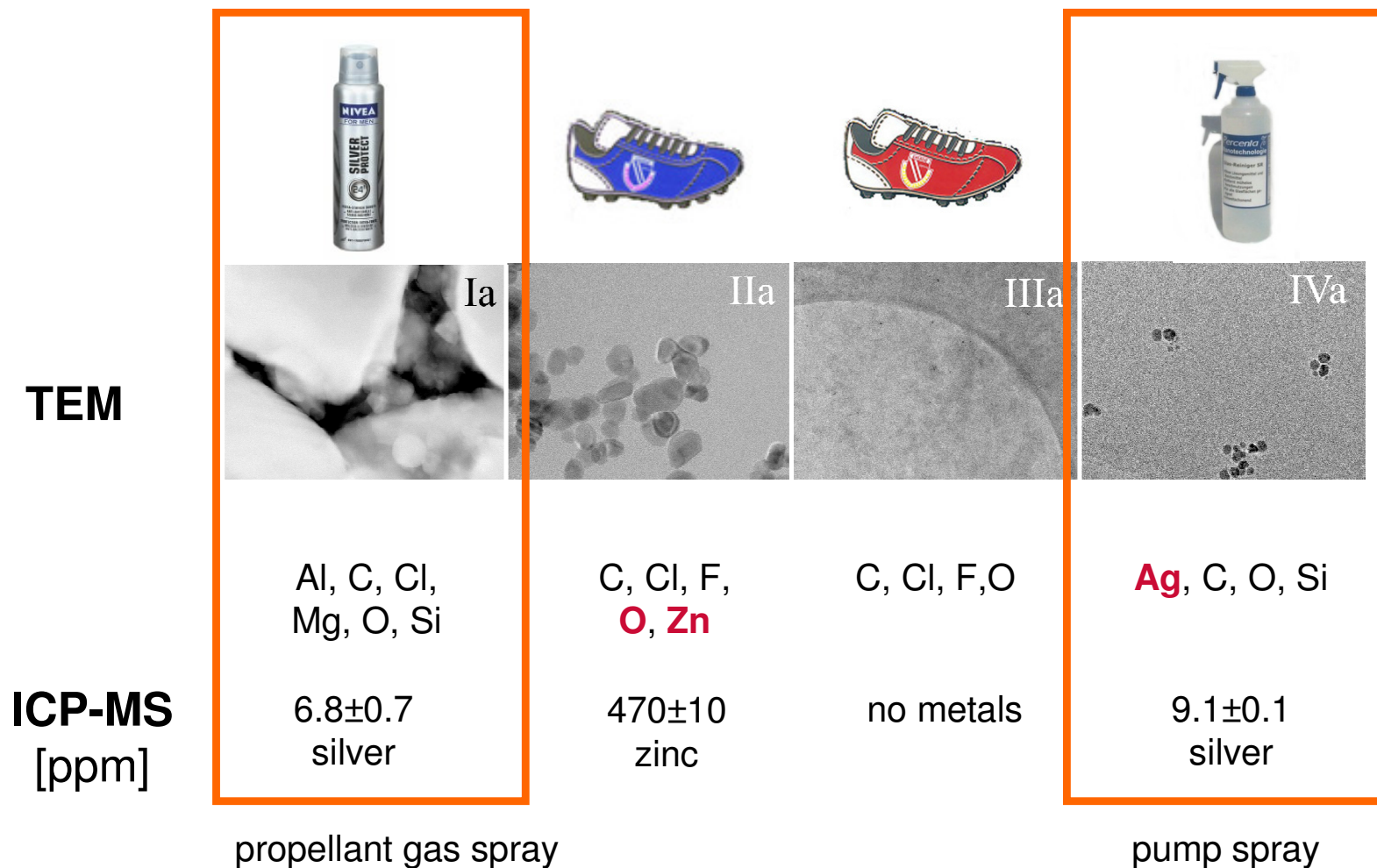


NanoSpray II: Sabrina Losert,
Andrea Ulrich, EMPA, Start 2011

Analysis of spray dispersion



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Lorenz et al, 2011, J Nanoparticle Research, **13**, 3377-3391
Hagendorfer et al, 2010, J Nanoparticle Research, **12**, 2481-2494

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EMPA 

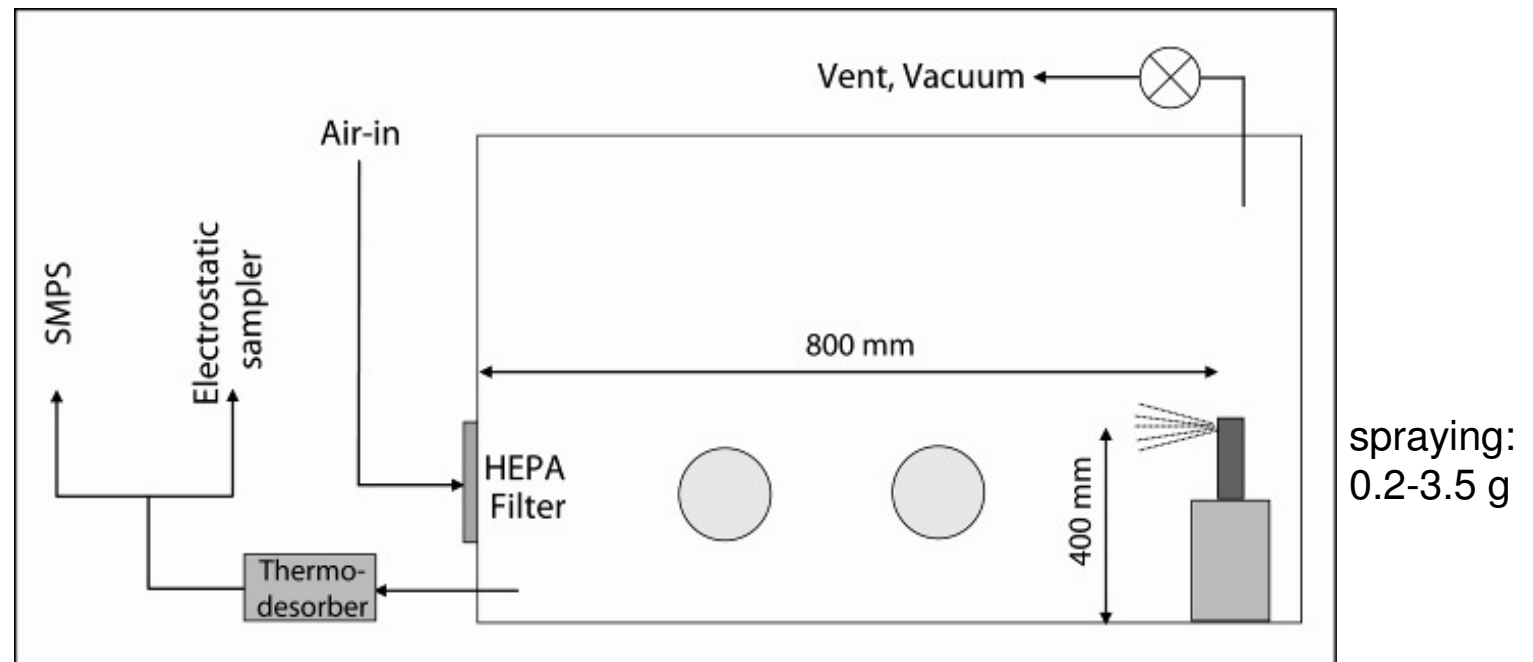
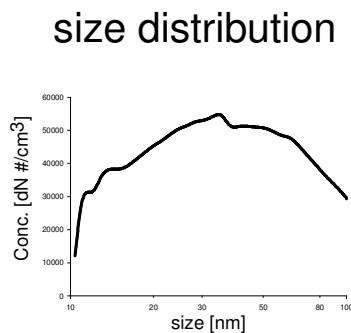
Natalie von Goetz, BfR-Conference on Nanosilver, Berlin, 8./9.2.2012

Analysis of aerosol



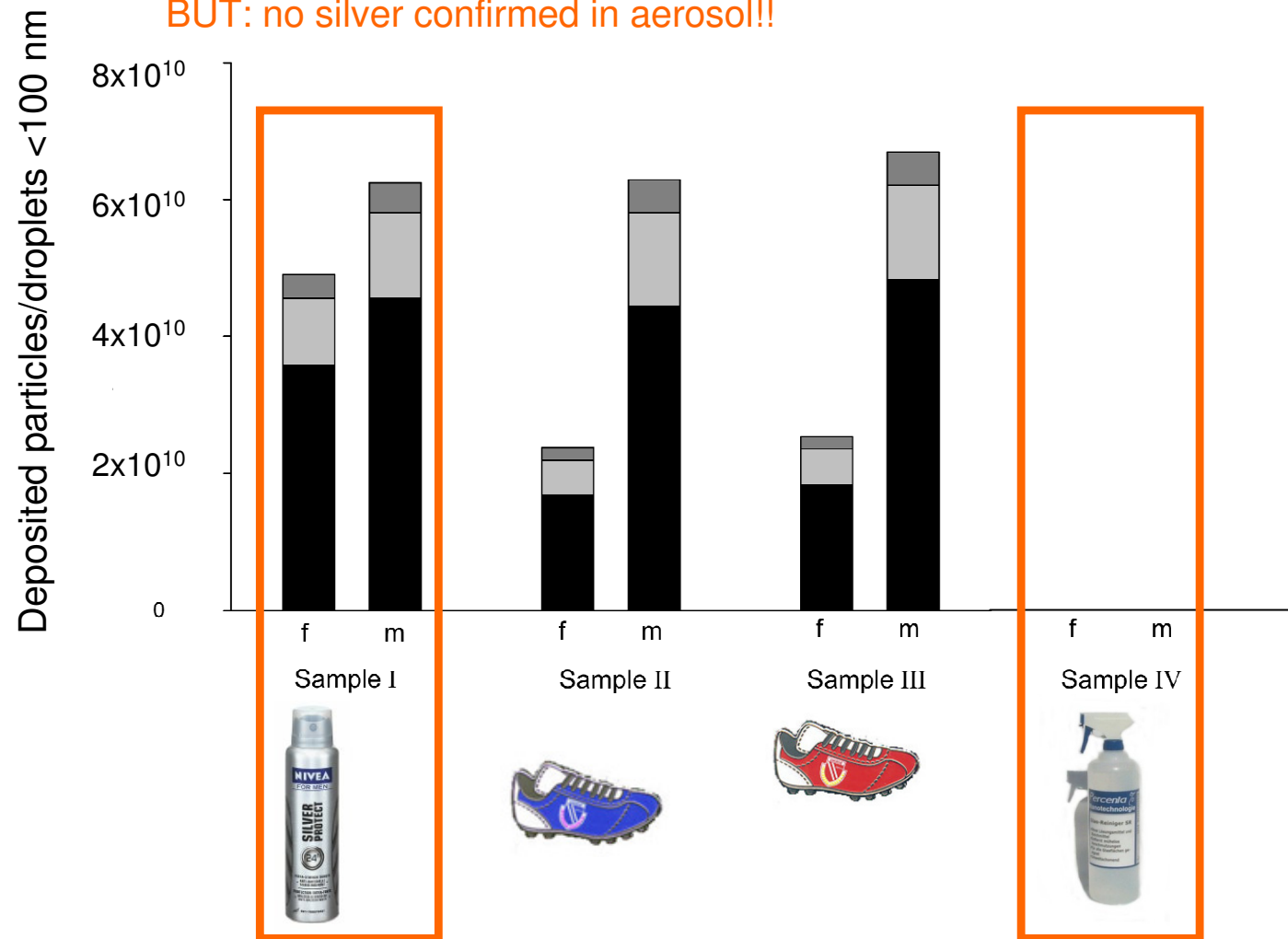
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- particle **shape/size/elemental analysis**:
transmission electron microscopy (TEM) with EDX
- particle **size distribution** 10-100 nm (No. of particles per cm³ air):
scanning mobility particle sizer (SMPS)

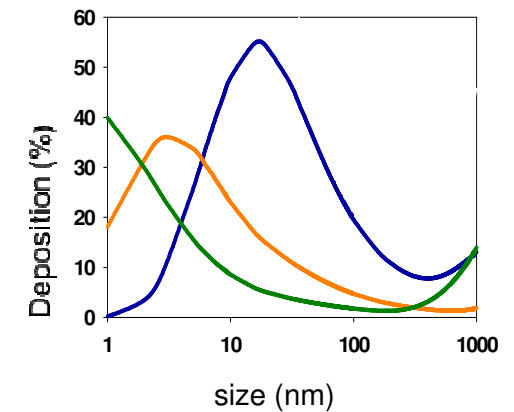


Exposure to nanoparticles in sprays

BUT: no silver confirmed in aerosol!!



- nasal region
- tracheobr. region
- alveolar region



ICRP model

Nanoparticles in US consumer sprays



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Publication	Quadros & Marr, 2011 design comparable to Hagendorfer et al, 2010	Nazarenko et al, 2011 focus on nanoparticles in general, not silver
Sprays	<ol style="list-style-type: none"> 1. Antiodor spray 2. Surface disinfectant 3. Throat spray 	<ol style="list-style-type: none"> 1. Disinfectant personal care silver spray 2. Nasal spray (water based)
Spray dispersion	1-100nm (size specific conc) <ol style="list-style-type: none"> 1. 1.7 ppm 2. 1.8 ppm (mainly Ag+) 3. 16.5 ppm 	<ol style="list-style-type: none"> 1. 3-65 nm particles 2. <3-435 nm particles
Ag in aerosol	0.24-56 ng silver per spray action	no quantification, only size distribution
Size of aerosols	1-2.5 μm	particles 13nm - 20 μm
general		nanoparticles also from non-ENP containing products

Ingestion from food contact materials

Target: Commercial tupperware and PE-bags claiming “Nano silver inside”

- Product Analysis with scanning ICP-MS and TEM
- Release experiments with food simulants, analysis with ICP-MS and TEM



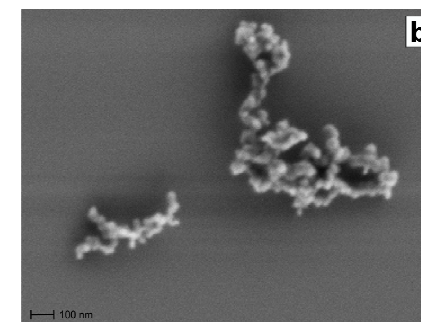
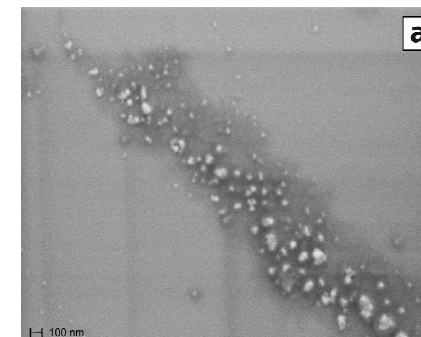
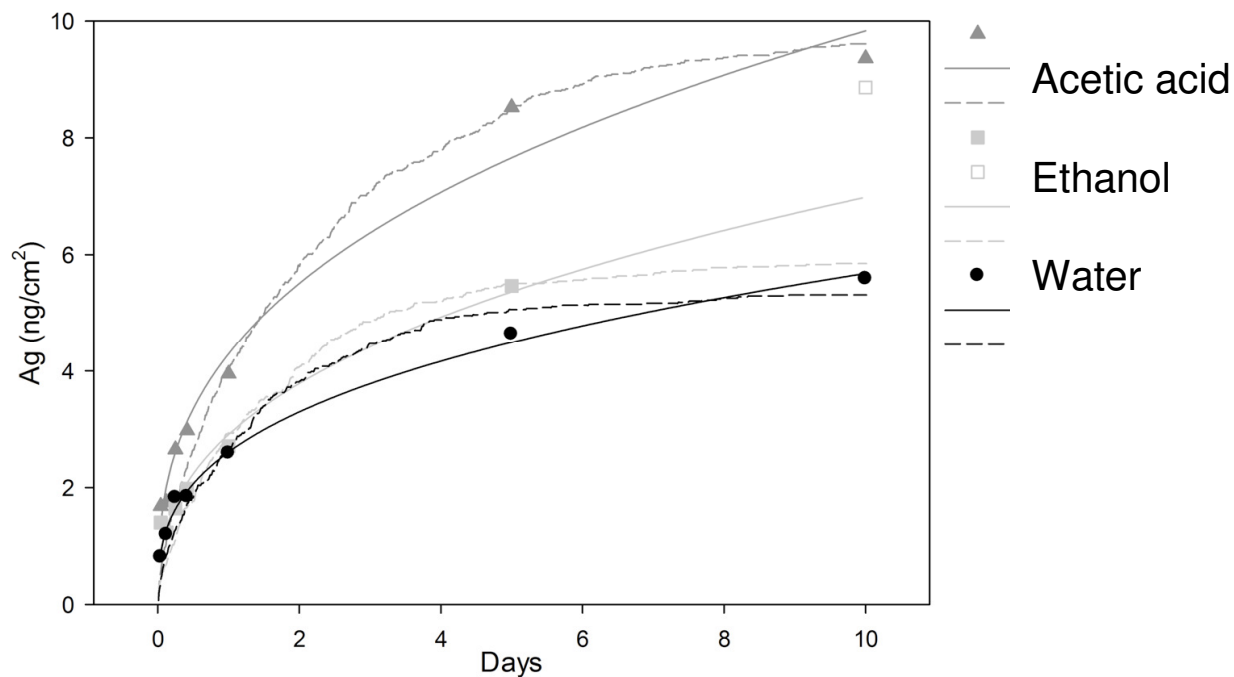
Tradename	Producer	Bulk Material/Description	Origin	Silver content in µg/g plastic
Kinetic Go Green Nano Silver Basic	Kinetic, Pathway Davenport, US	Polypropylene	US	18.7
Kinetic Go Green Nano Silver Premium	Kinetic, Pathway Davenport, US	Polypropylene	US	<0.1
Nanosilber-Frisch-haltedosen, Everin®	Newlife Co., Korea	Rubber sealing	Germany	<0.1
FresherLonger™	Sharper Image Corporation, US	Polyethylene	US	37.1



Release from food boxes



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MD-ICP-MS: 10-20% Ag as particles

Multiple use,
after 10 d



N von Goetz, L Fabricius et al., 2012, submitted



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Exposure to Ag from food boxes



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Worst case assessment:

30 ng/cm² (worst case new box, acetic acid)

100 ml food in tupperware will cover **140 cm²** (1x10x10)

→ **worst-case acute exposure to 4.2 µg silver**



Comparison to natural sources:

- Ag concentrations in drinking water in the US: 0.1 to 9 µg/L (1969)
- also food contains trace amounts of silver

- exposure to Ag from these food boxes very low, but might consist of nanoparticles
- product claim is questionable (under threshold of bactericidal activity)



Dermal exposure from PCP&C

Remederm repair cream: 0.1% Ag

silver lotion

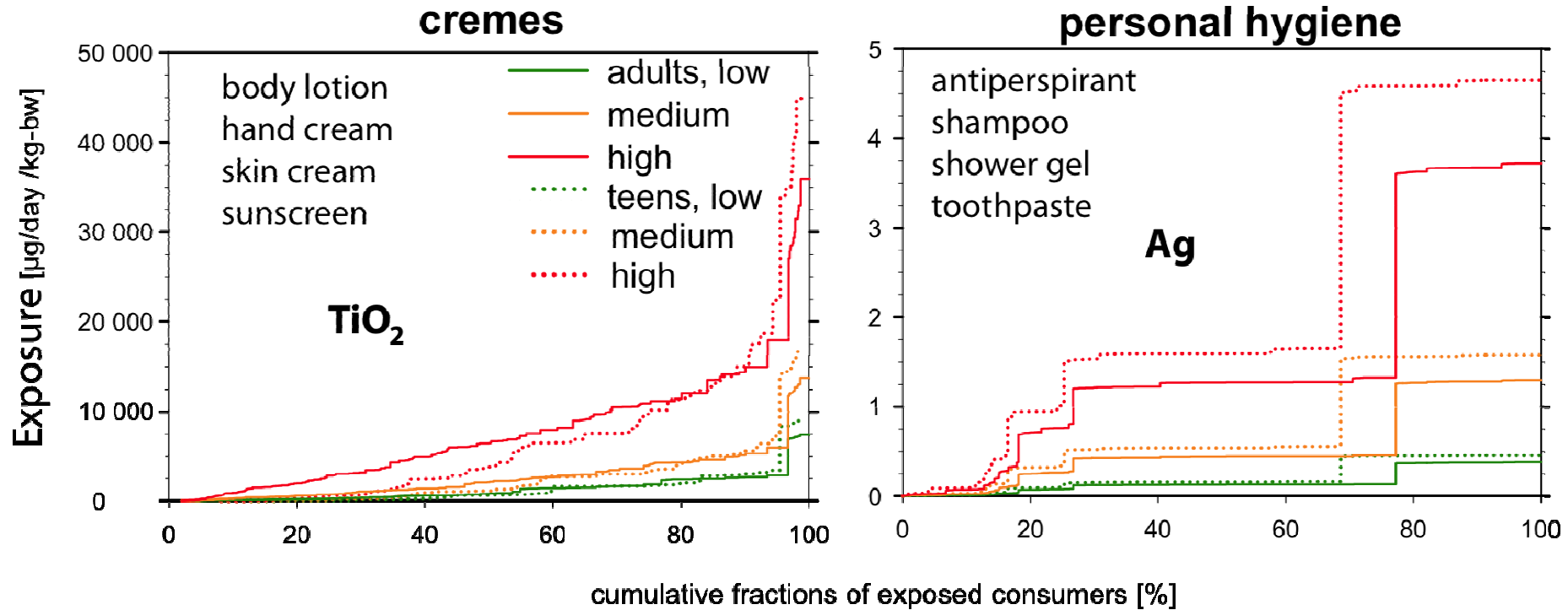
silver antiperspirant



$$E = w_{\text{Prod}} \cdot a_{\text{Ret}} \cdot f_{\text{Event}} \cdot \frac{q_{\text{Prod}}}{m_{\text{bw}}}$$



Aggregate dermal exposure



Lorenz et al., 2011, "Potential exposure of German consumers to engineered nanoparticles in C&PCP", Nanotoxicology, 5 (1), 12-29

→ Personal hygiene (medium case) $0.5 \cdot 60 \text{ kg} = 30 \mu\text{g/day}$

→ Cremes: e.g with 0.1% Ag in Remederm Repair
hand cream+ face cream, 3 times a day, both 0.8 g $4500 \mu\text{g/day}$

Uptake of silver nanoparticles

- **Inhalation:** no data for silver; gold: **1.5% for 40 nm**
(Sadauskas et al, 2009 Chemistry Central Journal (3) 16)
- **Oral:** not more than **1% (largest for 30 nm)**
(Bouwmeester et al, 2011 ACSNano (5) 5)
- **Dermal:** less than **0.01%**
(Larese et al, 2009 Toxicology (255))

BUT: potentially size, surface (coating), shape dependent

Project: Gerald Bachler “The total exposure to silver”

Conclusions

- Spray: mind the generation of secondary nanoparticles
- Oral: current use in food contact material not alarming
- Dermal: external exposure comparatively large → uptake crucial

Silver in consumer products further means

- depletion of resources
- destruction of a potent antibiotic (resistance building)

Acknowledgement

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Reto Glaus, Detlef Günther (ETH, Anorganic Laboratory)

