Nature Inspires Chemistry Engineers

ALTERNATIVE ANTIMICROBIAL SYSTEMS BASED ON PHOTOACTIVE MATERIALS

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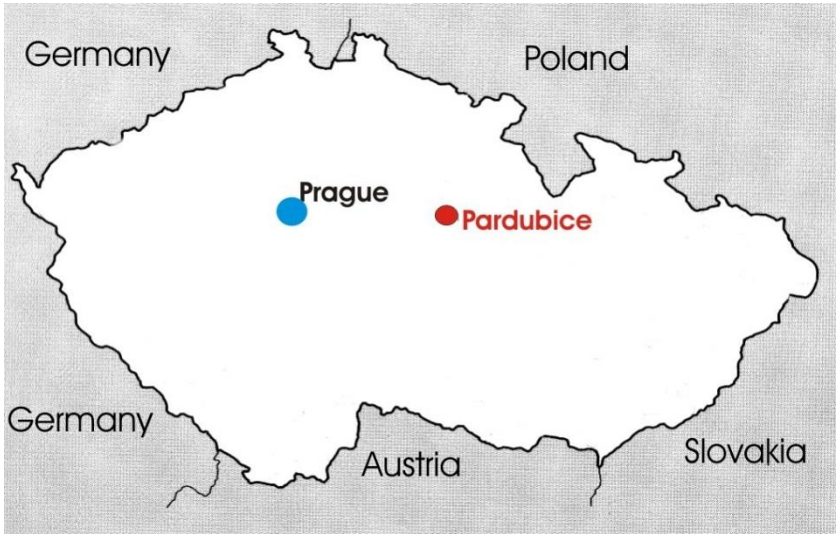
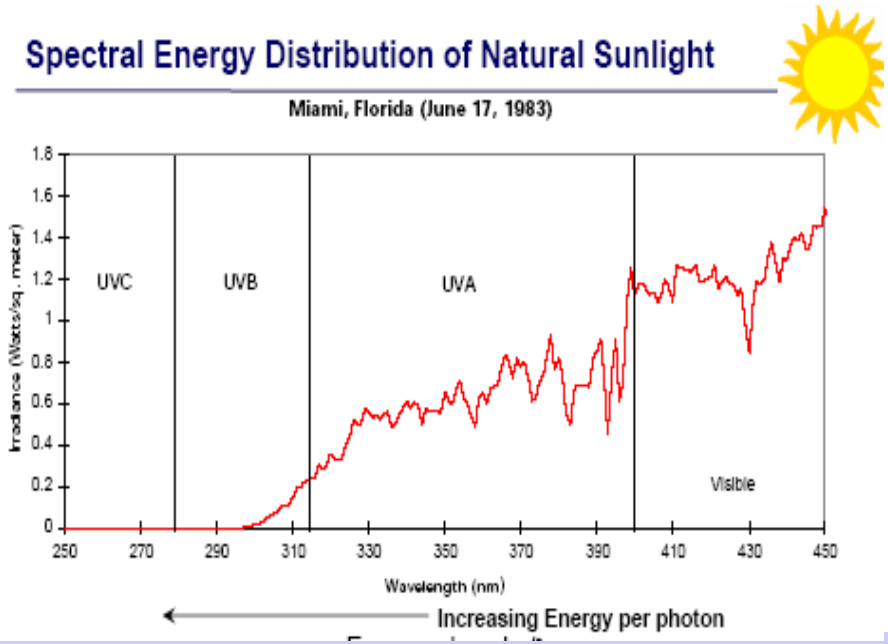
Company introduction

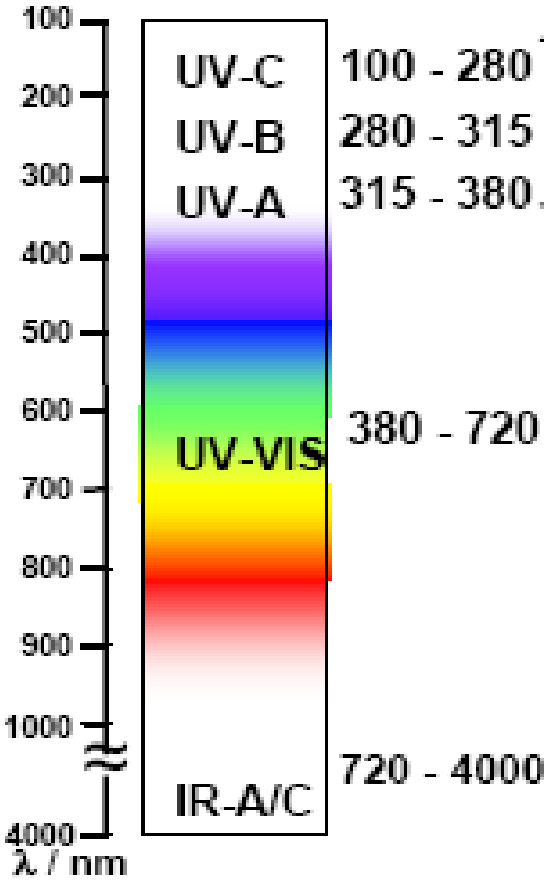
- Private research company founded in 2009
- R&D of organic compounds for application in industry and science
- Core business – electronics, photosensitizers, UV protection
- Up scaling and transfer of technology
- Small batch production of new compounds



Photoactive materials

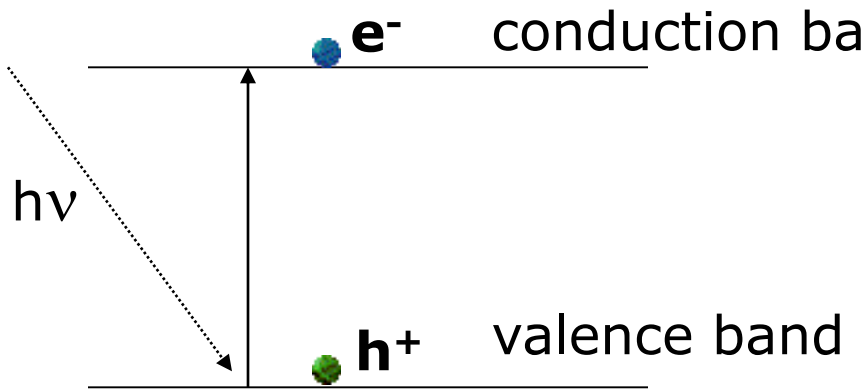
- Inorganic metal oxides, activated by UV radiation
- Derivatives of organic colorants, activated by VIS radiation





TiO_2 – efficient inorganic photosensitizer

- TiO_2 is highly efficient inorganic photoactive semiconductive material
- Efficiency of photoactivity depends on its surface weight
- Nanoform brings high photoactivity



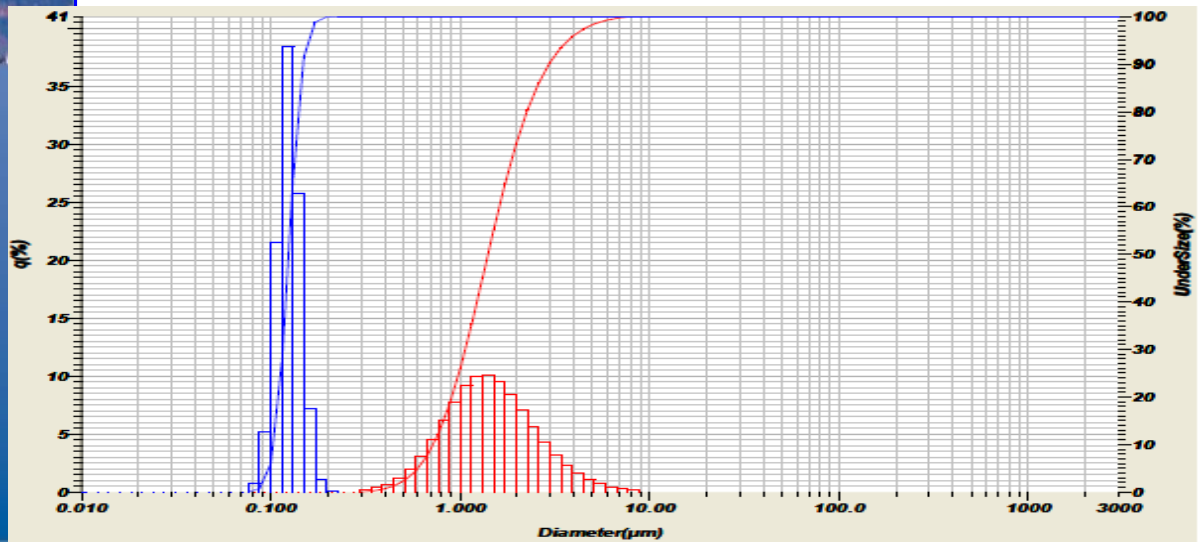
$TiO_2 + UV\text{-}ray \rightarrow (h^+ + e^-)$

$H_2O + h^+ \rightarrow H^+ + OH$ radical

$O_2 + e^- + H^+ \rightarrow HO_2$ radical

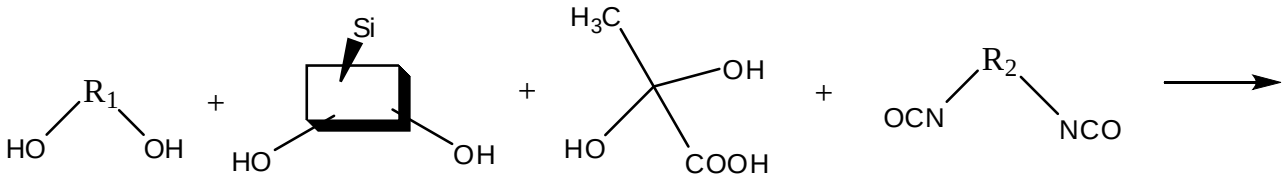
Antimicrobial process has some limitations

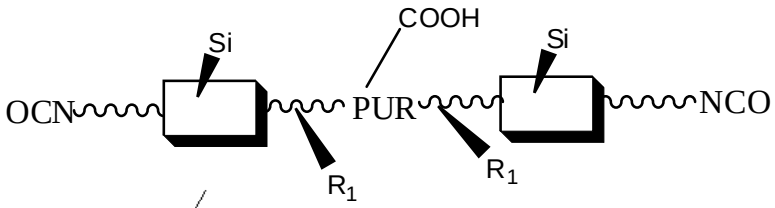
- TiO_2 needs for activation relevant source of UV radiation – the most effective Sun outdoor radiation
- Nanoparticles of TiO_2 make agglomerates – it is necessary to prepare dispersions by pearl milling
- The production of free radicals is highly destructive for all organic materials including carrier polymers
- The photoactive process is too slow – is not suitable for fast disinfection

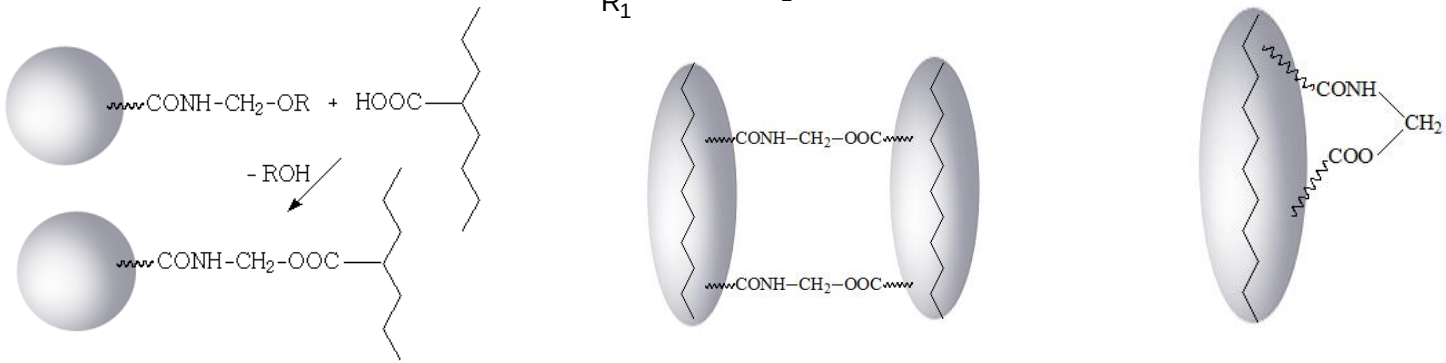


Self-cleaning fabrics

- Incorporation of hybrid silicon-acryl-urethane thermo-fixative polymeric system as carrier of TiO_2 on textile







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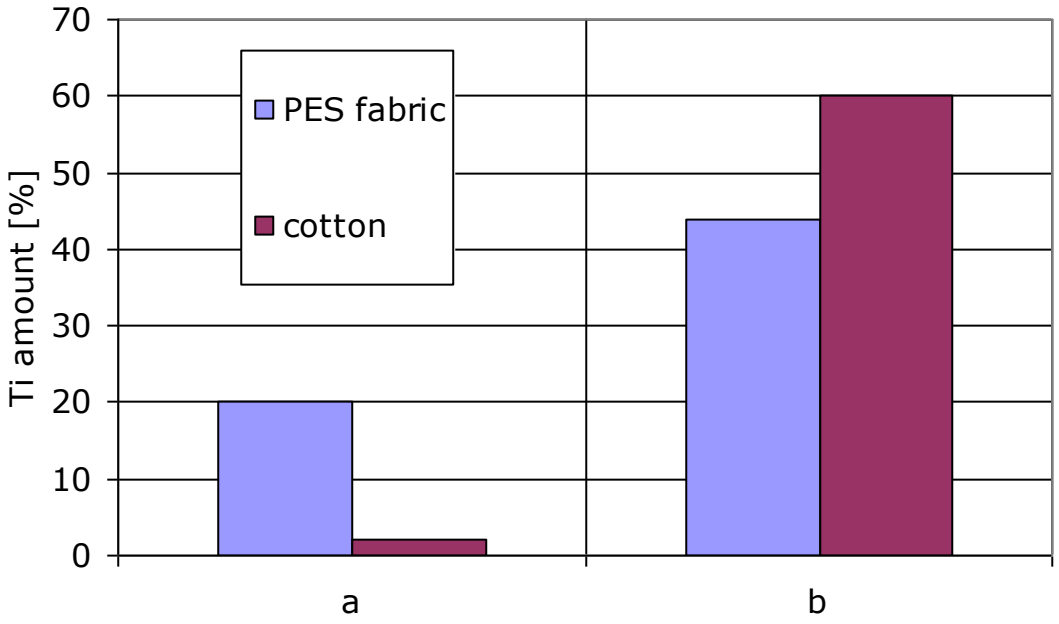
Self-cleaning fabrics

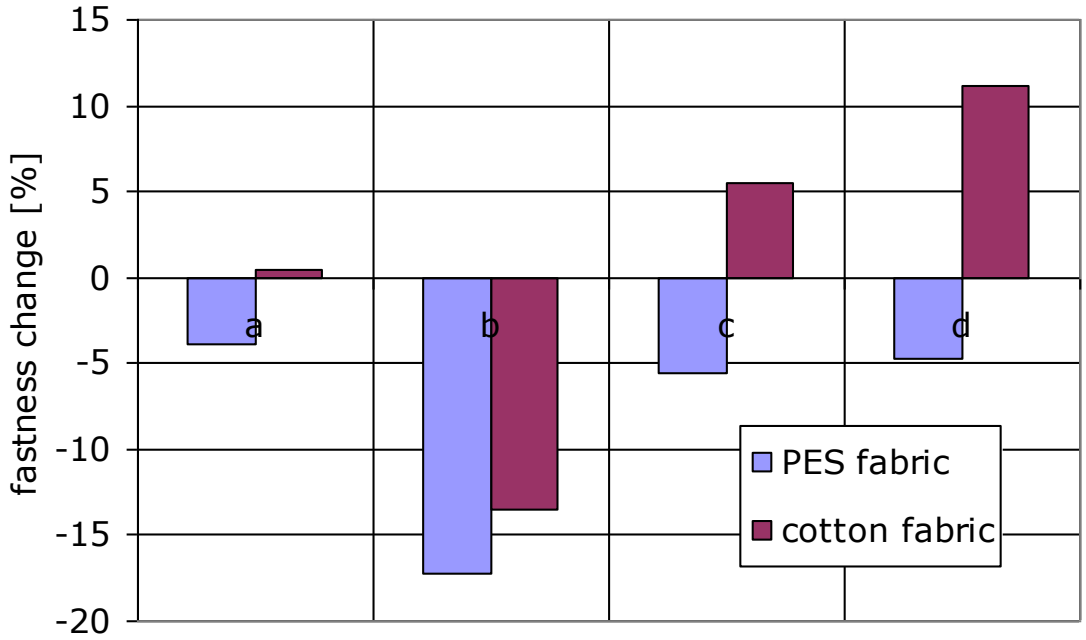
Wash-fastness of TiO_2 in modified fabrics



a) fabric modified by TiO_2 by standard method
b) fabric modified by mixture of TiO_2 and SIPURINO

Self-cleaning fabrics

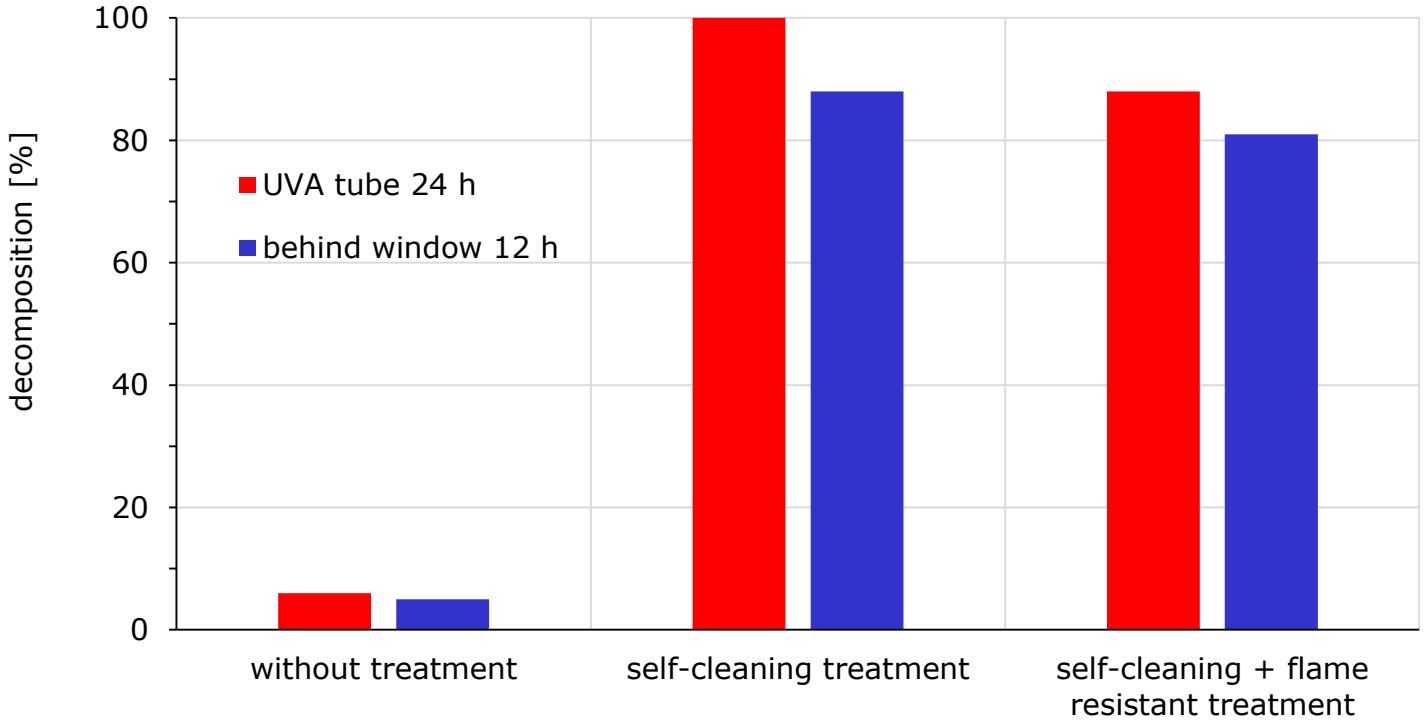
Mechanical stability of modified fabrics – tensile strength



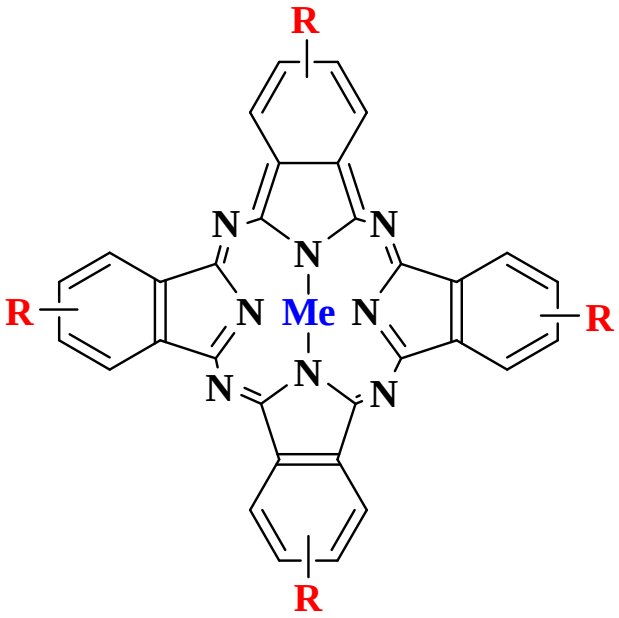
a) fabric without modification; b) fabric modified by TiO_2 alone;
c) fabric modified by TiO_2 and SIPURINO;
d) fabric modified by SIPURINO

Self-cleaning fabrics

Decomposition efficiency against formaldehyde



Phthalocyanine (Pc) as organic photosensitizer



Me – Zn, Al

R – H

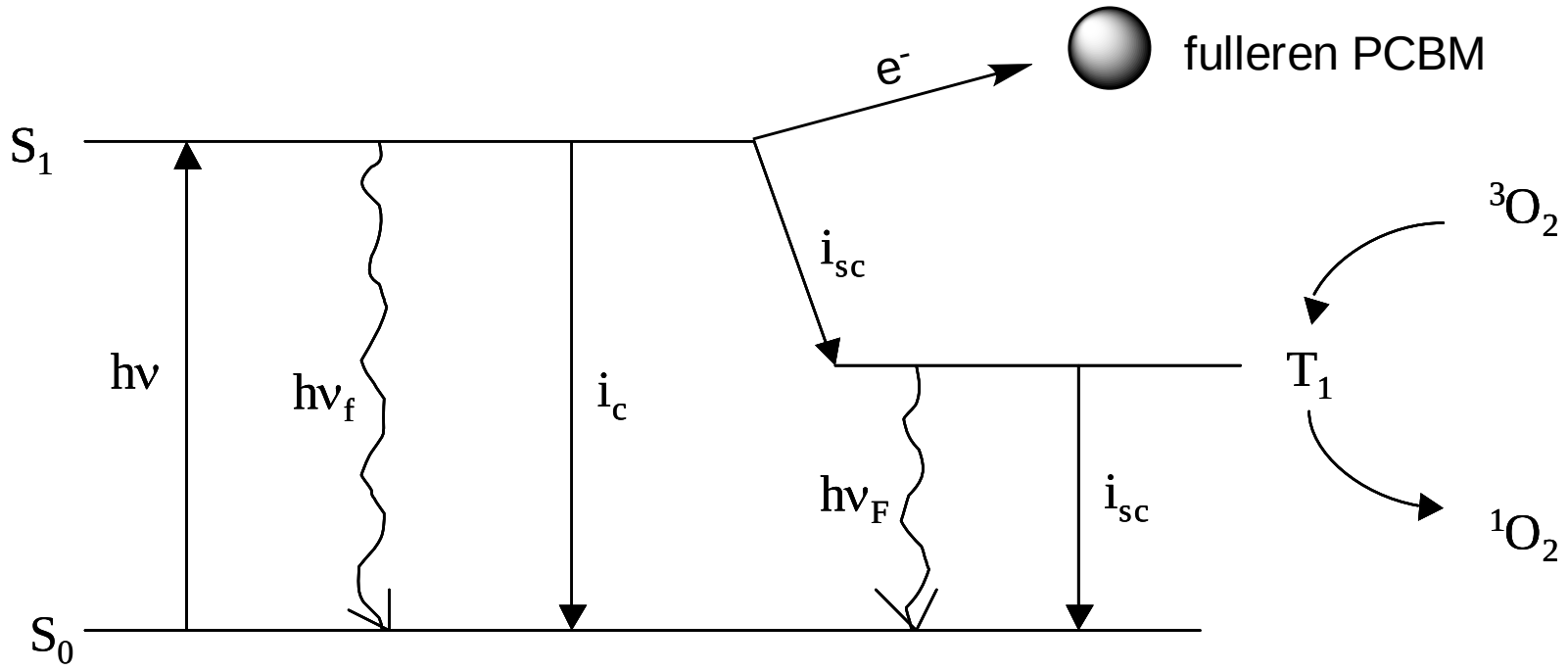
- solubilizing group
- polymerizing group

Application in the form:

- Dispersion
- Solution
- Reactive bound into polymer structure

Phthalocyanine (Pc) as organic photosensitizer

Jablonski diagram



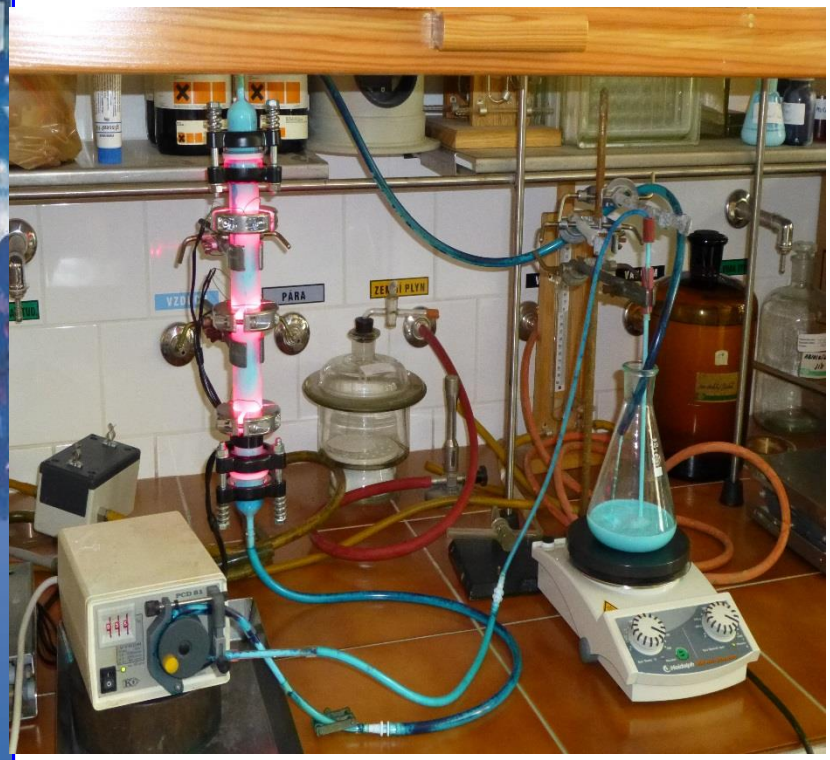
Application of Pc in the solution

Cutting fluids for Engineering

- Conventional biocides are not stable
- Conventional biocides makes serious dermatitis
- Mixture of oil and water is suitable environment for yeasts, bacteria and moulds

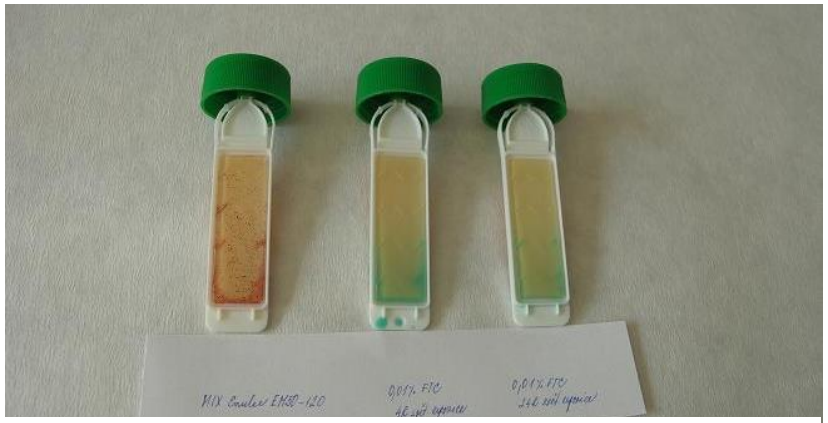
Application of Pc in the solution

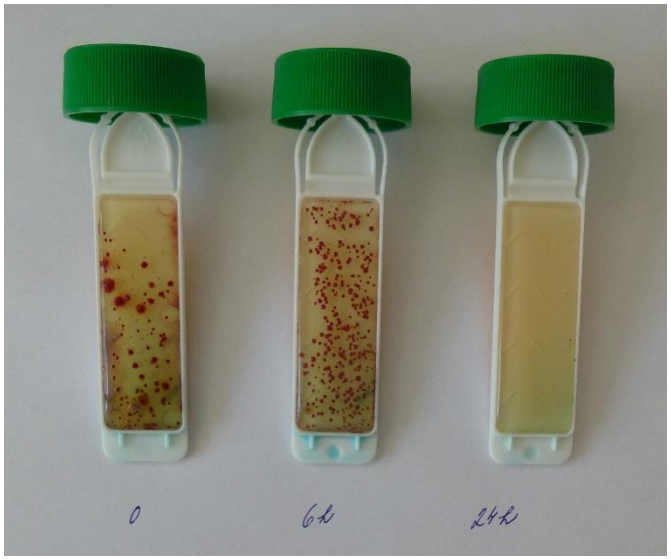
Laboratory and pilot plant tests

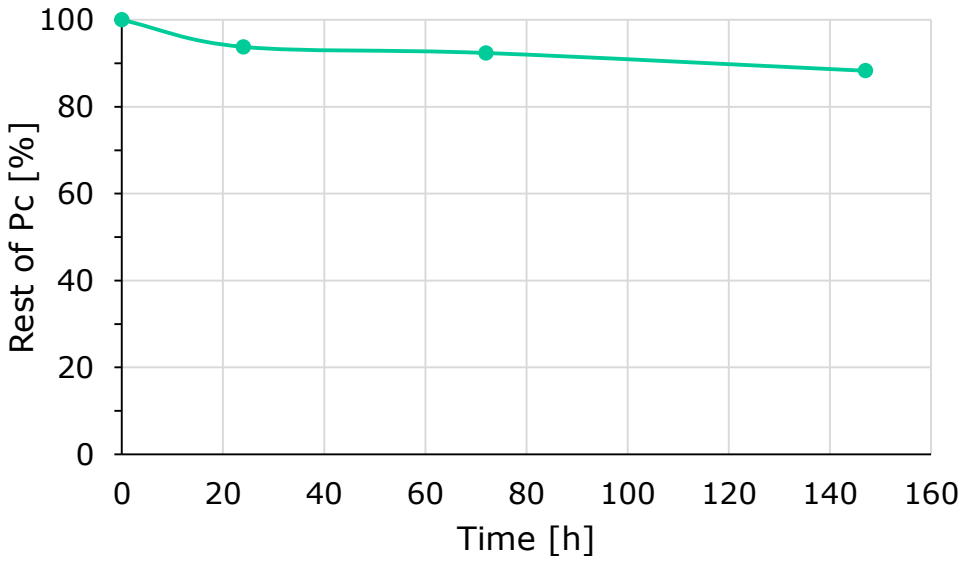


Application of Pc in the solution

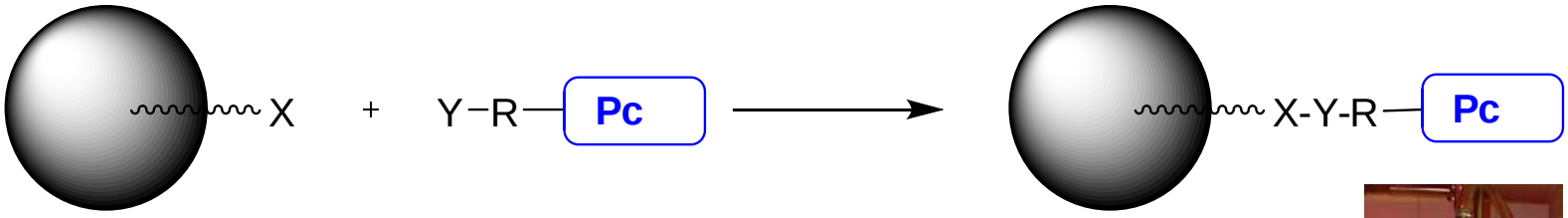
Cult dip test for bacteria existence evaluation







Application of Pc bonded on textile fabrics

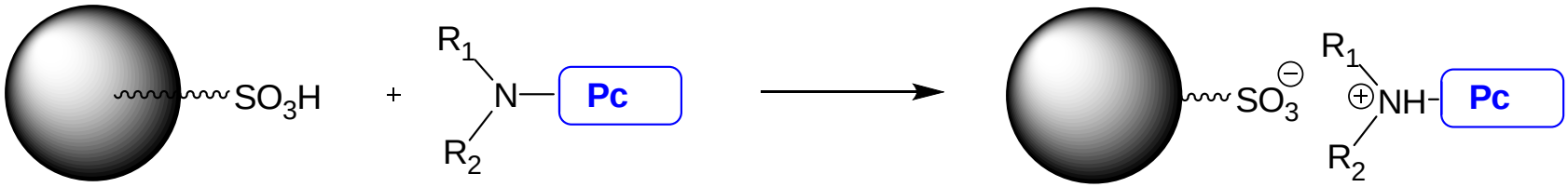


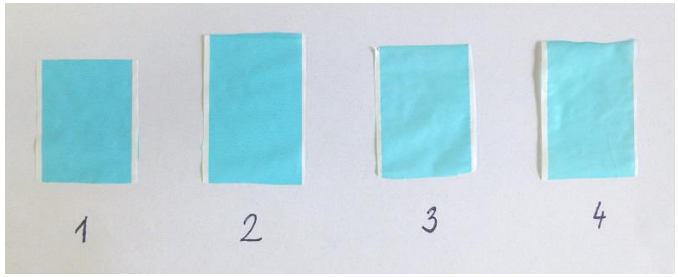
Escherichia coli - log CFU/ml					
Central metal of Pc	**starting bacterial suspension**	**cotton - blank**	**dyed cotton**	**5x washed**	**10x washed**
Al	4,0	4,0	1,0	1,7	2,9
Zn	4,0	4,0	0,2	1,3	2,0

Application of Pc applied on foil

Application of flexography printing inks

- Pc bound on polymeric matrix by ionic bond
- Application of inks on vapor permeable foil
- Antimicrobial protection of foil
- Application mainly for health care





Application of Pc applied on foil

	Escherichia coli CNCTC 6244		Staphylococcus aureus CCM4516	
	0 hod	**24 hod**	**0 hod**	**24 hod**
Blank sample - irradiated	$7{,}4.10^4$	$2{,}5.10^2$	$6{,}6.10^4$	$1{,}2.10^2$
Blank sample without irradiation	$7{,}4.10^4$	$1{,}1.10^7$	$6{,}6.10^4$	$2{,}7.10^6$
Sample with Pc - irradiated	$7{,}4.10^4$	< 10	$6{,}6.10^4$	< 10
Sample with Pc without irradiation	$7{,}4.10^4$	$9{,}3.10^6$	$6{,}6.10^4$	$2{,}6.10^6$

Application of Pc applied on foil

Roll to Roll application system

- From laboratory into plant
- Fatra Sontec foil product

Conclusion

- Antimicrobial behaviour of photoactive materials was demonstrated
- System of application of photoacitve TiO2 for self-cleaning and antimicrobial application suggested
- System was tested with self-cleaning fabrics
- Photoactive phthalocyanine as efficient anti-microbial agents were developed
- Application in soluble form for cutting fluids antimicrobial protection
- Application after covalent bonding on cotton fabrics with antimicrobial behaviour
- Application as printing inks for vapour permeable foils for health care

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Thank you for your attention!

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