Universität Paderborn

Chemie und Technologie
der Beschichtungsstoffe

Nanotechnologie in Beschichtungen

Wolfgang Bremser
Coatings Science
University Paderborn

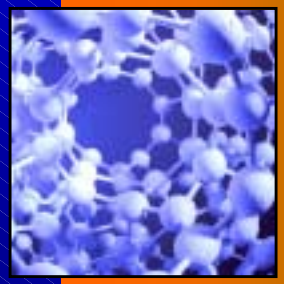
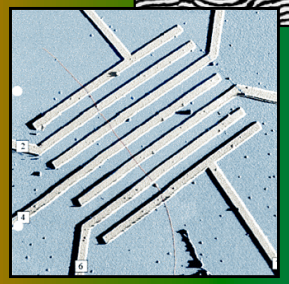
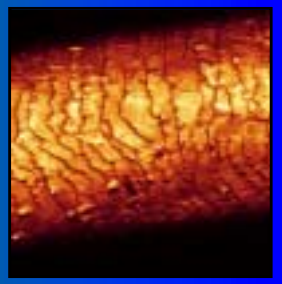
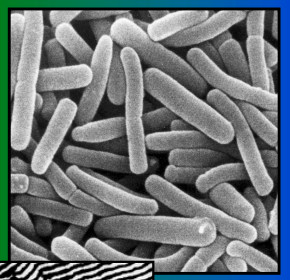
Scales

Nano **Micro** **Macro**

Materials

Set Ups

Systems

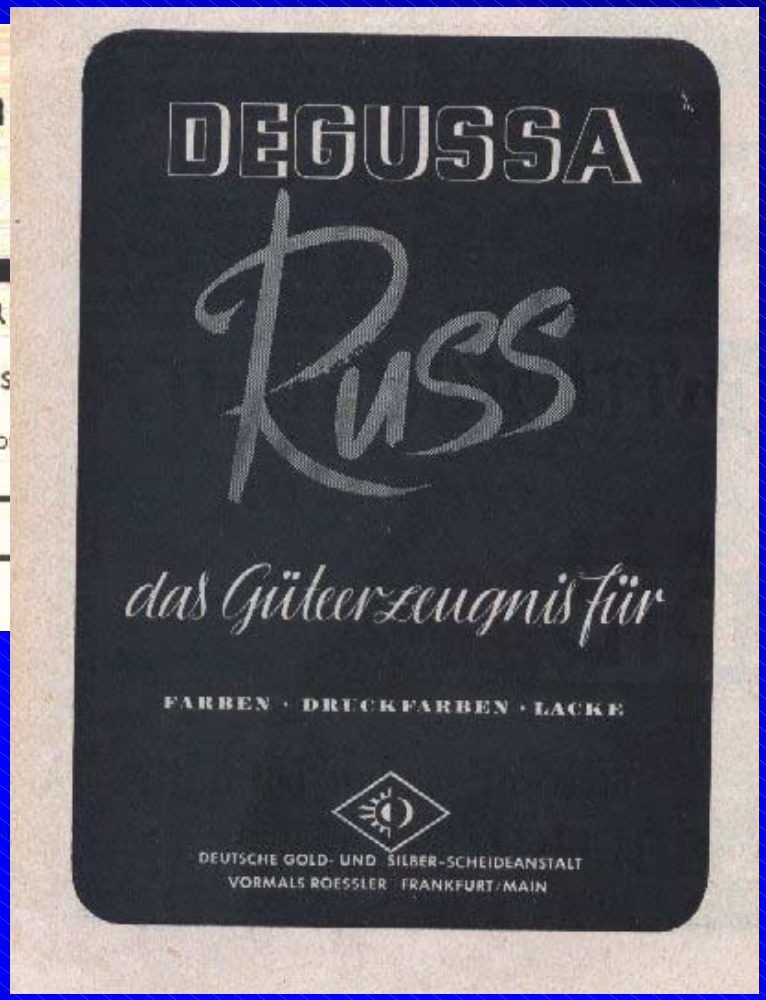







0,1 nm | 1 nm | 10 nm | 0,1 µm | 1 µm | 10 µm | 0,1 mm | 1 mm | 1 cm | 0,1 m | 1 m

The Coatings Industry at the Forefront

Rheology



Color

Nanotechnology in Science

Truth in Science

„Only measured phenomena are true“

„Only written things are true“

- Scanning Tunnel Microscopy
- Scanning Probe Microscopy
- Beginning of 80s

Truth in Industry

„Only tested phenomena are true“

„Only what I konw is true“

Nanotechnology in Material Science

- What´s new about it?
- Quantum size effects?
  - Not used in Coatings
- New Physical Properties?
  - There is no other or new physics
  - Described by Colloid and Interface Science
- Everything can be achieved by Nanotechnology?
  - Deus ex machina
- Nanoparticles offering any desired Solution?
  - Even more powerfull Deus ex machina

Nanotechnology in Material Science

- Nanotechnology as a selling argument?
  - Works in industry
  - Works in the scientific community
  - Works in politics
- Nanotechnology as a tool?
  - Necessary to control materials on the nano scale
  - Necessary to control all other levels

Synonyms for Nanotechnology

- Coatings
- Pigments, Effect Pigments
- Fillers, functional Fillers
- Colloid and Interface Science
- Molecular Control
- Hierarchical Materials
- Hybrid-Materials
- Polymer Science
- …
- Everything that is not a simple molecule or a crystal
  - Real Material
- Every New Property

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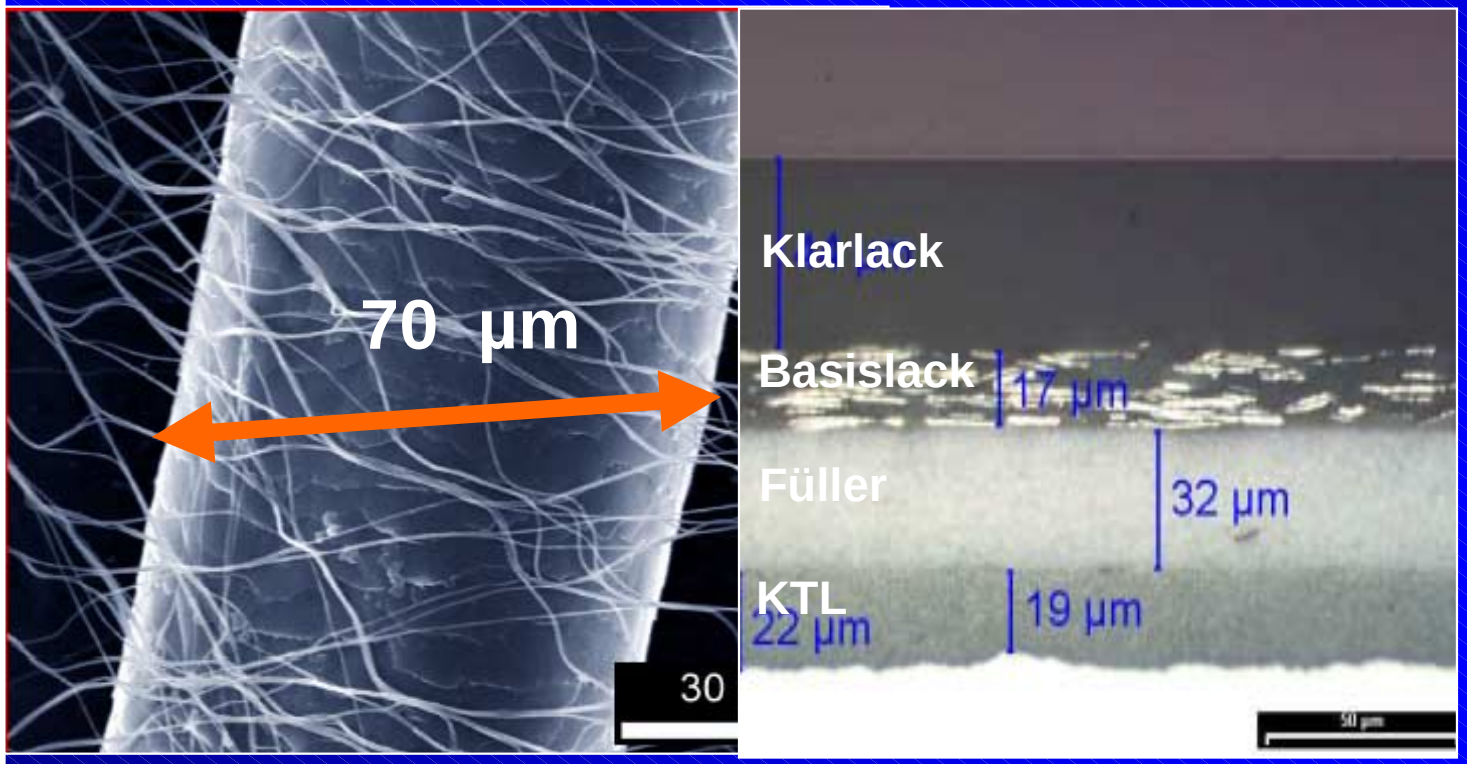
Nanoelements in Automotive Coatings

4-Layer System



Crosslinking Topologie

Colloidal System

Mechanical Properties

Gradient system

- Complex Heterophase System with Suprastructures on different length scales

Lotus Effect

Illusion

- In nature...

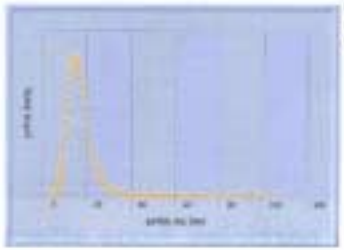
... In technical materials

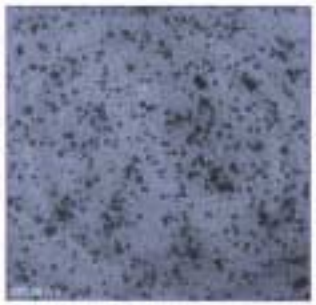
Everything is Fine with Nanoparticles?

Tiny particles,
huge effect

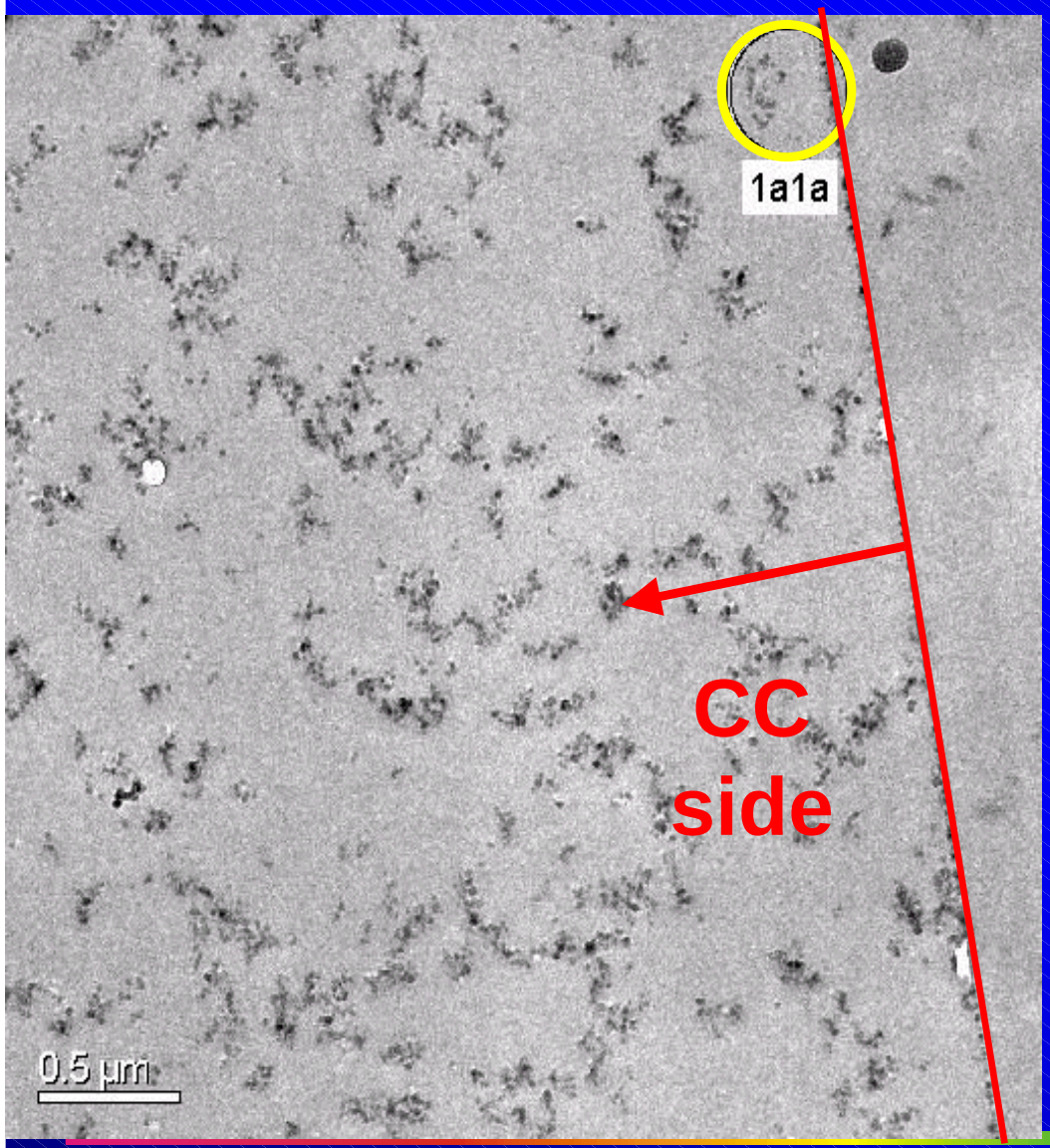
Radiation curable silica nanocomposites for scratch and abrasion resistant coatings

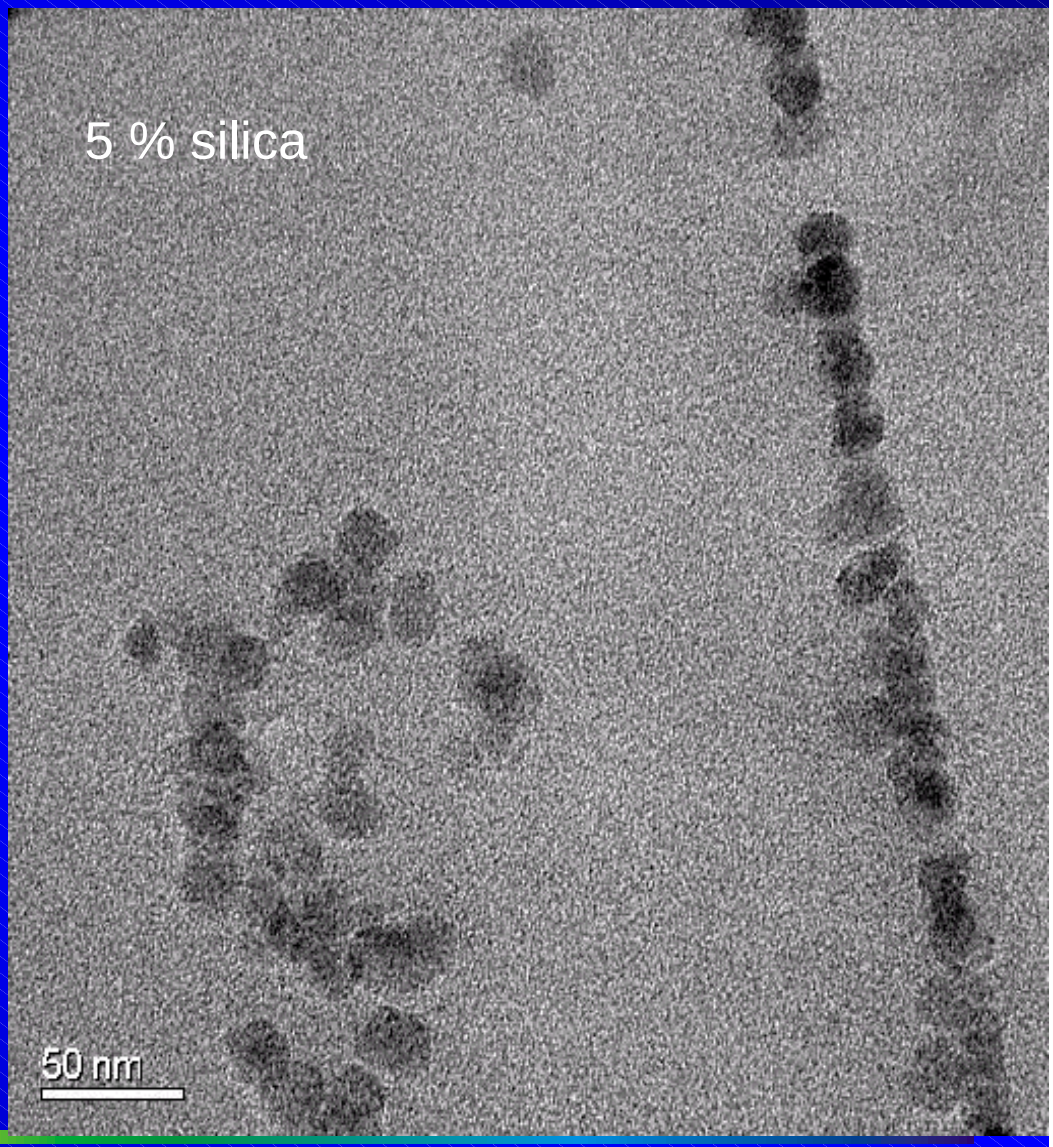
Christof Reuscher





Verteilung der Nanopartikel





Patents are Revealing Efforts

- Nano Particles
- (Gradient Structure)
- Pentasiloxane
- Melamine Resins
- Isocyanate
- 3-4 Levels of Crosslinking
- Suprastrucrure
- Brittle
- Unsufficient Adhesion
- Internal Stress
- Costs

TION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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n Date
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PCT

C08K 3/00,

PCT/US00/20836

uly 2000 (31.07.2000)

English

English

99 (30.07.1999) US
99 (23.12.1999) US
00 (21.01.2000) US

OHIO, INC. [—/US];
72 (US).

e, G.; 165 White Oak
BARKAC, Karen, A.;
15668 (US). CHAS-
e Drive, Allison Park,
A.; 118 Robinhood
HARTMAN, Marvis,
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annon Road, Verona,
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CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: CURED COATINGS HAVING IMPROVED SCRATCH RESISTANCE, COATED SUBSTRATES AND METHODS RELATED THERETO

- Marktreife Systeme: 4-5 Jahre Entwicklungsarbeit, 20 – 30 MJ
- Verhältnis Forschung zu Entwicklung: 1:10
- Systemverständnis anstatt isolierter Lösungen
- Kratzfest, nicht Wandalenfest
- Technische Alternativen möglich

Nanotechnology Environmental Hazards and Toxicity

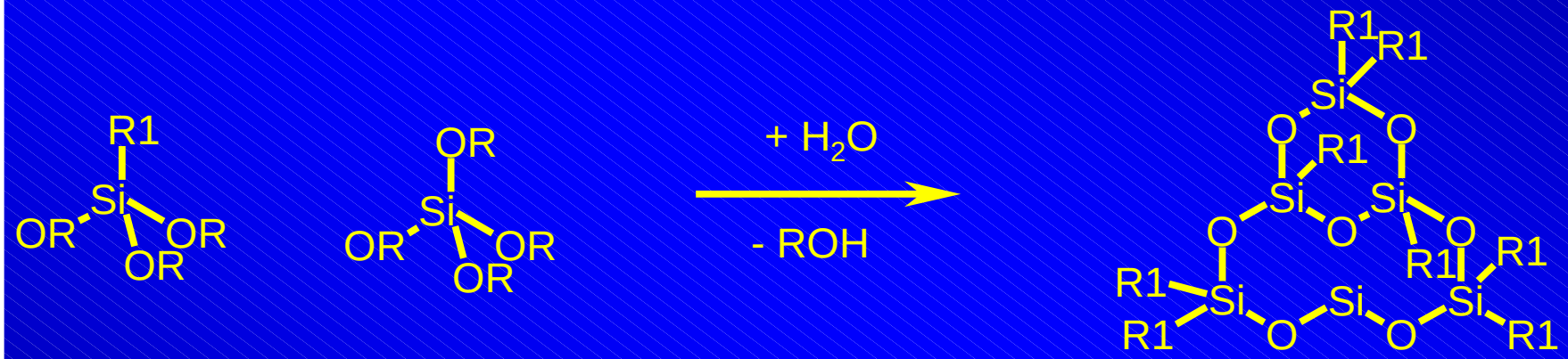
- Nanoparticles
- Permanent Association with Asbestos
- Covered by existing legislation

- Free Nanoparticles?
  - Aerosol
  - Dispersion
  - Material

- Toxic Effect observed
- Defined Conditions?

Nanolacke - Siloxanbasis

Siloxan-Lacke, „Nanolacke“

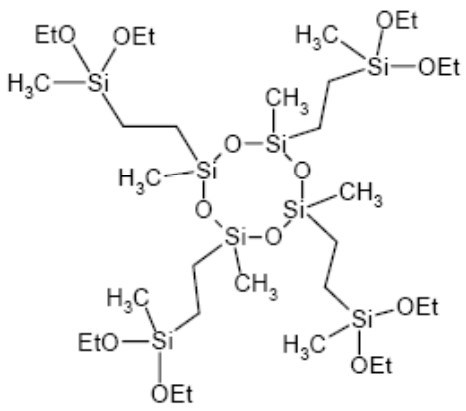


- Organisch-Anorganische Kompositwerkstoffe
- „Ormocere“, „Sol-Gel“, „Nanolacke“

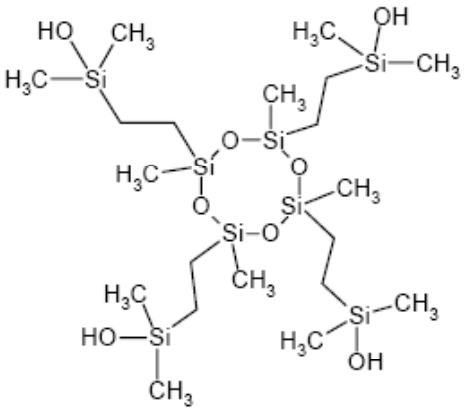
- Polysiloxane als Bindemittel anstatt „normaler Polymere“
- „Übliche Rezeptierung“: Additive, Füllstoffe usw

Siloxan Bausteine

„D4-Diethoxide“

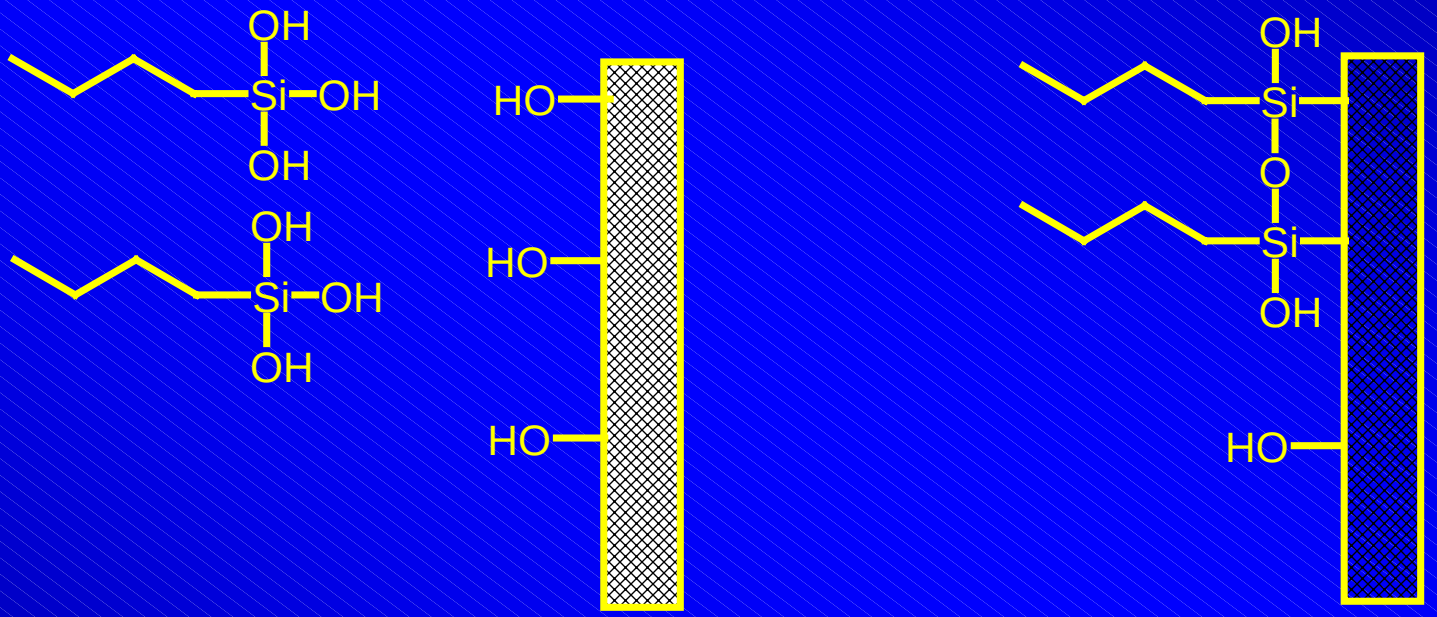


„D4-Silanol“



Bayer AG

Siloxan-Lacke - Korrosion



- Anbindung an OH-Gruppen
- Stabil verankerte Oxide notwendig (Aluminium)
- „Nanolack“ = Siloxanbindemittel

„Nanolacke“ im Alltag

Easy to Clean - Sanitär

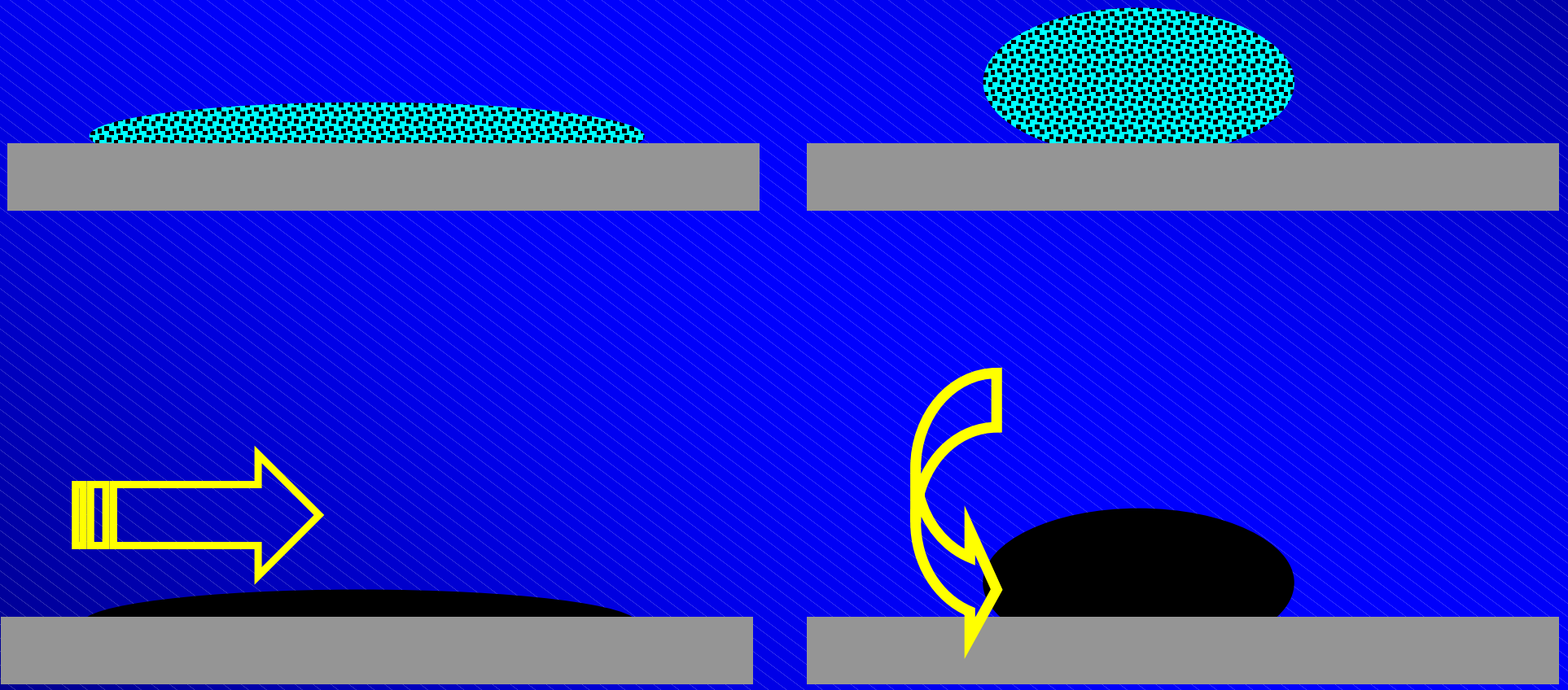
***DUSART PLUS Glasbeschichtung auf der Innenseite**

Anhaftung von Schmutz und Kalk wird reduziert

Easy to Clean - Sanitär

- Abperlende Tropfen auf Hydrophober Oberfläche
- Abperleffekt
- Schmutzform

Easy to Clean - Dusche



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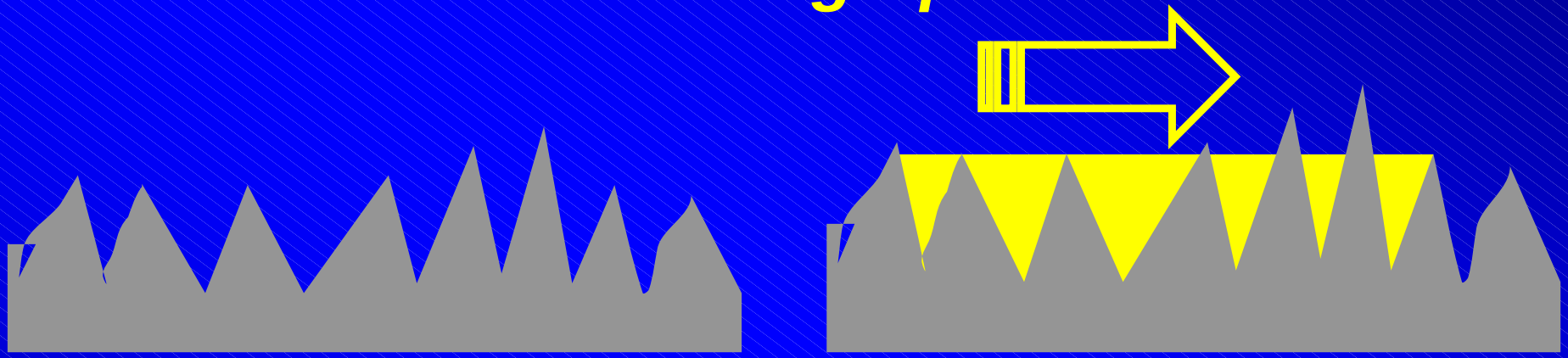
Anti-Fingerprint

270-Liter-Kühl-/Gefrierkombination Edelstahl

Designgerät. Der Blickfang für Ihre Küche.

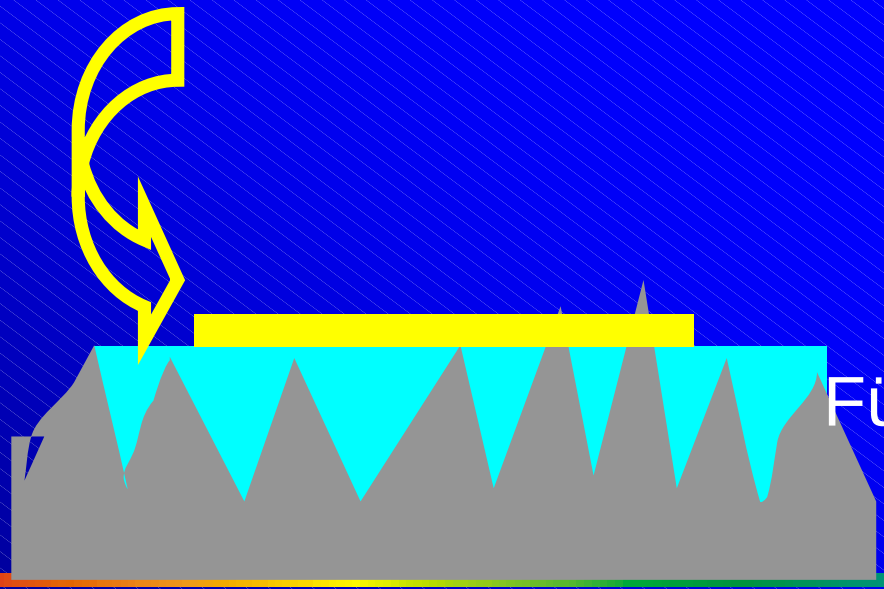
Matte Oberfläche mit Anti Fingerprint Beschichtung

Anti-Fingerprint



Matte Edelstahloberfläche

Fingerabdruck



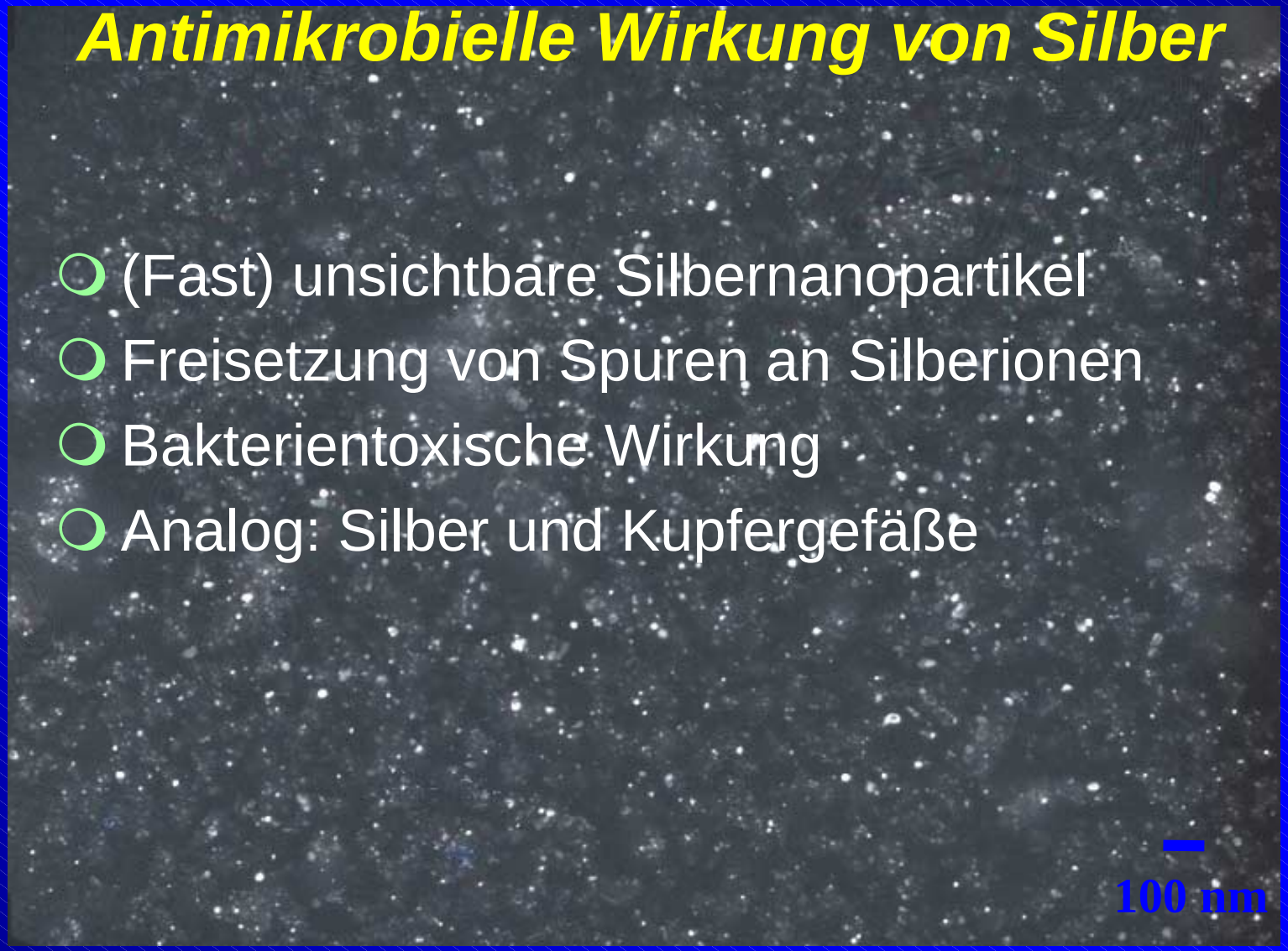
Füllung der Vertiefungen

Anti-Mikrobiell

Nutzinhalt Kühlraum 346, Gefrierraum 186 l Elektronische Temperaturreglung **Silver Nano: Antibakterielle Beschichtung** No-Frost-Technik Twin Cooling System Superfros & Supercool Abtau-Automatik Cool Se ür Temperaturen von + 2 über 1 5 5 Grad) Abstellfl ühl- und Gefrierteil aus stabilem Sicherheitsglas V d Eisspender für Würfel und "Crushed Ice" (Frischwas Innen liegender Wasserfolter Hausbar, W dersicherung Tür-offen-Warnsystem (akustisch) E rauch 525 kWh/Jahr Farbe silber

Antimikrobielle Wirkung von Silber

- (Fast) unsichtbare Silbernanopartikel
- Freisetzung von Spuren an Silberionen
- Bakterientoxische Wirkung
- Analog: Silber und Kupfergefäße

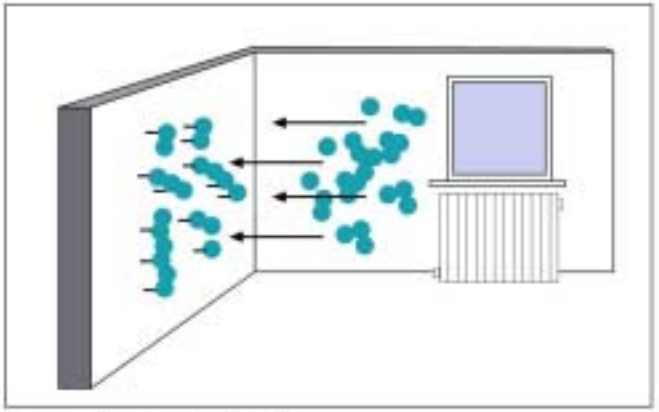


* Uncountable Ag nanoparticles is dispersion in dark field as like galaxy.

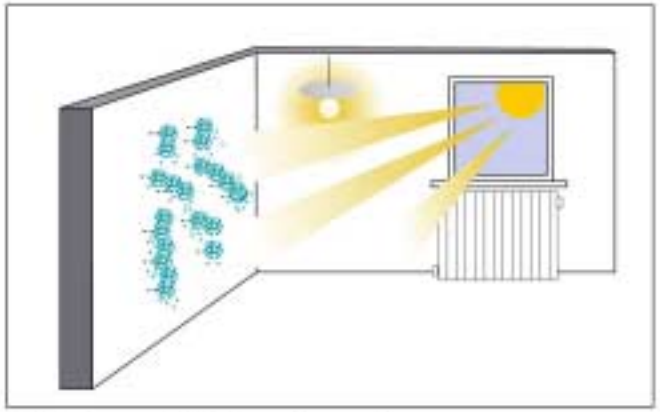
Photokatalyse –Wellness-Farben

Verbessertes Raumklima

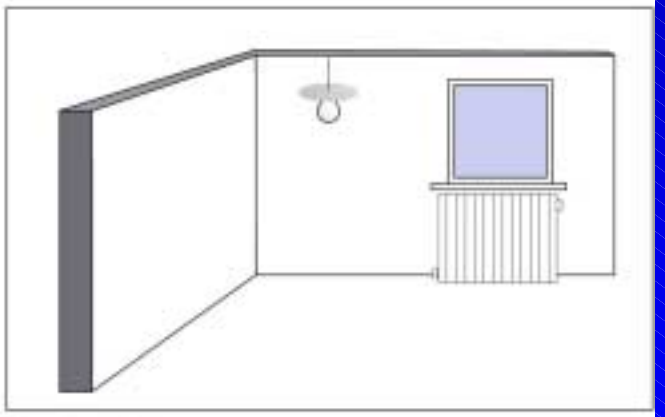
CapaSan. Innenfarbe mit photokatalytischem Effekt



Organische Bestandteile in der Raumluft lagern sich an der Wandfläche ab.



Auf Basis von Weißpigmenten und Lichtenergie werden organische Substanzen abgebaut.



Das Resultat:

Durch den photokatalytischen Effekt werden Schadstoffe in der Raumluft reduziert.

Conclusion

- Coatings are Nanotechnology
- Nanotechnology in Coatings is more than Siloxanes or Nanoparticles
- Nanotechnology is an Enabling Technology, but is No Innovation by itself
- Changing Focus from Molecules to Structure
- From Bricks to Architecture

- Hierarchical Structure on all Length Scales
- Control and Understanding
- Integrated Systems instead of Ísolated Solutions
- Properties Instead of Isolated Nano Elemts
- Be Inspired, See the Challenge!

Visionäres

Be Inspired

Lack als

- Leuchte
- Reflektor /Reflektorstreifen
- Warnleuchte, Unfallsignal
- Display

- Solarzelle

- Sensor

Lack mit neuen Effekten

- **Schaltbarem Farbton**
  - **/Nutzer**
  - **Reversibel irreversibel**
  - automatisch
    - durch Energieeintrag
    - durch Pigmentausrichtung
    - durch chem. Reaktion
    - **irreversibel**

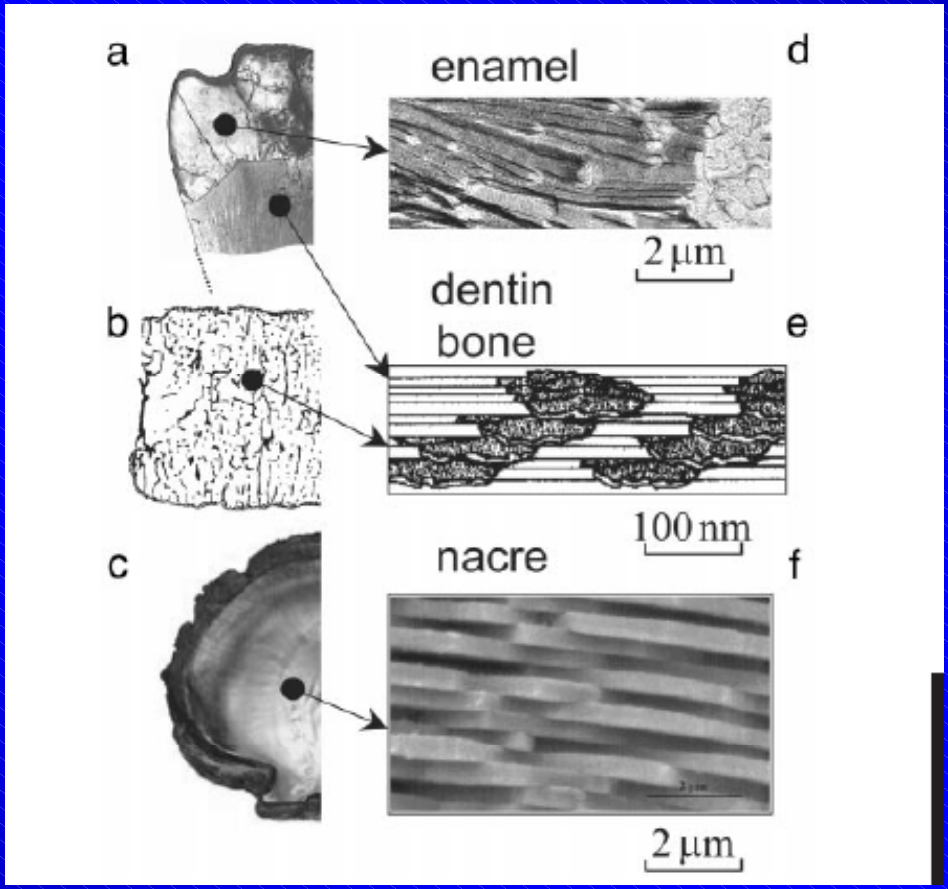
- Schaltbarer Struktur
  - Lotuseffekt
  - Benetzbarkeit
  - Muster/Maserung
  - Oberflächenspannung
  - Glanz

Lack mit neuen Eigenschaften

- selbst reparierend (Bionik)
- regnerierbar
- Struktur
  - Lotuseffekt
  - Benetzbarkeit
  - Muster/Maserung
  - Oberflächenspannung
  - Glanz

  »
- Korossionsschutz
- Härtung

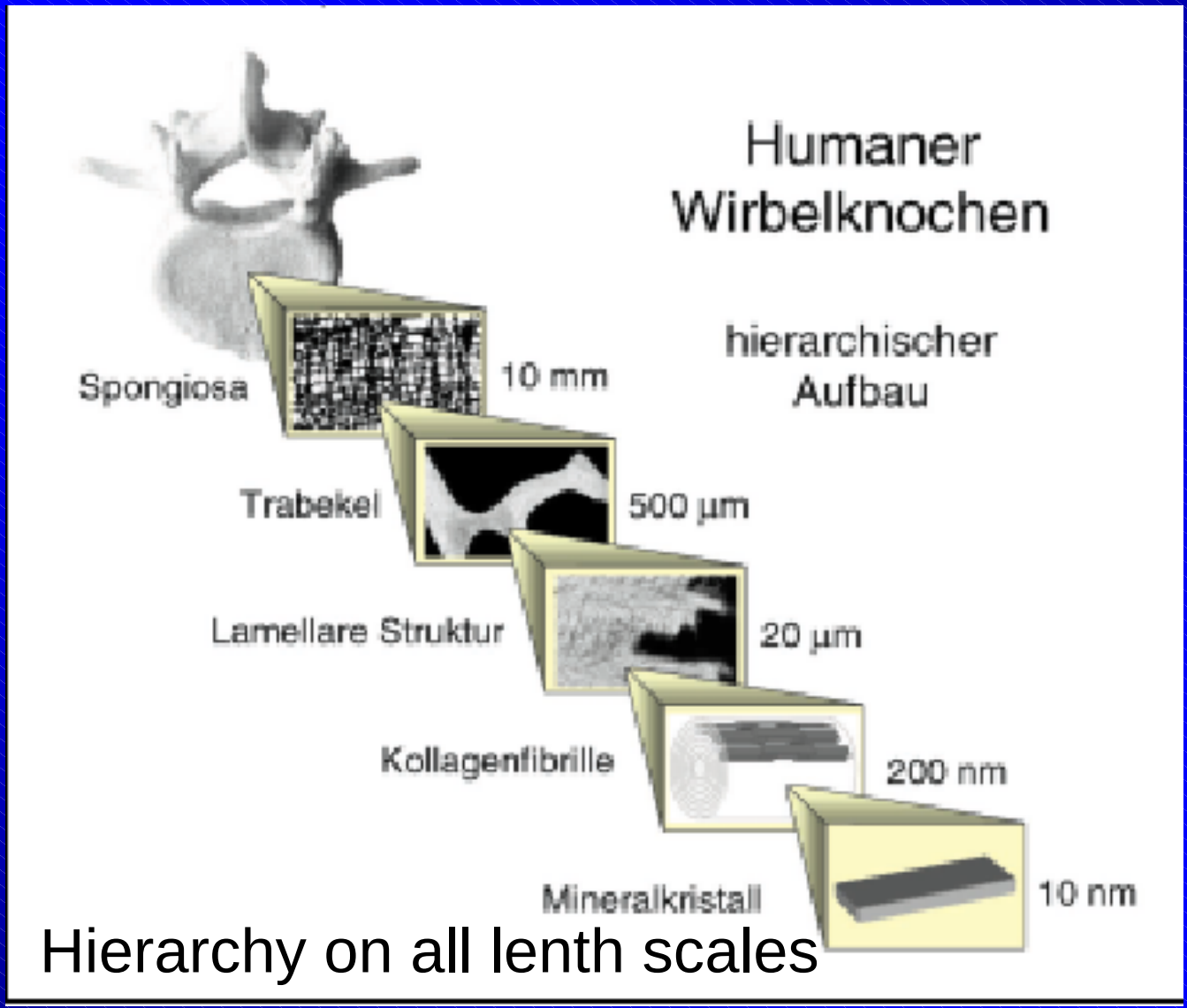
Bioinspired Materials



Integrated Systems

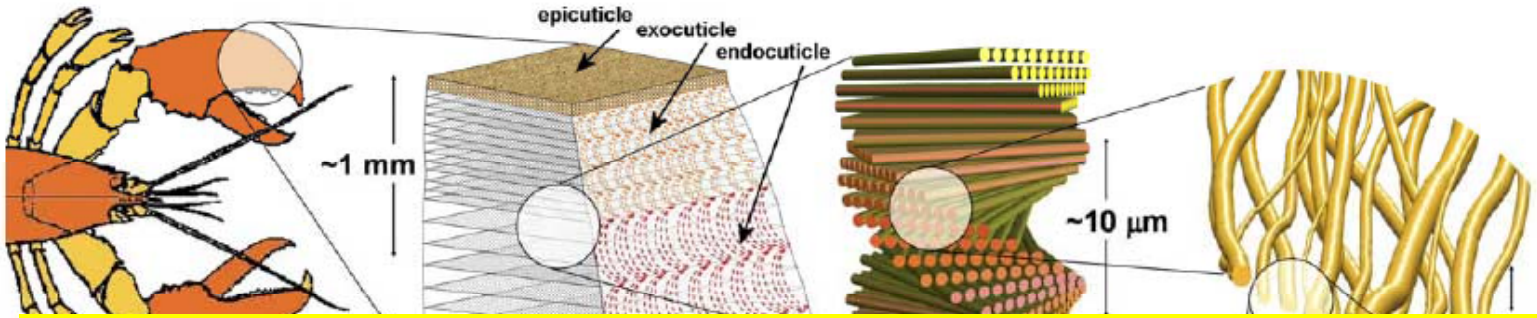
Hierarchy on all lenth scales

Human Vertebral Bone



Hierarchy on all lenth scales

Visionäres



Genießen Sie Ihren Hummer

und

Vielen Dank für Ihre Aufmerksamkeit

Fig. 1. Hierarchy of the main structural levels and microstructure elements of the exoskeleton material (referring to the exocuticle and endocuticle layers) of *H. americanus* (American lobster). The first structure level (Bouligand or respectively twisted plywood pattern) is presented as a cross section through the thickness of the cuticle.