

■ GENERAL INFORMATION ON NANOCOMPOSITE COATINGS

PROPERTIES OF COATINGS

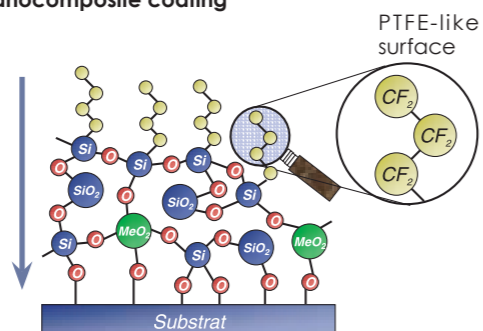
- Highly effective, glass-ceramic- or teflon-like, easy-to-clean hydrophobic coatings
- Coloured, transparent or decorative ("soft feel") and anticorrosive coatings
- Highly non-abrasive by chemical bonding of the coating to the substrate (in contrast to conventional PTFE coatings)
- Good chemical and thermal resistance
- Barrier to diffusion for certain metal ions
- Cleanable with minimal effort

BACKGROUND KNOWLEDGE

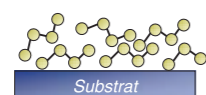
Strictly speaking, not a "coating", but a permanent chemical modification of a part's surface by a gradient material

Example of a nanocomposite coating

Decreasing fluor carbon content creates soft transition from PTFE-like to glass-like structure



Glass-ceramic, polar Si-O-network with embedded nano particles and tight chemical bond to the substrate



In contrast, traditional PTFE coating without chemical bond to the substrate

SKILLS OF MÖLLER NANOCOATINGS

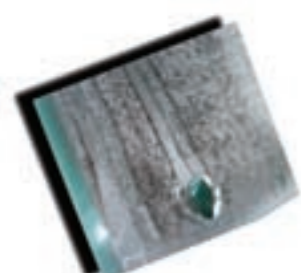
- Surface finishing with nanocomposite coatings; coating systems developed in-house
- Coating of steel, aluminum, brass, copper, glass and plastics like PC
- Coating of mid-sized down to very small parts, in particular coating of the inside of thin cannulas/tubes
- About 20 standardized and tested coatings available (list is continuously being extended)
- Development of coatings to your needs and specifications in a project setup possible

APPLICATIONS

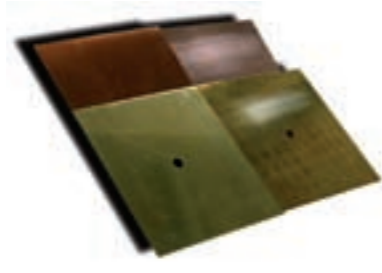
- Dirt-repellent coating for engineered parts and covers
- Scratch-resistant coatings for display covers made from plastics
- Easy-to-clean, biocompatible, autoclavable coatings for medical technology
- Interior and exterior coating of cannulas for chemical analysis technology and human medicine



hydrophilic ... or hydrophobic



... dirt-repellent...

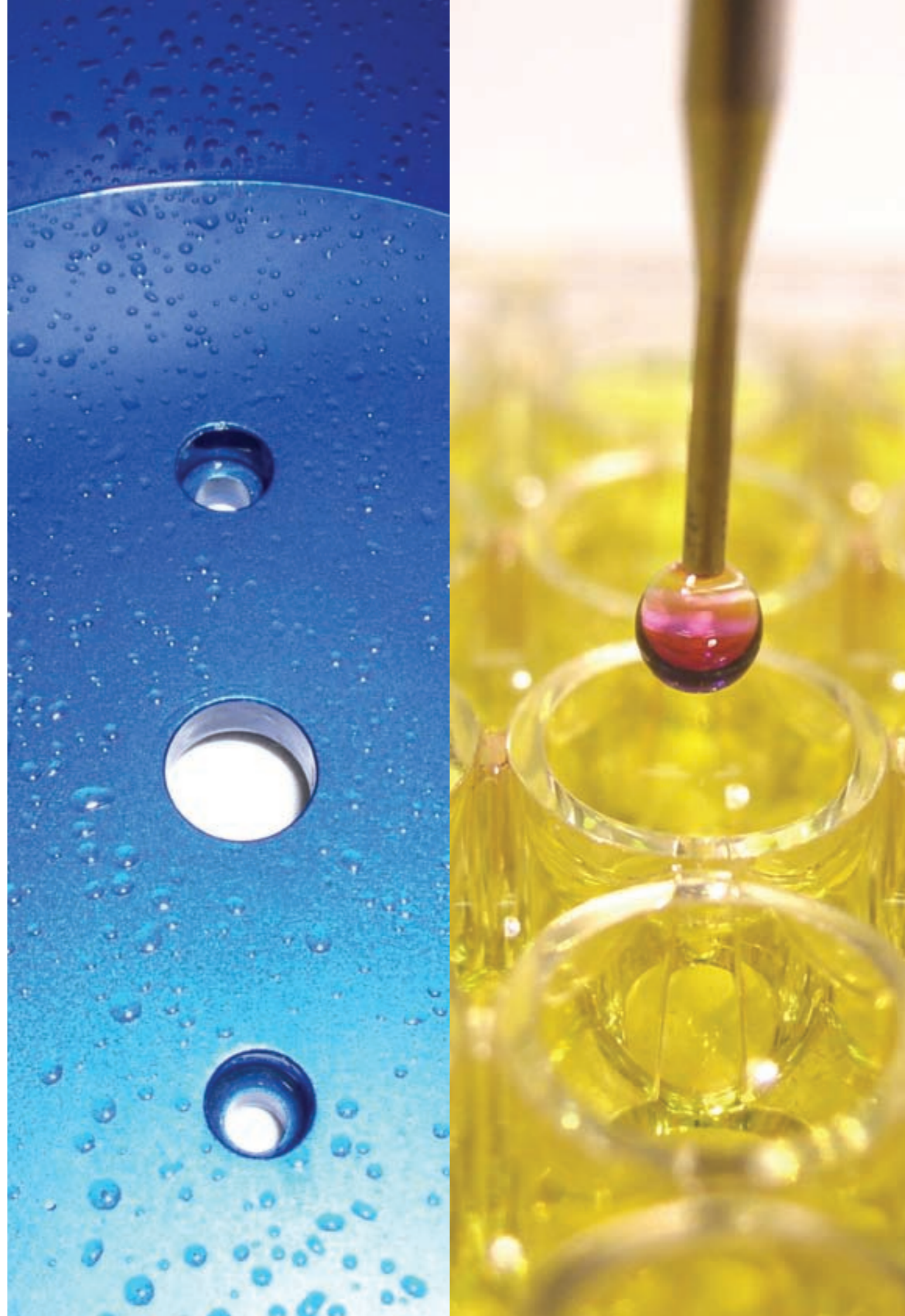


...scratch resistant (left side coated, right side uncoated)



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NanoCoatings
PRODUCT INFORMATION 2006





PRODUCT INFORMATION NANOCOATINGS

NAME	APPLICABLE SUBSTRATES							PHYSICAL PROPERTIES							CHEMICAL RESISTANCE, INCLUSION IN SUBSTANCE AT ROOM TEMPERATURE																				BIOCOMPATIBILITY ACC. TO ISO 10993-5	QUALITATIVE DESCRIPTION	NAME																									
	Stainless Steel	Aluminum	Copper	Brass	Glass	Polycarbonate	Tubes int. dia. 0,1-10 mm	Hardening temperature [°C]	Thermal resistance [°C]	Thickness [µm]	Contact angle to water [deg]	Pendulum dampening test** [sec] acc. to DIN EN ISO 1522	Cupping test [mm]** acc. to DIN EN ISO 1520	Abrasive resistance [mg] acc. to DIN 53754	BASES					ACIDS					ORGANIC SOLVENTS																																					
														Sodium Hypochlorite	Sodium Hydroxide 50% conc., pH>14	Potassium Hydroxide 60% conc., pH>14	2 mol/l KOH	Ammonia 5% pH=10,5	Triethylamine pH = 9,5	Hydrochloric Acid 25% conc.	2 mol/l HCl	Nitric Acid 65% conc.	Sulfuric Acid 75% conc.	Phosphoric Acid 85% conc.	Perchloric Acid 70% conc.	Hydrogen Peroxide 30%	0.5% Hydrogen Peroxide in 0.1M Nitric Acid	Trifluoroacetic Acid 99% conc.	Formic Acid conc.	Acetic Acid conc.	Dichloromethane	Chloroform	Tetrahydrofuran	Acetone	Dimethylsulfoxide	Ethyl Acetate	n-Hexane	Toluene	Acetonitrile	Meliseptol (Disinfectant)	Boiling test (2h in boiling deionized water)	Autoclavability (15 Cycles)																				
NanoSkin 75	x	x	x	x	x	x	80-150	200	5-50	75	140-160	1,2	10 ³	+++	+++	+++	+++	+++	+++	++	+++	-	+++	+++	++	0	+++	+++	-	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+	yes	Biocompatible*	Non-abrasive coating with extreme chemical resistance, also applicable for plastics substrates	NanoSkin 75																		
NanoSkin 78	x	x	x	x	x	x	60-150	200	15-30	78	70-90	0,7	26 ²	-	0	-	0	+	++	--	-	--	--	--	--	+++	-	--	--	--	+++	0	0	--	+++	+++	++	+++	0	+	no	Biocompatible*	Transparent, scratch-resistant coating also for plastics with good resistance against dissolvents	NanoSkin 78																		
NanoSkin 81	x	x	x	x	x	x	120-210	230	5-50	81	160-180	1,1	14 ³	+++	+	0	0	+++	++	0	+	--	+	+++	+	0	+++	0	--	+++	+++	+++	+++	0	+++	+++	+++	+++	+++	+++	+	yes	Not tested	Boiling-water resistant, non-abrasive coating with very good chemical resistance	NanoSkin 81																	
NanoSkin 90	x	x	x	x	x	x	120-210	230	5-50	90	160-180	1,6	14 ³	+++	+	0	0	+++	+++	0	+	--	0	+++	0	+	+++	0	--	+++	+++	+++	+++	-	+++	+++	+++	+++	+++	+++	+++	+	yes	Biocompatible in all tests	Boiling-water resistant, non-abrasive, dirt-repellent, biocompatible coating with very good chemical resistance	NanoSkin 90																
NanoSkin 94	x	x	x	x	x	x	80-150	200	5-50	94	140-160	1,5	11 ³	+++	+++	+++	+++	+++	+++	++	+++	-	+++	+++	++	0	+++	+++	--	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	-	yes	Biocompatible in all tests	Non-abrasive coating with extreme chemical resistance, easy-to-clean, biocompatible, also for plastics	NanoSkin 94																
NanoSkin KL-VP	x	x	x	x	x	?	80-150	?	2-9																																	attempts in progress																				
NanoSkin Magic 101 L	x	x	x	o	o	-	300-380	300	3-10	101/80*	140-160	6,0	68 ¹	0	+	+	+++	+++	+++	--	+	0	+++	+++	++	+	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+	no	Biocompatible in all tests	Conducting coating with very good chemical resistance, biocompatible, becoming hydrophilic after water contact	NanoSkin Magic 101 L																		
NanoSkin Magic 112	x	x	x	o	o	-	300-320	350	15-40	112	100-120	0,5	64 ³	+++	++	-	+	+++	+++	0	++	++	++	+++	++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+	yes	Biocompatible in all tests	Thermal resistant coating with outstanding easy-to-clean effect and chemical resistance, bioinert	NanoSkin Magic 112																
TafSkin 98	x	x	x	x	o	-	220-260	300	15-40	98	120-140	8,5	37 ³	+	++	+	+++	0	0	0	+++	-	+++	++	+	+++	+++	--	0	0	+++	+++	+++	+++	++	+++	+++	+++	+++	+++	+	yes	Biocompatible in all tests	Flexible, non-abrasive, temperature-stable, dirt-repellent coating, biocompatible	TafSkin 98																	
TafSkin 103	x	x	x	-	o	-	340-400	250	10-30	103	120-140	8,3	21 ³	+++	++	++	+++	+++	+++	0	+++	0	+++	++	+++	0	+++	+	+++	+++	++	+	+++	+++	--	+++	+++	+++	+++	+++	+++	+	yes	Biocompatible in all tests	Highly flexible, non-abrasive, chemical-resistant PTFE coating with very good easy-to-clean properties, biocompatible	TafSkin 103																
TafSkin 109 L	x	x	x	-	o	-	340-400	300	2-10	109	140-150	5,2	30 ²	+	+++	++	+++	++	++	-	+++	++	+++	+++	+++	0	+++	+	+	+++	++	++	+++	+++	--	+++	+++	+++	+++	+++	+++	+	yes	Biocompatible in all tests	Electrically conducting, chemical-resistant, thin, easy-to-clean PTFE coating	TafSkin 109 L																
TafSkin 115	x	x	x	o	o	-	280-320	260	25-50	115	100-120	1,4	43 ³	+++	+++	0	+++	+++	+++	-	+++	0	+++	+++	+	+++	+++	+	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+	yes	Biocompatible in all tests	Non-abrasive easy-to-clean PTFE coating with very good chemical resistance, and outstanding easy-to-clean properties, bioinert	TafSkin 115																	
PolySkin 78 M	x	x	x	x	x	o	25-80	200	3-10	78	160-180	8,4	44 ²	++	+	+	++	+++	++	-	0	--	--	--	--	-	++	--	--	-	+	0	--	--	--	--	+++	+++	--	--	-	no	Not tested	Decorative coating in "metallic look", hardening at room temperature up to 80°C	PolySkin 78 M																	
PolySkin 80	x	x	x	x	x	o	25-120	200	15-40	80	160-180	8,4	33 ³	+++	+++	+++	+++	+++	+++	++	+++	--	-	+++	0	+++	+++	--	--	--	--	-	+++	+++	+++	+++	+++	+++	+++	+++	+++	+	yes	Not tested	Flexible, non-abrasive, decorative coating hardening at room temperature up to 120°C	PolySkin 80																
PolySkin 81	x	x	x	x	o	-	140-150	200	15-30	81	160-180	8,4	11 ³	+++	+++	+++	+++	+++	+++	++	+++	--	-	0	--	0	+++	--	--	-	+++	-	+++	+++	-	+++	+++	+++	+++	+++	+++	+	yes	Not tested	Flexible, non-abrasive, decorative coating; easy-to-clean effect can be added	PolySkin 81																
PolySkin 82	x	x	x	x	o	-	170-180	200	15-40	82	210-230	8,4	6 ³	+++	+++	+++	+++	++++	+++	0	+++	--	+++	+++	++	++	+++	--	--	-	+++	+++	+++	+++	--	+++	+++	+++	+++	+++	+++	+++	-	yes	Not tested	Flexible, very non-abrasive, chemical-resistant decorative coating	PolySkin 82															
PolySkin 95	x	x	x	x	o	-	170-180	230	15-40	95	210-230	8,4	6 ³	+++	+++	++	+++	++	+++	++	+++	-	+++	++	++	++	+++	--	--	-	+++	+++	+++	+++	--	+++	+++	+++	+++	+++	+++	+++	-	yes	Not tested	Flexible, very non-abrasive, chemical-resistant decorative coating with easy-to-clean properties	PolySkin 95															
PolySkin 98 S	x	x	x	x	o	-	180	200	80-140	98	100-115	8,8	0 ³	+++	0	-	+++	+	+++	-	+++	--	--	--	--	+++	+++	--	--	0	+++	0	0	+++	++	+++	+++	+++	+++	+++	+++	+	no	Not tested	Flexible, non-abrasive "soft feel" coating with velour-like surface	PolySkin 98 S																
PolySkin 102 M	x	x	x	x	o	-	140-150	250	1-10	102	130-140	8,4	44 ¹	++	+	+	++	+++	++	-	0	--	--	0	--	+	++	--	--	+	++	++	+++	+	++	+++	+++	++	++	+	yes	Not tested	Decorative, thermally stable coating with "metallic look", easy-to-clean effect can be added	PolySkin 102 M																		
LEGEND	x = applicable o = applicable with restrictions - = not applicable							Abrasion of friction disc CS 17 and 500 g load after x turns, normalized to 1000 turns for comparison ¹ x = 250 turns ² x = 500 turns ³ x = 1000 turns							Chemical resistance -- affected after 1h - affected after 2h 0 unchanged after 4-8h + unchanged after 24h ++ unchanged after 48h +++ unchanged after 72h																				Boiling test + unchanged after 2h - affected or delaminated after 2h							Biocompatibility test One-parametric cytotoxicity test after production of a series of solutions with 90%, 30%, 10% and 3.3% extract concentration							* following previous water contact ** Comparison value for glass = 250 *** Flexibility measure							* Not tested, but similar to NanoSkin 90						
VALIDITY OF RESULTS	Measurement on stainless steel substrate, results generally transferable to substrates brass, copper, aluminum; results with plastic substrates not yet available							Measurement on stainless steel substrate, results generally transferable to all other substrates																				Measurement on stainless steel substrate, results generally transferable to all other substrates																																		