

# Refining textiles by using nanotechnology

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# GMBU e.V.

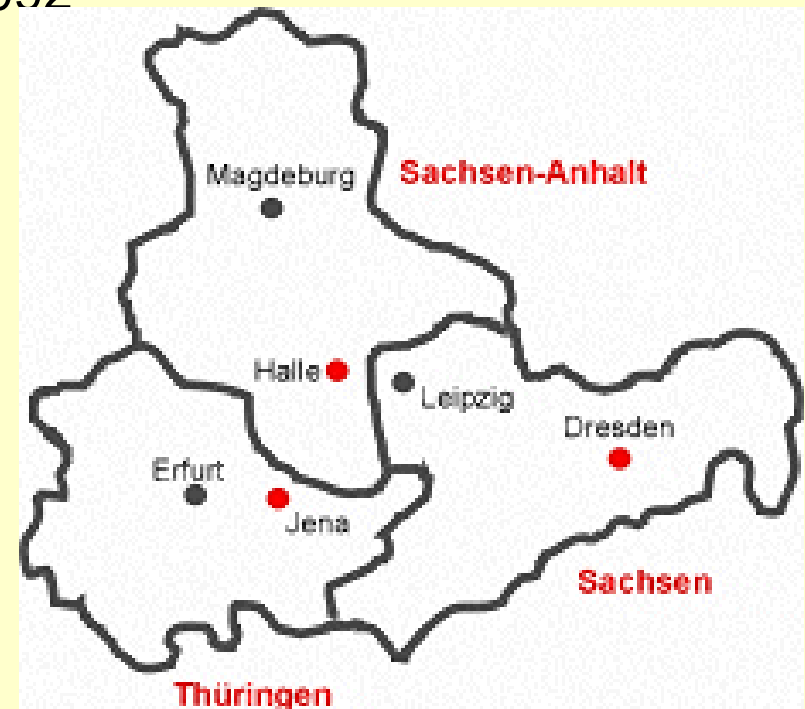
*Gesellschaft zur Förderung von Medizin-, Bio- und Umwelttechnologien*

is a non-profit organization for industrial research & development

founded in 1992

## Departments:

- *Functional Coatings (Dresden)*
- *Environmental Biotechnology (Halle/Saale)*
- *Photonics and Sensorics (Jena)*



## Department Dresden – Functional Coatings

- Innovative and professional research on demand for small and middle enterprises
- Nanosol – coatings for the functionalisation of textiles, paper, medical products, polymer films, wood and metal
- Embedding of bioactive substances and biomolecules into nano-structured inorganic metal oxide matrices (Biocere)
- services: analytical measurements, coatings, technical consultation

## Textile functionalisation by using modified inorganic nanosols

- (1) Antimicrobially equipped textiles by application of new, simply prepared  $\text{Ag@SiO}_2$  and  $\text{Ag@TiO}_2$  nanosols
- (2) Textiles coated with photoactive  $\text{TiO}_2$  for the photocatalytic degradation of waste water
- (3) Textiles with health care and wellness effects by sol-gel immobilized natural oils and natural active agents

Antimicrobially equipped textiles by application of new, simply prepared Ag@SiO<sub>2</sub> and Ag@TiO<sub>2</sub> nanosols

## **Antimicrobial finishing of textiles with the aims:**

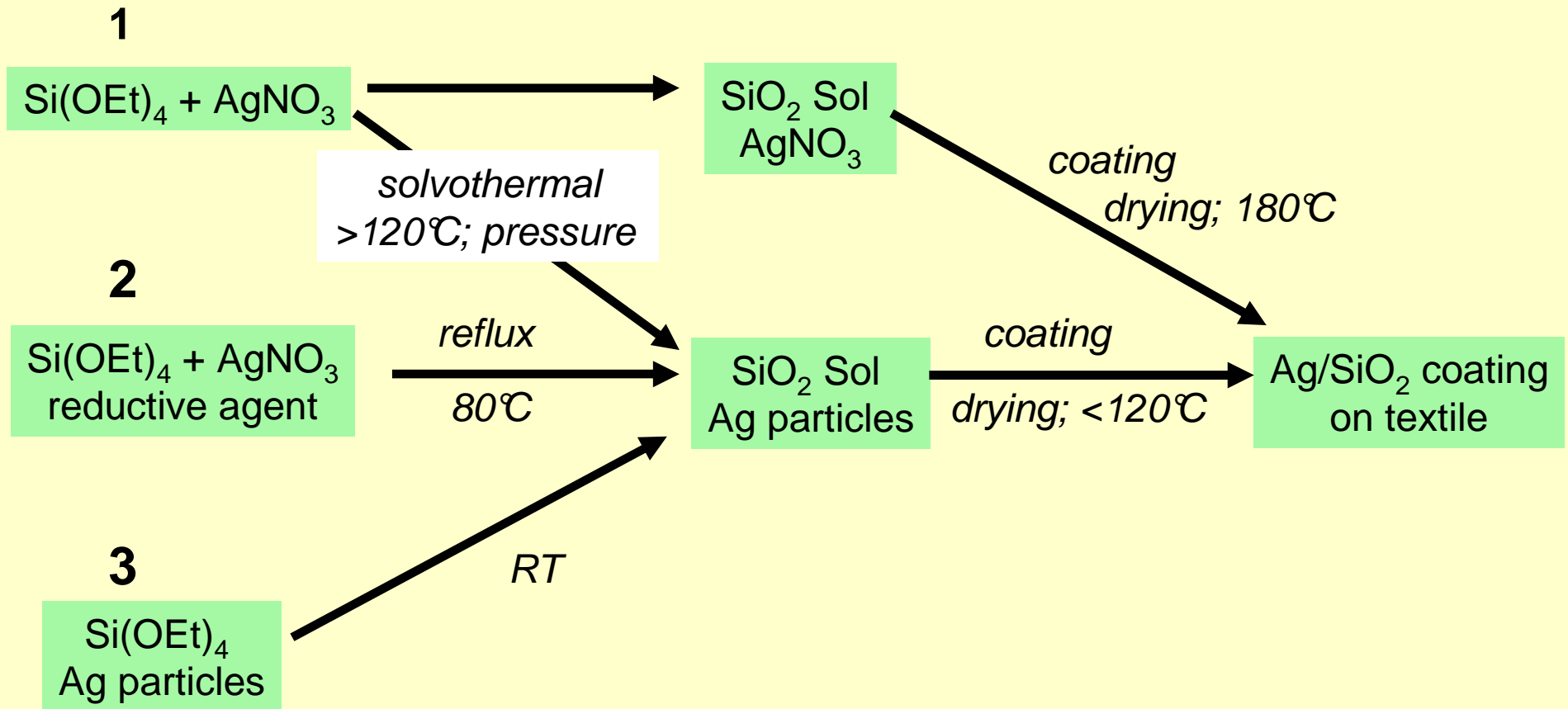
- prevention of destruction of materials by germ contamination
- prevention for health risk by reducing the germ concentration

## **Application techniques:**

- spraying
- padding
- add to spinning solution and spinning fibres

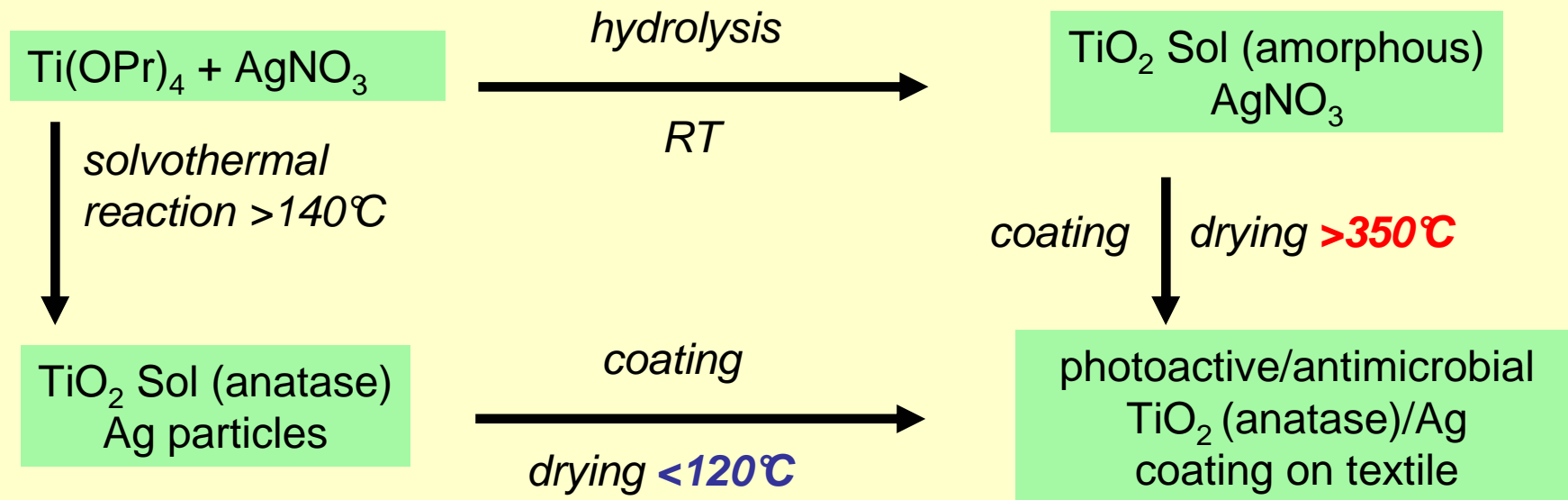


## Approaches of producing Ag@SiO<sub>2</sub>



# Ag@TiO<sub>2</sub> coating preparation

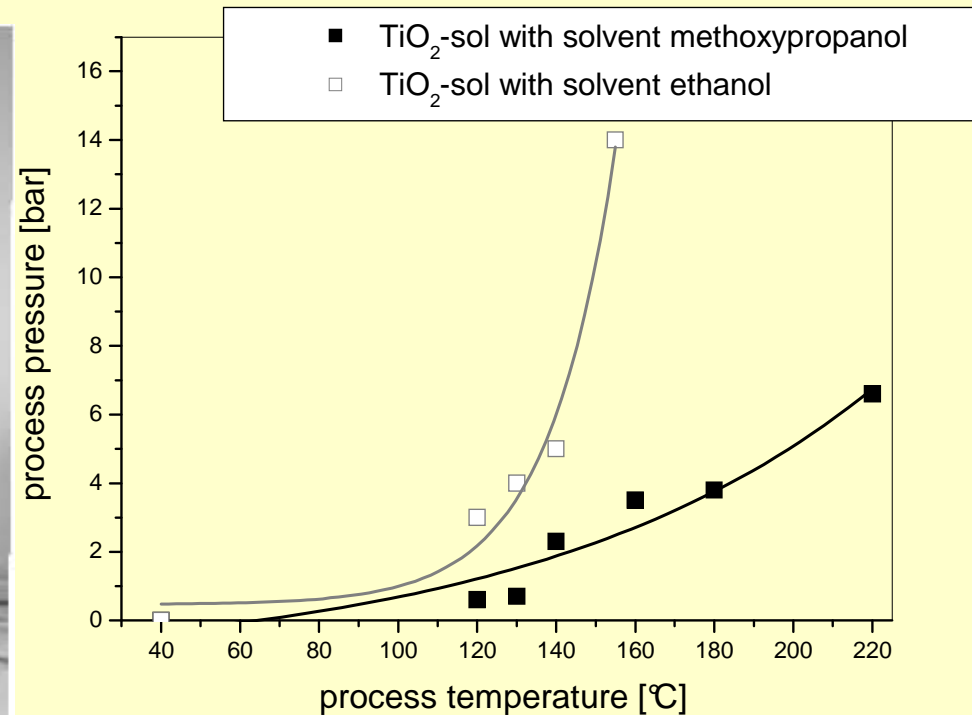
RT and solvothermal route of preparing Ag@TiO<sub>2</sub>

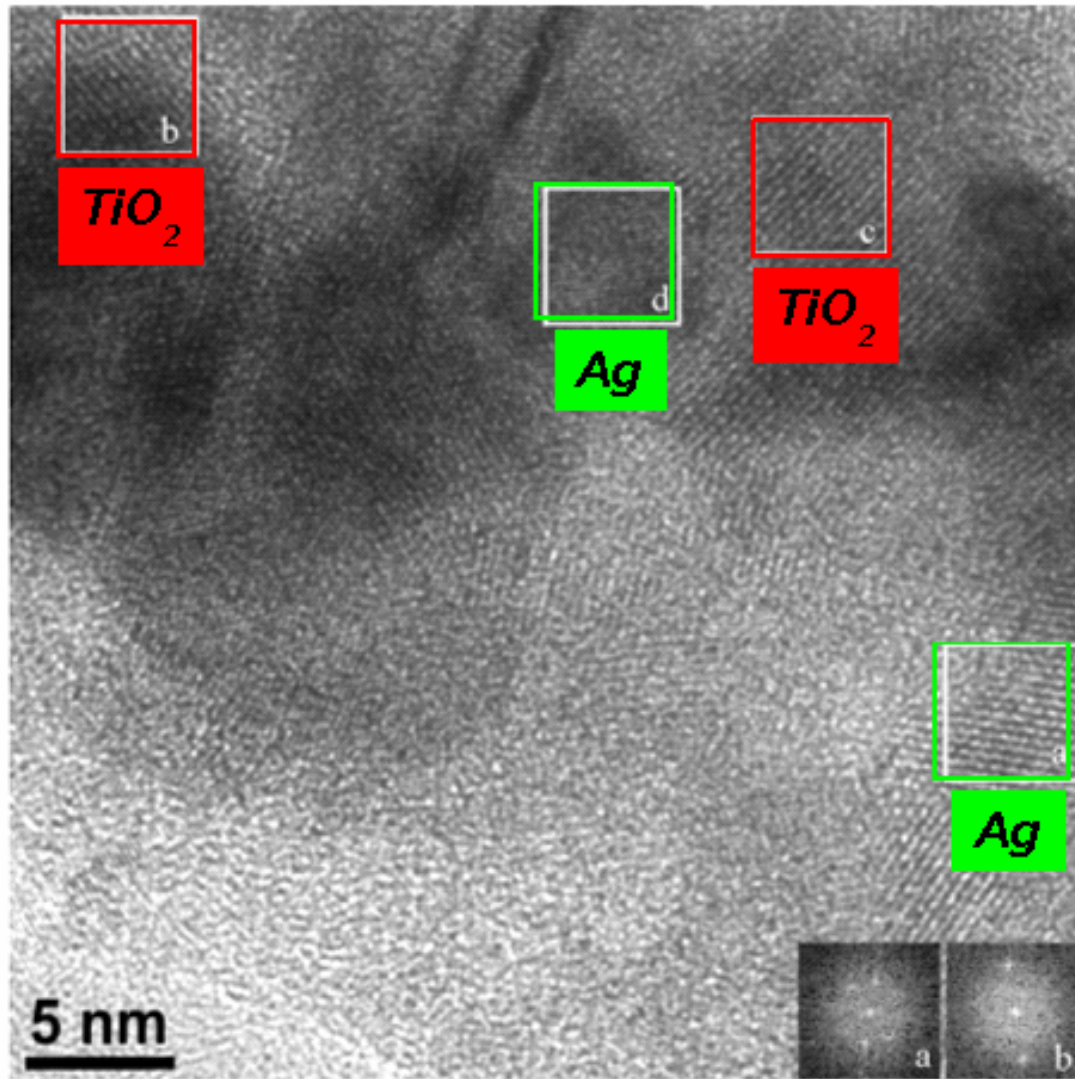


under solvothermal conditions simultaneous formation of silver particles and anatase from simple precursors

# Solvothermal preparation of silver containing nanosols

- Solvothermal preparation in an autoclave vessel
- High pressure and temperatures between 100°C to 200°C





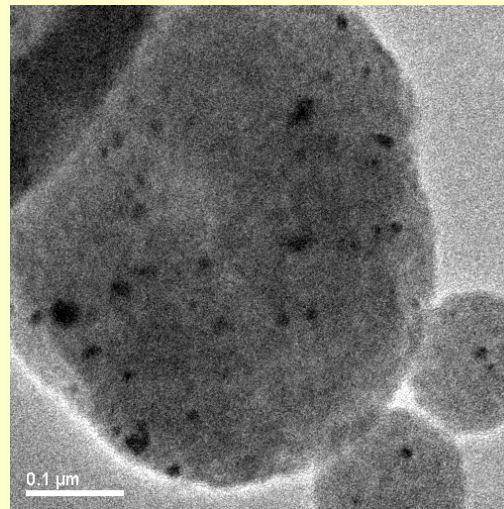
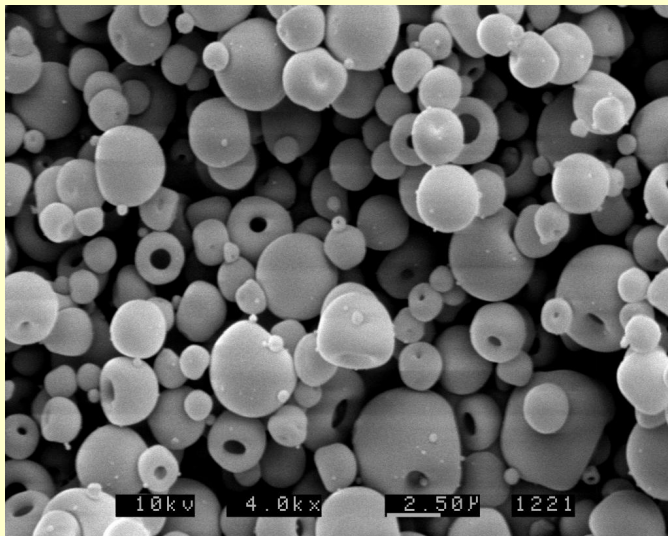
- HR-TEM image with FT evaluation of Ag/TiO<sub>2</sub> composites
- Formation of anatase and crystalline silver under solvothermal conditions at 140°C

# Application of Ag/SiO<sub>2</sub> sols onto textiles

Ag/SiO<sub>2</sub> Sol  $\xrightarrow{\text{application onto textiles}}$  textiles with antimicrobial coating

spray  
drying

Ag/SiO<sub>2</sub> Powder (micro-scaled)  $\xrightarrow{\text{use as antimicrobial additive}}$  spinning process, masterbatch, coating additive



## 2 ways of bulk-production of Ag@SiO<sub>2</sub> for addition to spinning solution

1: Ag/SiO<sub>2</sub> – sol: spray drying

2: Ag/SiO<sub>2</sub> – sol: gelling, drying and milling

Spray drying system



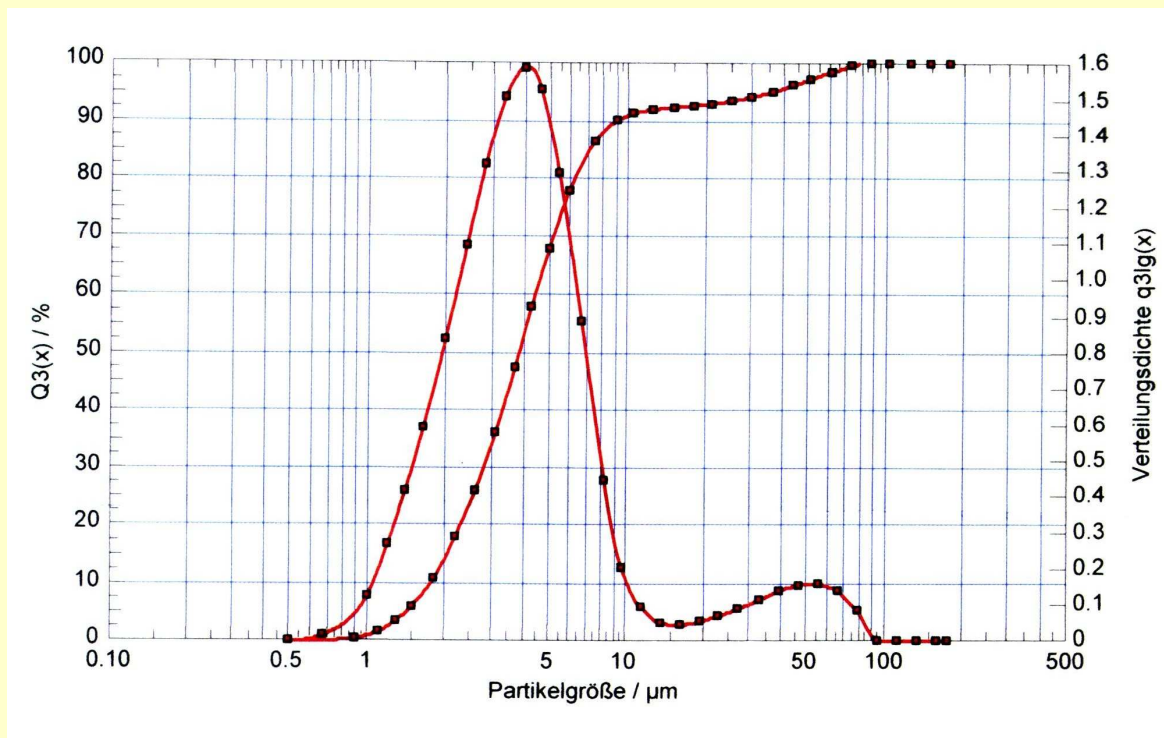
Vibration mill



# Particle size distribution

Particle size distribution of Ag@SiO<sub>2</sub> particles produced by spray-drying

- < 10 μm necessary for spinning textile fibres



produced textile sample

(needle fleece):

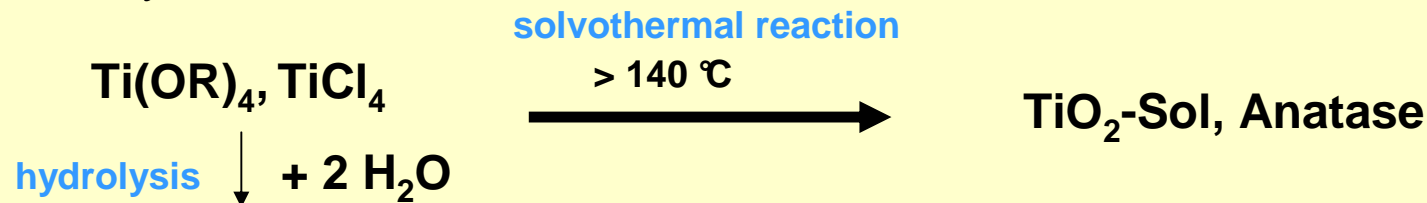
50% cellulose, 50% Ag@SiO<sub>2</sub>

0,6 % Ag in the textile



## Textiles coated with photoactive TiO<sub>2</sub>

Synthesis:



$\text{TiO}_2\text{-Sol}$

coating

$\text{TiO}_2\text{-layer, amorph}$

(non- photoactiv)

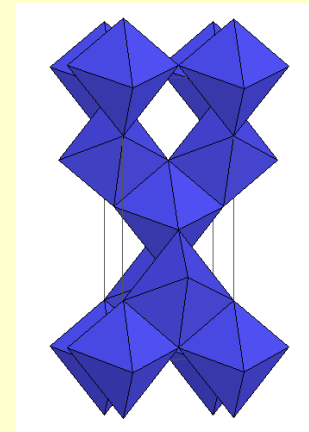
curing

$> 350^\circ\text{C}$

$\text{TiO}_2\text{-layer, crystalline}$

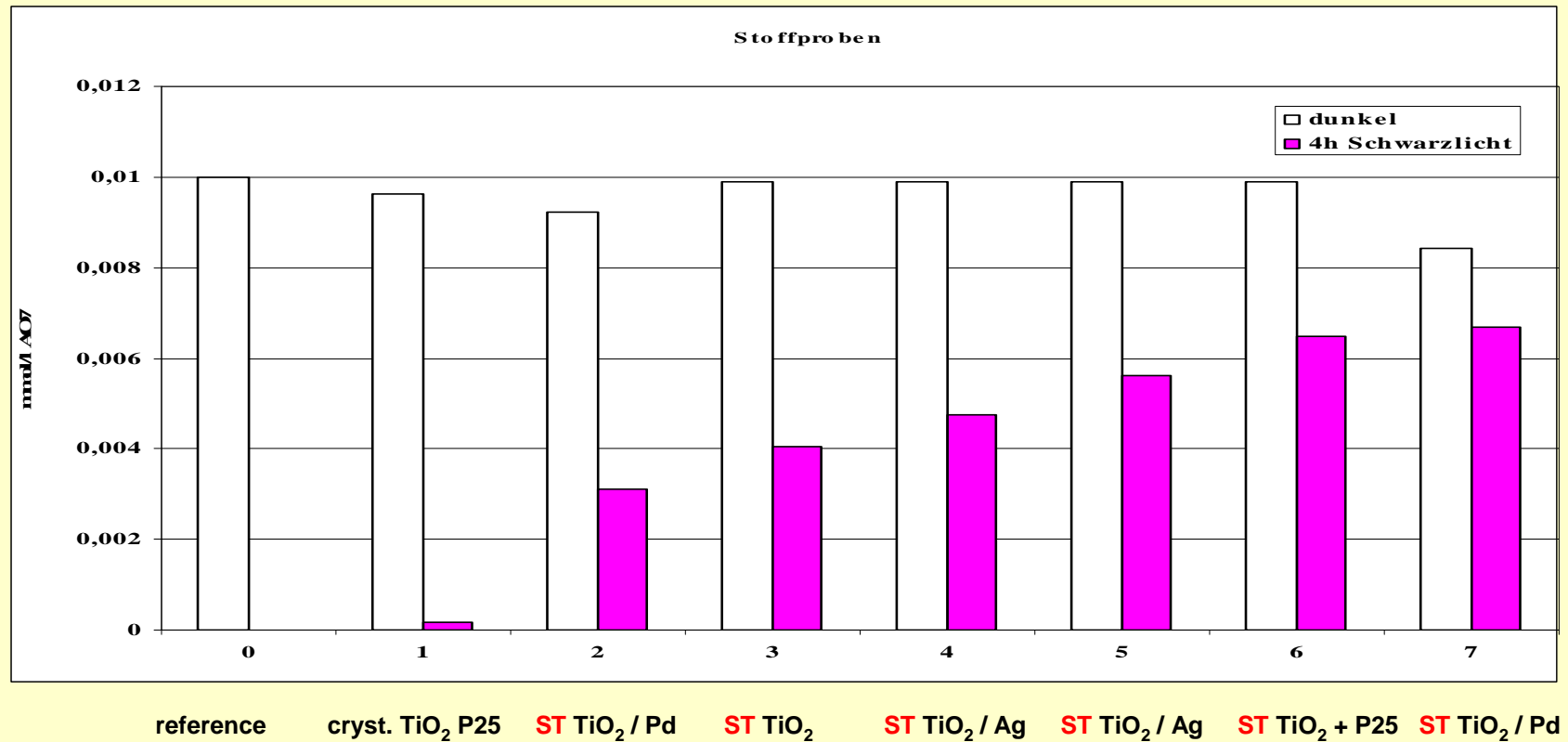
(Anatas, photoactiv)

Anatase: tetragonal, holohedral crystals



# Measurement of photocatalytical degradation

Photocatalytical degradation of dye acid orange 7 with black light (20W)  
by use of coated textiles (viscose)

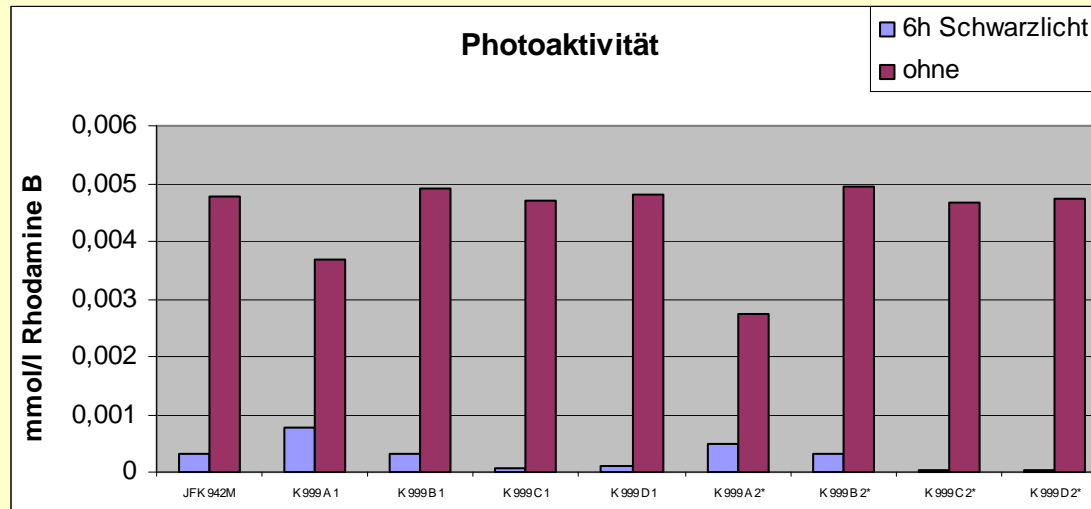


ST: solvothermal reaction 4h / 140°C

□ dark    ■ 4h black light

# Optimization of coatings

Optimization of coatings with photocatalytic activity by adhesion agents (improved wash stability)



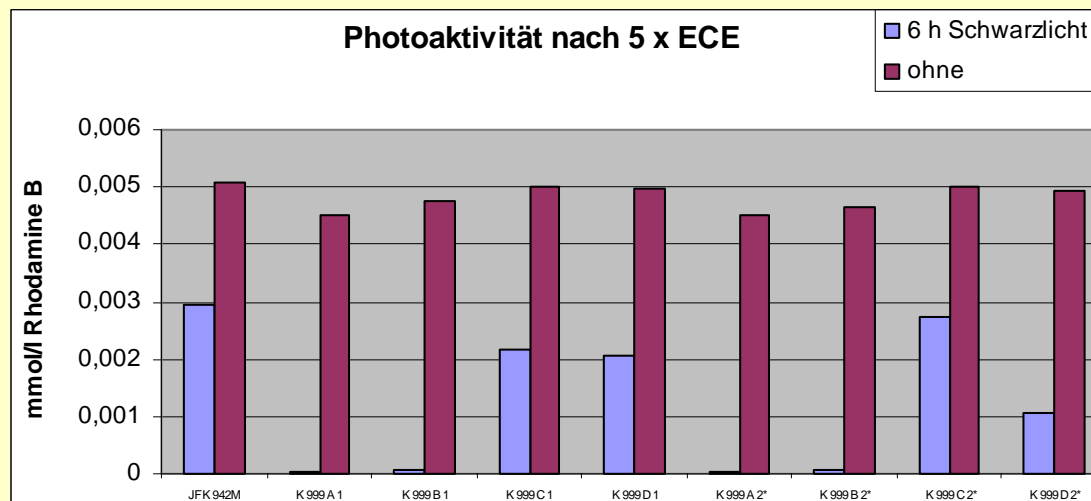
unwashed



6h black light



dark



5 x ECE  
washed

## Textiles with health care and wellness effects

sol-gel immobilized natural oils and natural active agents for:

- skin-friendly textiles with *antimicrobial* and *antiallergic* effects for alleviation of skin infections (Neurodermitis, Psoriasis)
  - use of **evening primrose** and **perilla** oil
- textiles for therapeutic treatment of the respiratory tract
  - use of **eucalyptol**, **camphor** and **menthol**

## Coatings on cotton textiles

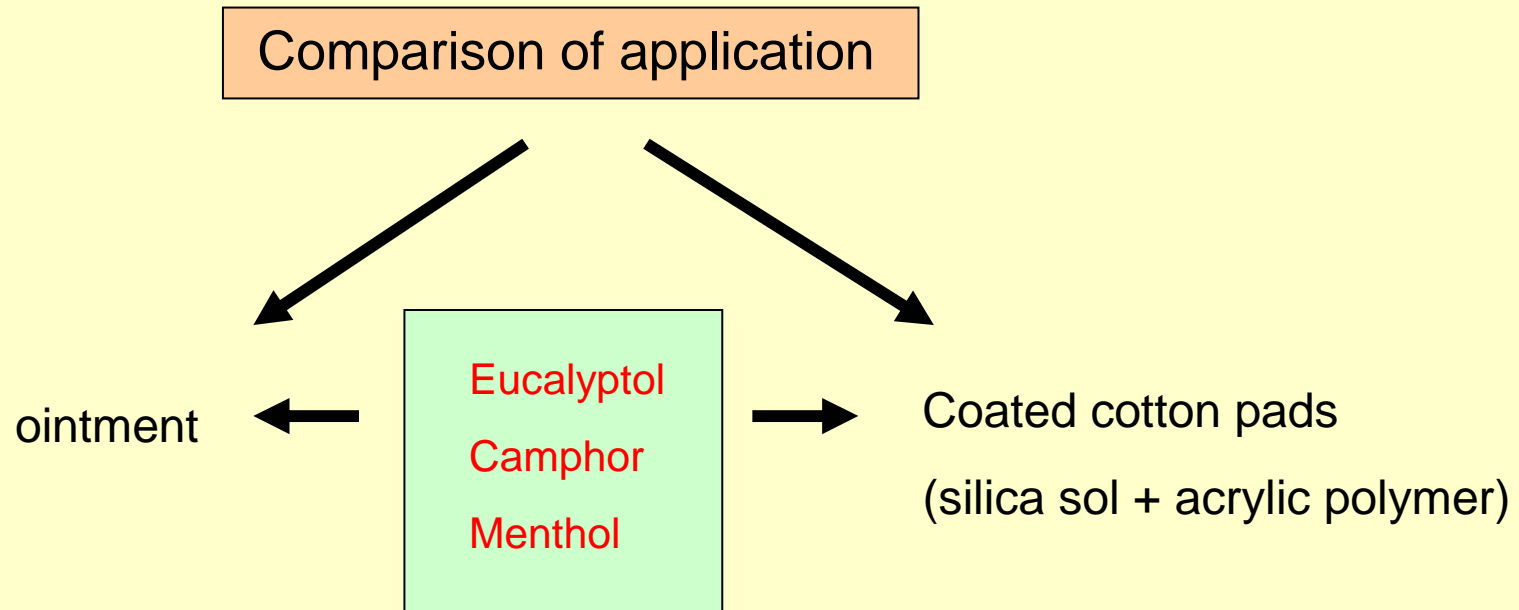
- Mixing of the silica-sol with the natural oils and coating onto textiles (33% of oils in the coating after drying)
- washfastness can be improved by adding of acrylic polymer

coating	BL / 100ml sol (l)	Acrylic polymer / 100ml sol (l)	BL content (g/m <sup>2</sup> ) after ECE washing		
			Before	1x	5x
L1	4 g EP	0	24.4	1.2	0.2
L2	4 g EP	2 g	22.7	15.1	4.2
L3	4 g PO	0	22.7	1.7	1.4
L4	4 g PO	2 g	19.5	4.1	2.7

BL: bioactive liquid

EP: evening primrose oil

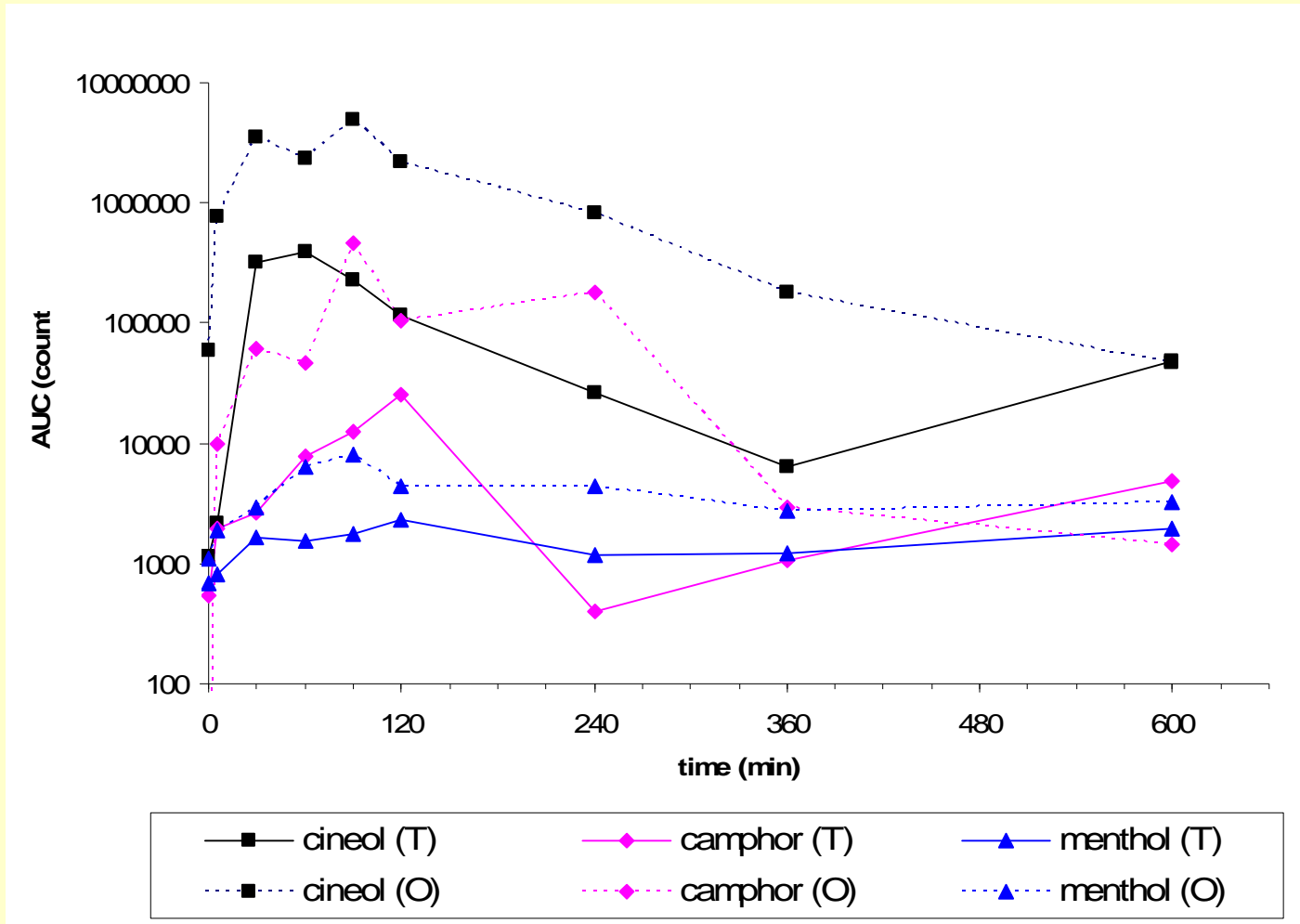
PO: perilla oil



- same concentration of natural agents in ointment and cotton pad
- measurement of concentration of eucalyptol, camphor and menthol in exhaled air by gaseous chromatography in two sets:
  - after volunteers used an ointment application
  - after volunteers used the coated textile

# Example for measurement of exhaled air

## Composition of the exhaled air of one volunteer



O: ointment application

T: textile application

healthy human subject 02

**Thank you for your attention !**