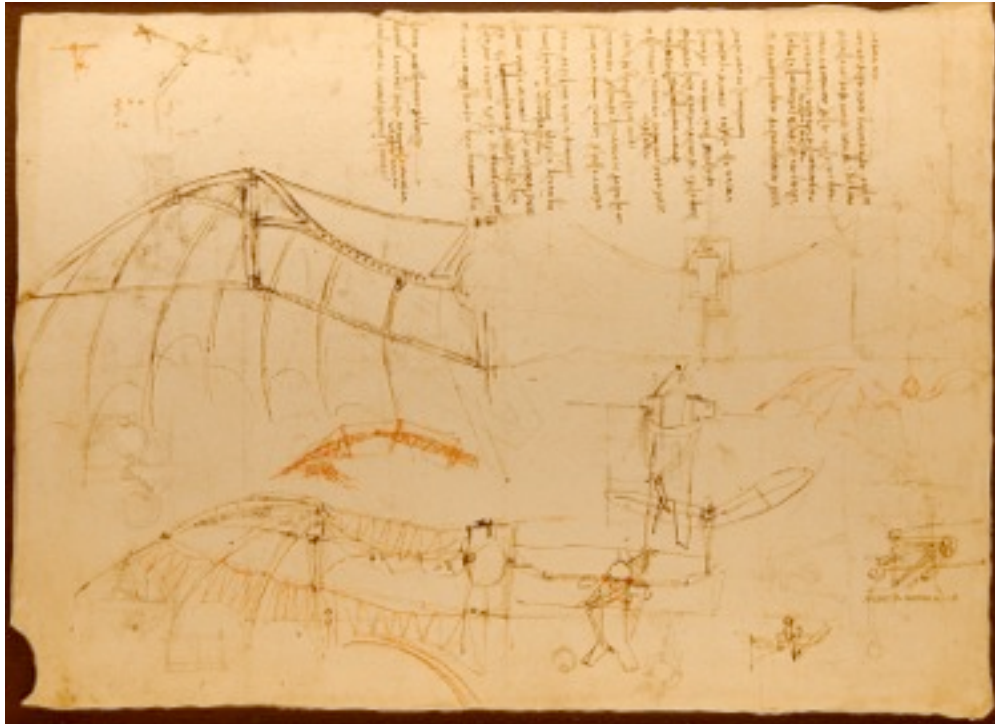


Patents of Nature

Thomas Brodbeck, Biologist, Media Producer, Executive Coach, Dozent





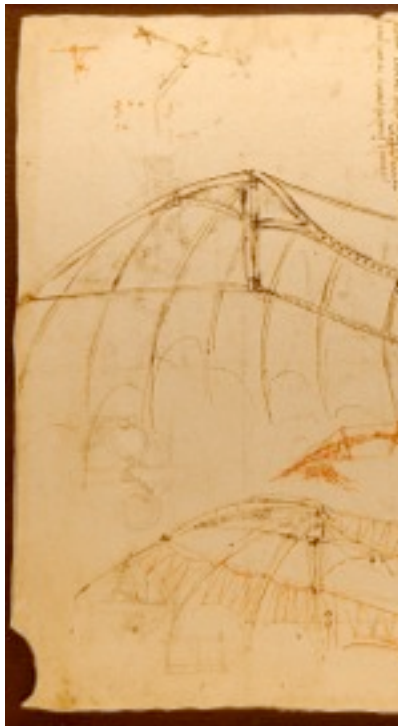
Thomas Brodbeck 25.Sept. 2013



Thomas Brodbeck 25.Sept. 2013



Thomas Brodbeck 25.Sept. 2013

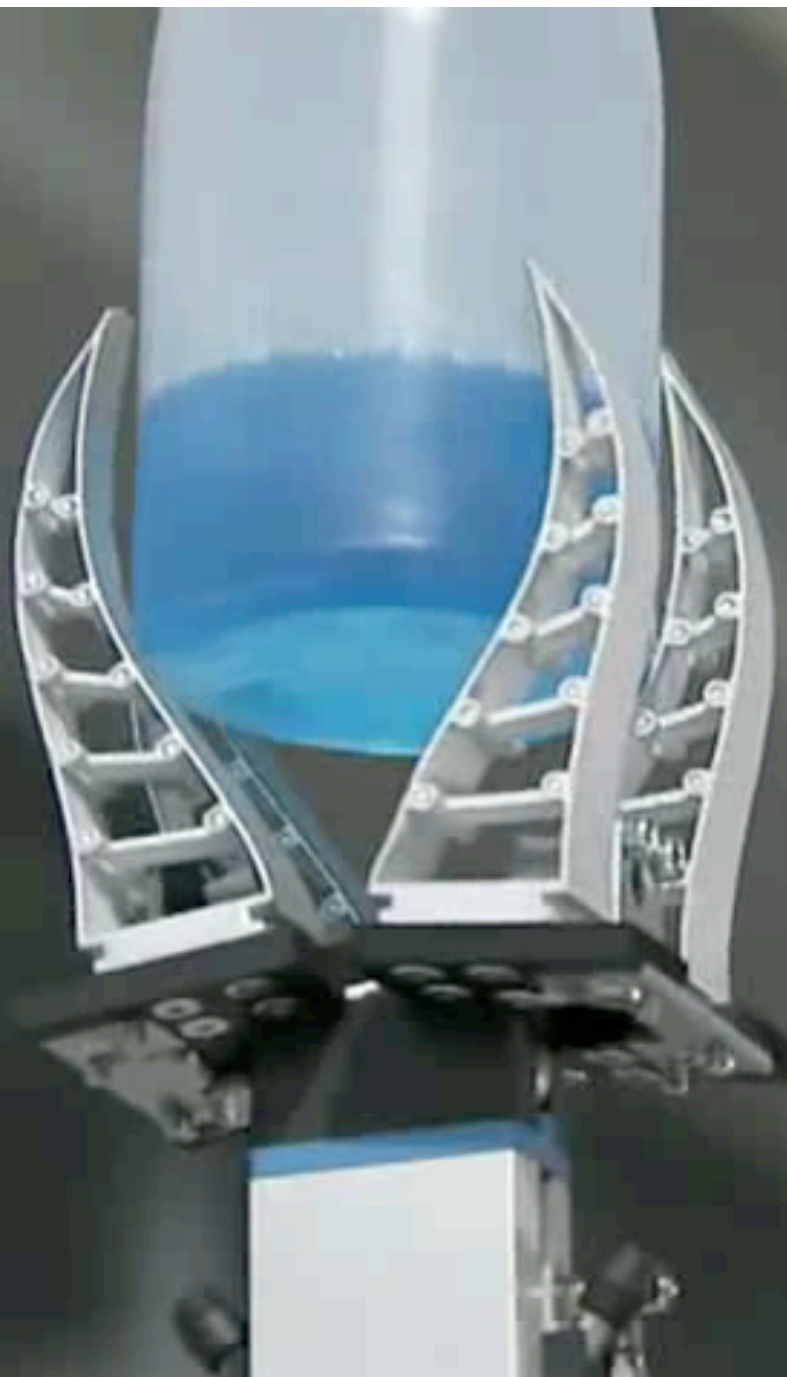


Thomas Brodbeck 25.Sept. 2013



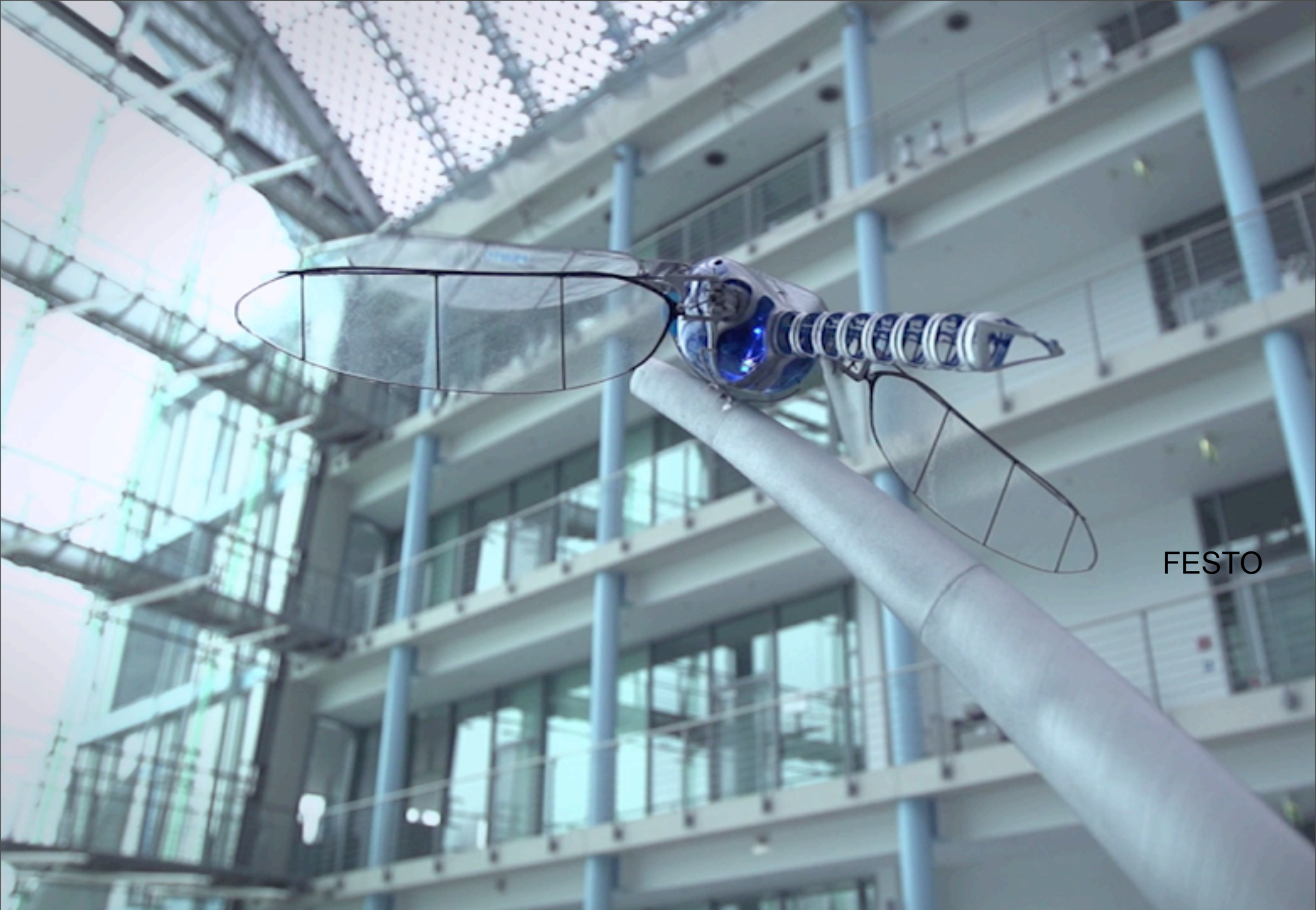
Thomas Brodbeck 25.Sept. 2013

FESTO



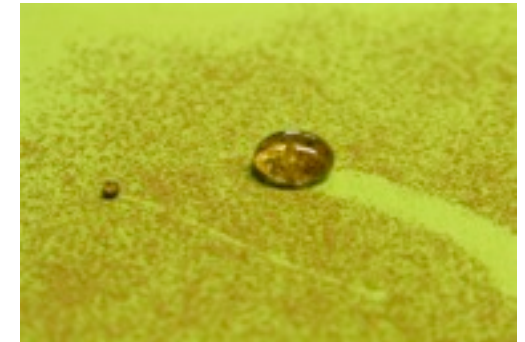
FESTO

FESTO

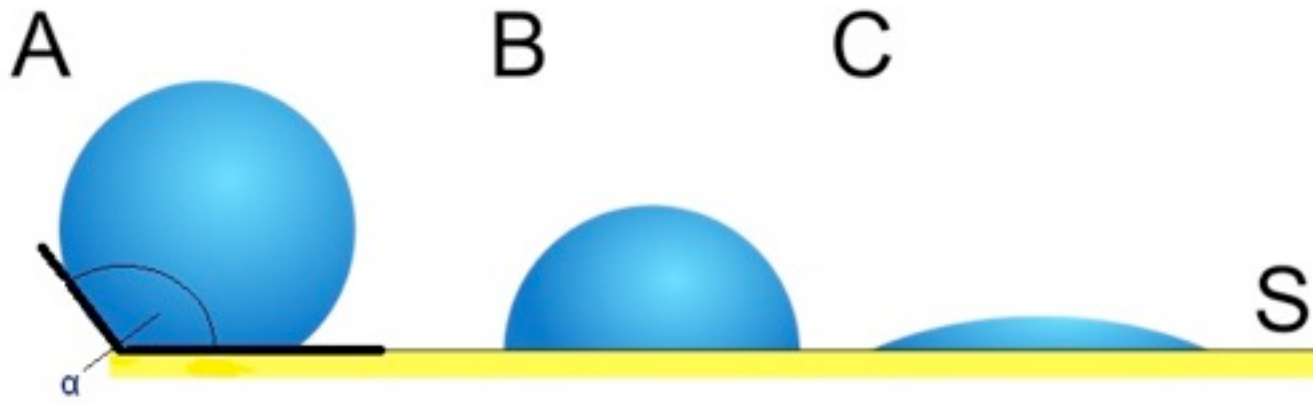


FESTO

1. Lotus



Thomas Brodbeck 25.Sept. 2013



Superhydrophob, $\alpha > 160^\circ$ Hydrophob, $\alpha > 90^\circ$ Hydrophil, $\alpha < 90^\circ$



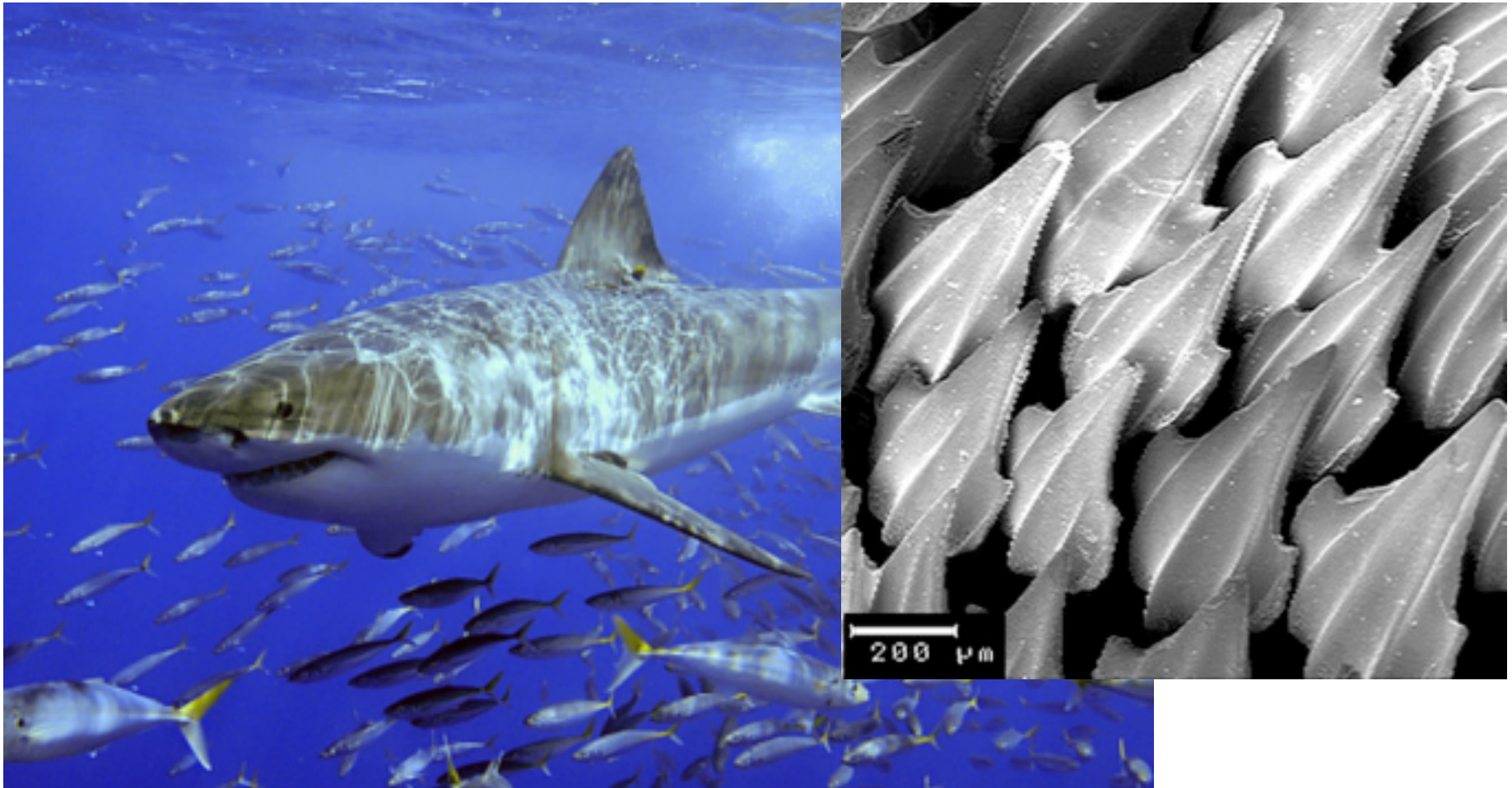


Montag, 14. Oktober 13



Thomas Brodbeck 25.Sept. 2013

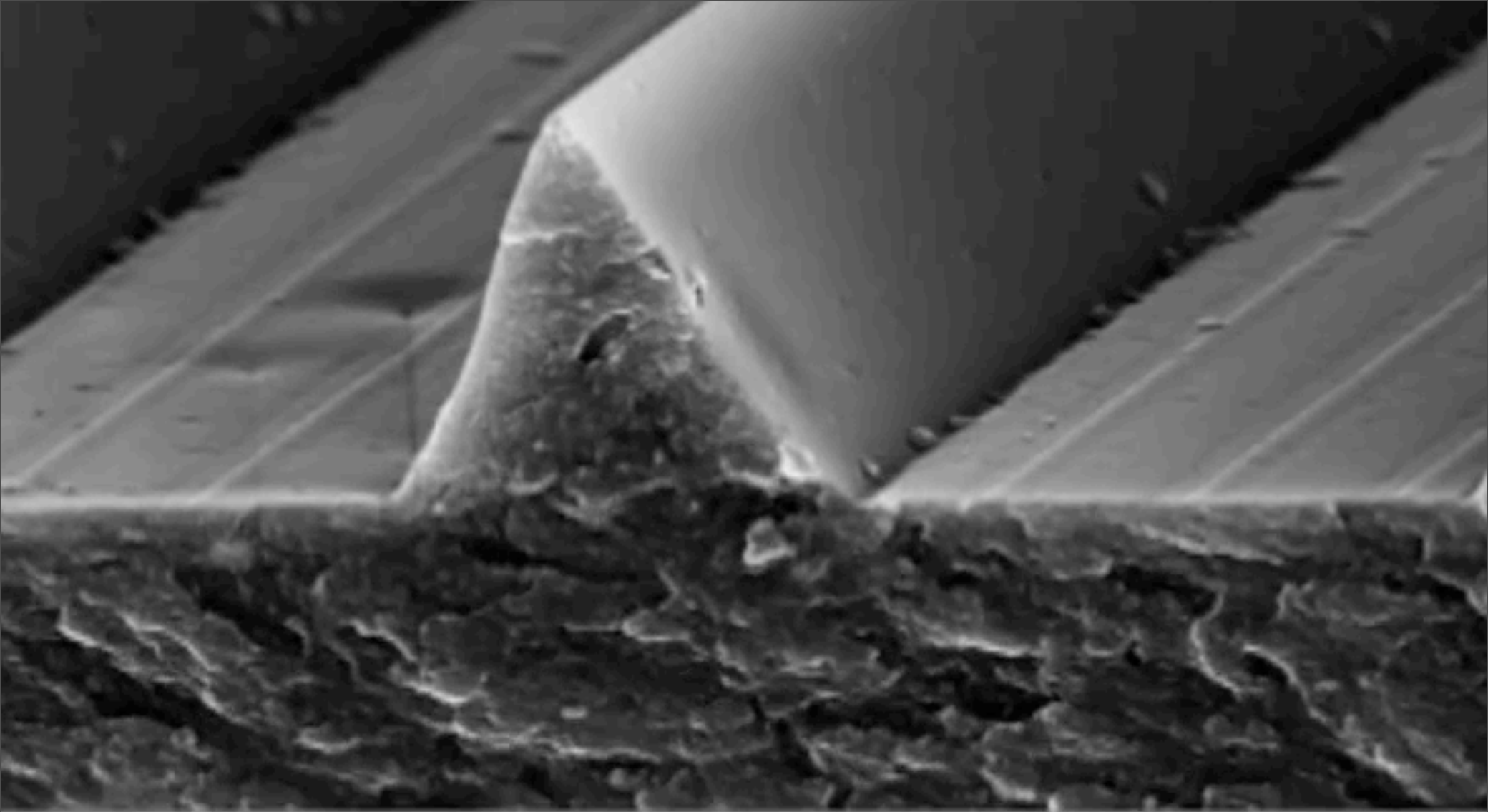
2. Shark Scales



Thomas Brodbeck 25.Sept. 2013



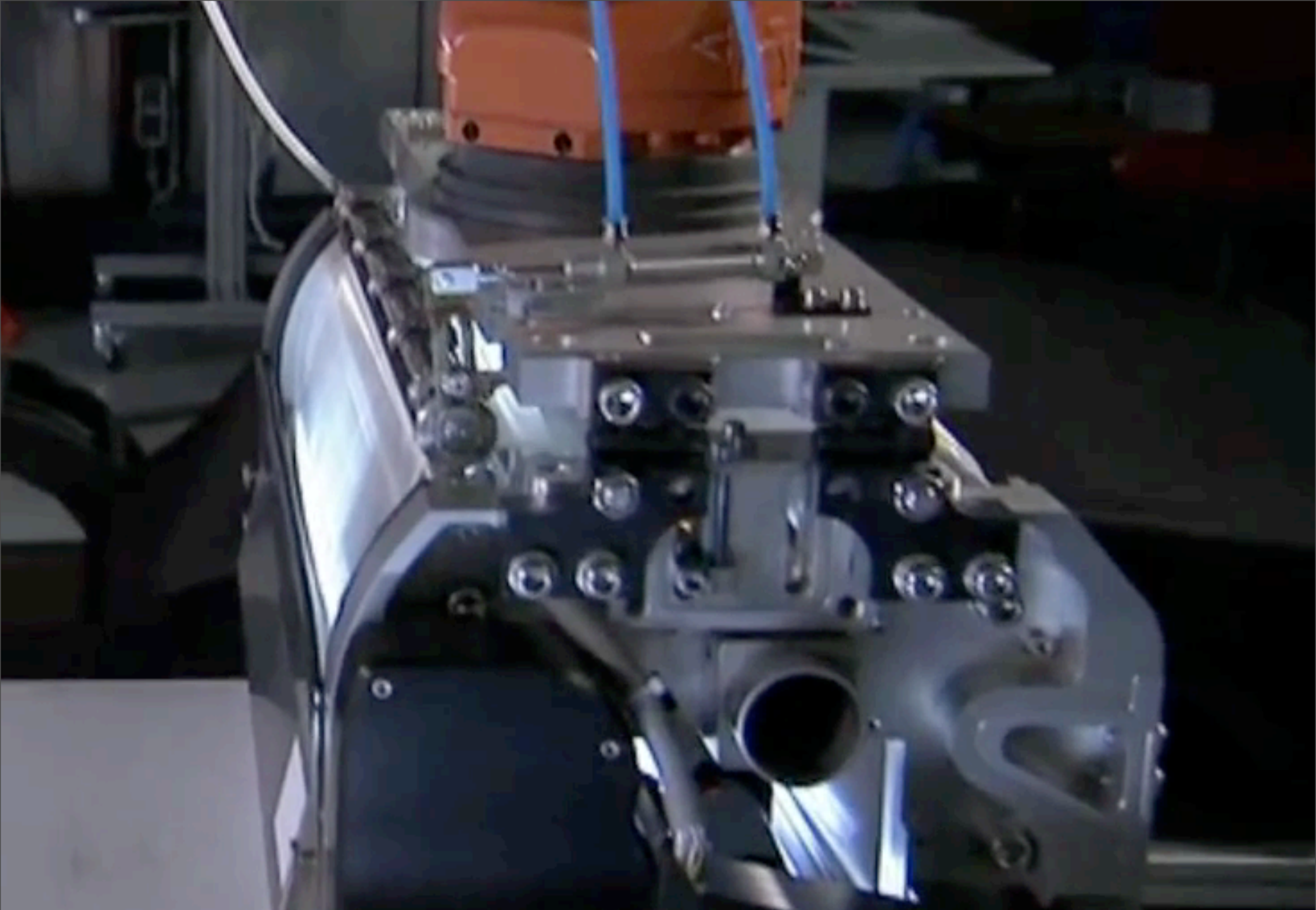
Thomas Brodbeck 25.Sept. 2013



20.00 kV
20 mm

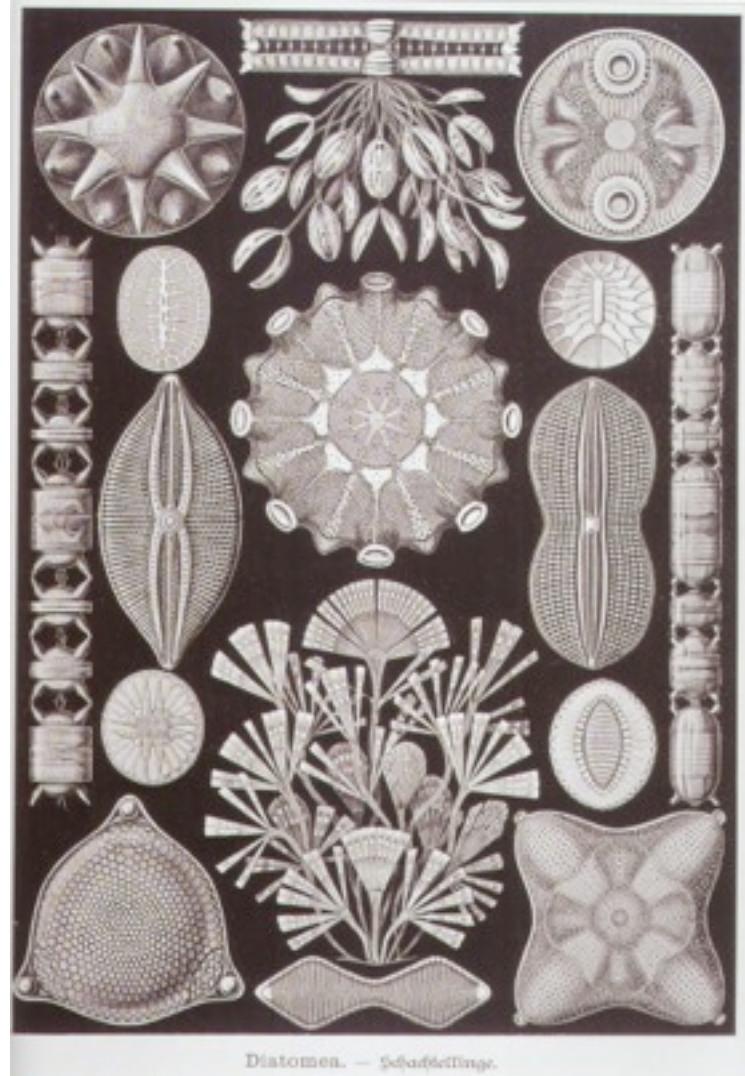
Signal A = SE1
Signal B = SE1

Signal = 1.000
Bild- Nr.: 2010_04662



Montag, 14. Oktober 13

3 Diatoms as a model for sturdy rims



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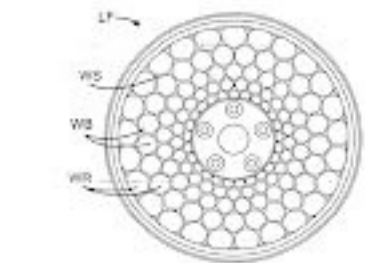
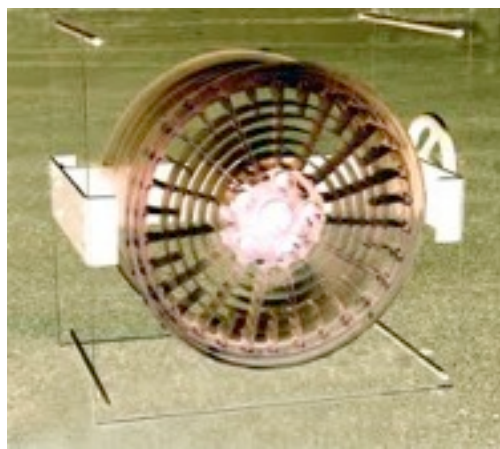
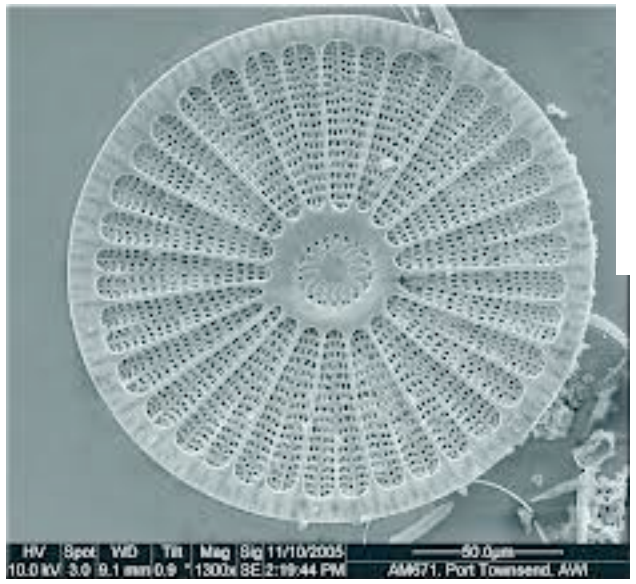


Fig. 13

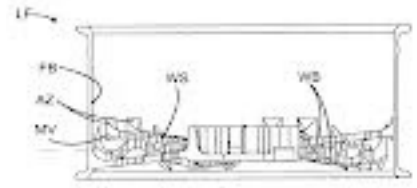


Fig. 14

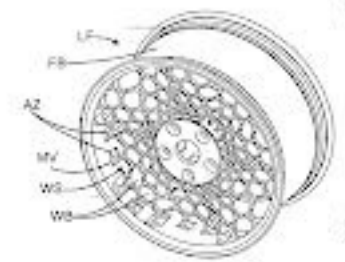


Fig. 15

Dr. Christian Hamm
 Alfred-Wegener-Institut

4. Mussle glue as an ideal adhesive





Thomas Brodbeck 25.Sept. 2013

MUSSEL-INSPIRED 'GLUE' FOR SURGICAL REPAIR AND CANCER DRUG DELIVERY

Mimic of key mussel adhesive protein is harnessed for biomedical applications

text size **AAA**

February 18, 2013 | [by Megan Fellman](#)

EVANSTON, Ill. --- When it comes to sticking power under wet conditions, marine mussels are hard to beat. They can adhere to virtually all inorganic and organic surfaces, sustaining their tenacious bonds in saltwater, including turbulent tidal environments.

Northwestern University's [Phillip B. Messersmith](#) will discuss his research in a talk titled "Mussel-Inspired Materials for Surgical Repair and Drug Delivery" at the American Association for the Advancement of Science (AAAS) annual meeting in Boston. His presentation is part of the symposium "Translation of Mussel Adhesion to Beneficial New Concepts and Materials" to be held from 8:30 to 11:30 a.m. Saturday, Feb. 16.

- See more at: <http://www.northwestern.edu/newscenter/stories/2013/02/mussel-inspired-glue-for-surgical-repair-and-cancer-drug-delivery.html#sthash.5IDDcIan.dpuf>

23.09.13

[Scientists Create Glue Inspired by Mussels] - [VOA - Voice of America English News] - VOA News



February 17, 2011

Scientists Create Glue Inspired by Mussels

by Rosanne Skirble

Sticky, self-healing properties could have far-reaching medical and industrial applications

Have you ever wondered how those hard-shelled mollusks known as mussels anchor themselves to rocks on lake and river bottoms? How they stick to sea walls, or resist pounding waves?

Scientists at the [University of Chicago](#) have done more than come up with some answers. They've actually created a synthetic gel that mimics the mussel's sticky, self-healing properties. Their invention could have far-reaching medical and industrial applications.

[Niels Holten-Anderson](#) - a post-doctoral scholar at the University of Chicago - says mussels do two things really well. They excrete a sticky adhesive and they can use that natural glue to repair the anchoring bond. "And the important thing to remember is that there are no cells. There is no live or living activity taking place inside these materials. The material is basically a dead material, just like our hair," says Holten-Anderson. "So this capacity to re-heal itself is completely automatic, and it's not relying on any energy input from living cells."

Holten-Anderson, his University of Chicago colleagues and a team of international scientists worked on how to turn what mussels create naturally into a synthetic material. They zeroed in on the chemistry of what the

5. The atomic adhesion of geckos

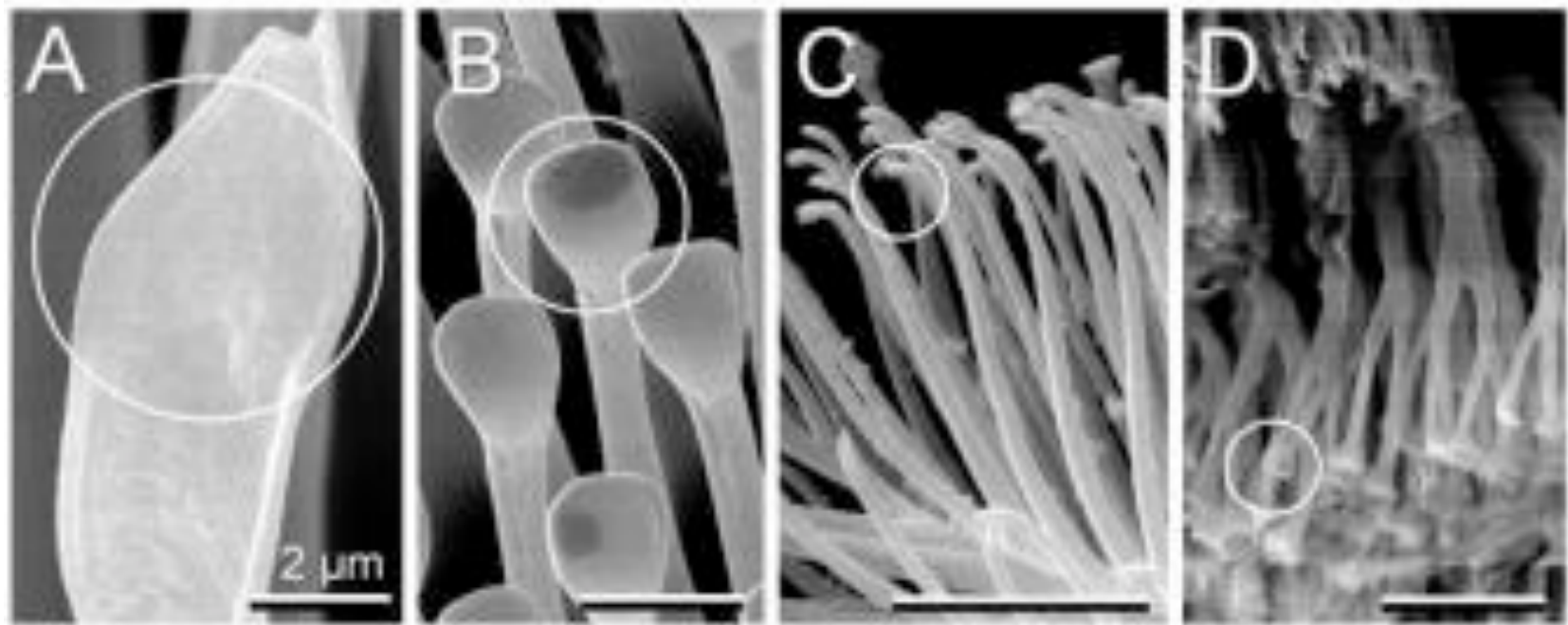


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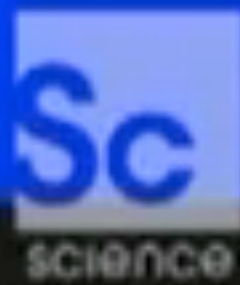
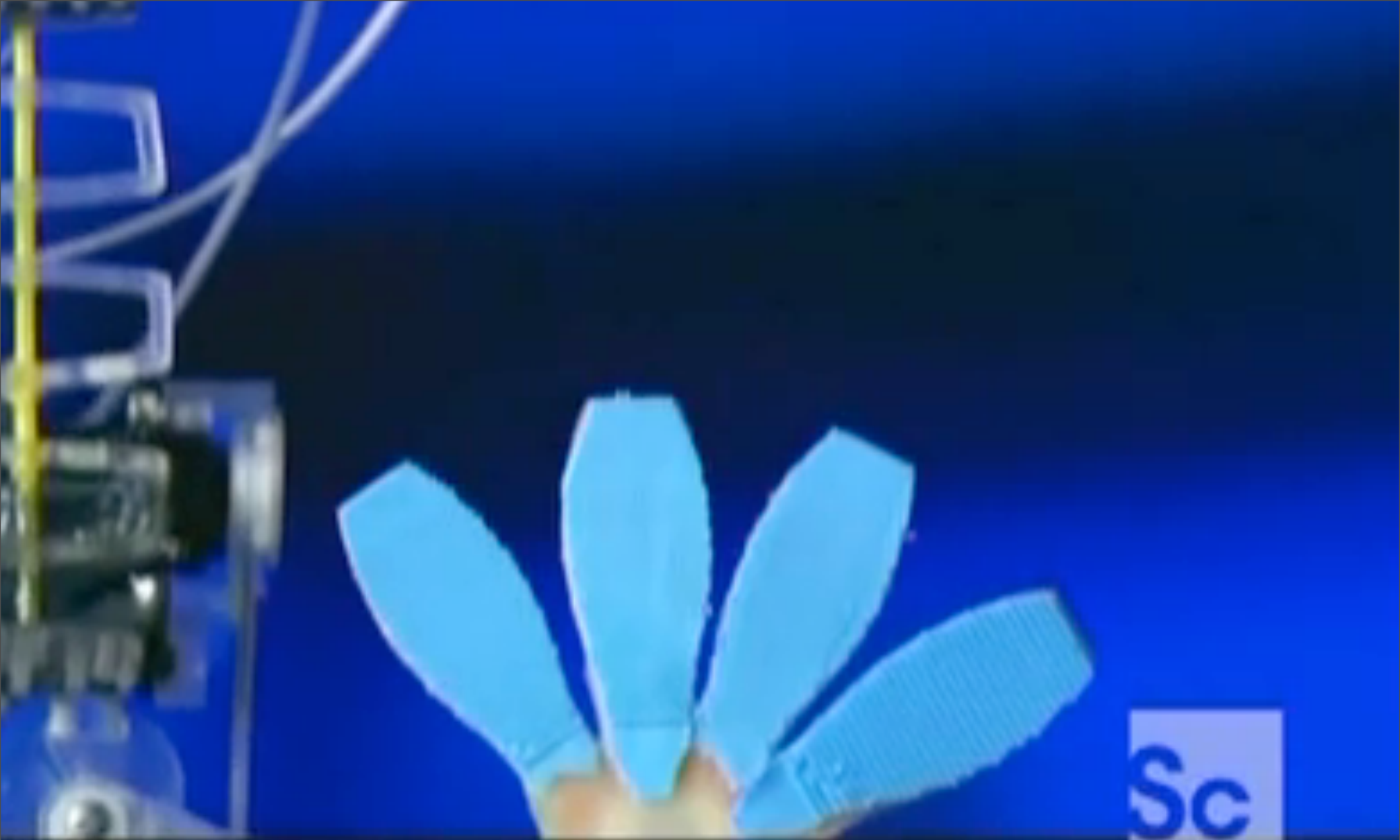


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body mass →



beetle fly spider gecko





Thomas Brodbeck 25.Sept. 2013

6. Friction and abration of the Sandfish

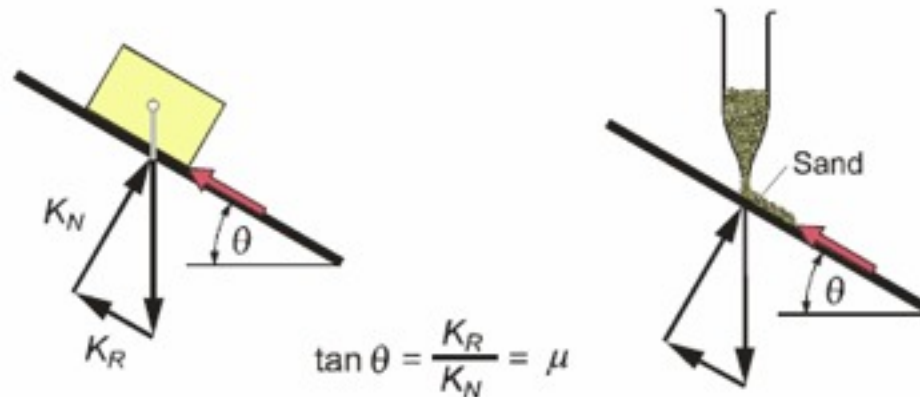
Description and classification

- **Scientific name:** Scincus scincus (spices of skink)
- **Habitat:** Northern Africa, east into Saudi Arabia, Iraq and Iran (mostly in deserts)
- **Size:** usually about 20 centimeters long
- **Colour:** yellow-caramel with brown-black cross bands



Functionality of the skin referring to friction

How to measure friction on a Sandfish skin compared to other materials?

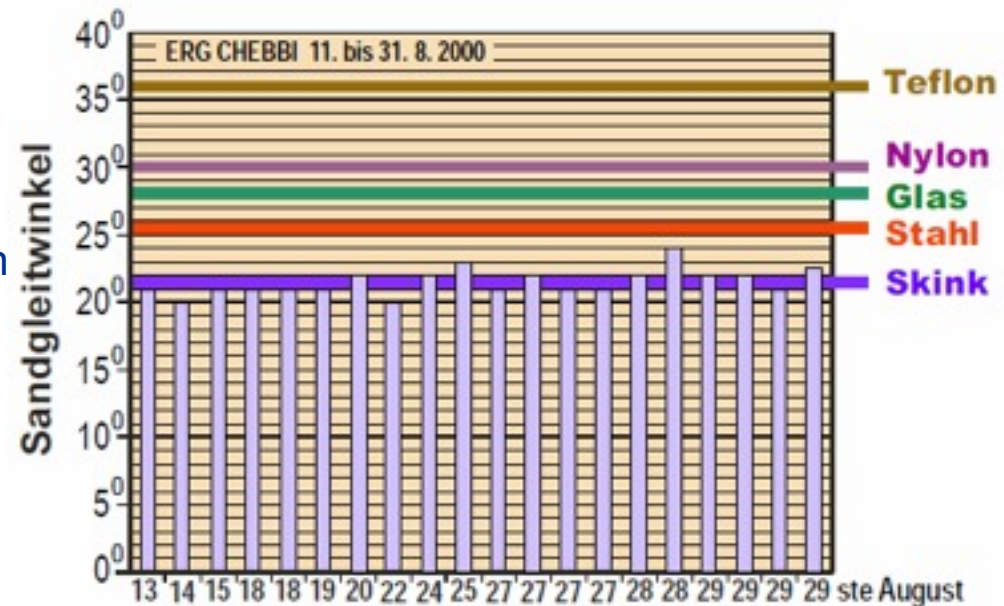


- Sand from a canula ripples on the test surface
- Slowly reducing the angle θ of the surface until the sand stops streaming down
- The tangent of this angle is the coefficient of sliding friction

Functionality of the skin referring to friction

The following results were made:

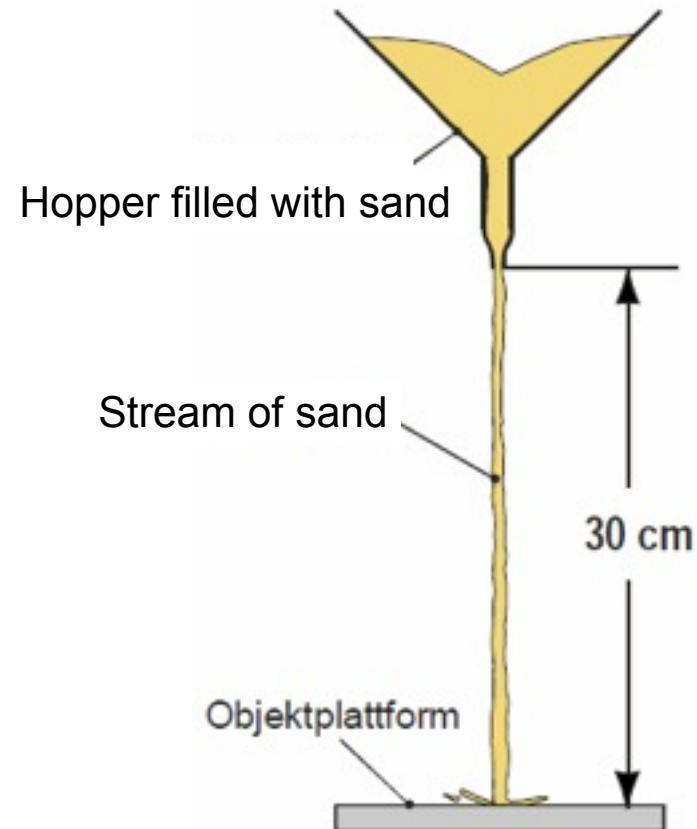
- The average value for Sandfish skin is at about 21°
- Buffed steel has 20% more friction than the skin's skin



Functionality of the skin referring to abrasion

To measure the abrasion of different surfaces a special device was built:

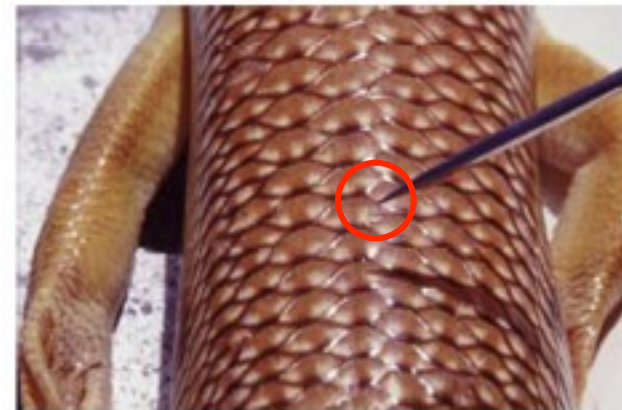
- Sand is filled into a hopper
- In a height of 30cm above the tested surface
- A constant stream of sand hits the surface for 10 hours



Functionality of the skin referring to abrasion

Result after 10 hours:

- Sandfish skin did not show any signs of abrasion: (Needle shows the point where the stream hit the skin)

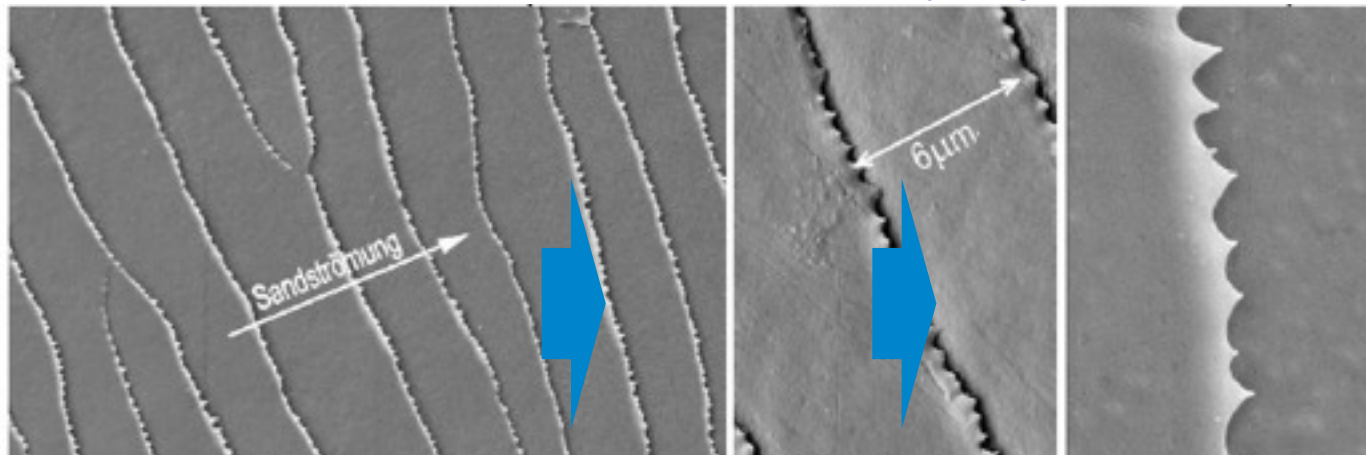


- Steel (a) and glass (b) showed clear signs of abrasion:



Patents by Sandfish

Reasons for this behaviour can be found on every single scale:



Source of picture: "Der Sandfisch der Sahara – Vorbild für Reibungs- und Verschleißminderung" by Ingo Rechenberg and Abdullah Regabi El Khyari

- Small spikes cover the surface of a scale
- Alignment across the grain of the sand
- Distance between two close-by spikes: 400nm

Reasons for the observed circumstances

Now taking the size of a grain of sand into consideration:

- The average external diameter of a grain of sand is $250\mu\text{m}$
- A single grain of sand would touch 20.000 spikes at once

→ This reduces the area of contact by 1 : 20.000

- Unevenness of a grain leads up to an effective area of contact of 1 : 2.000.000

Fields of application

The most important application might be a foil to cover solar panels.

- Bigger areas covered with solar panels will be in or close by deserts
 - Sand settles on these panels over time
 - Reduces their efficiency
 - Abrasion appears on the panels because of sand storms
- Friction-reducing foil would reduce both effects

• Some more examples of technical applications:

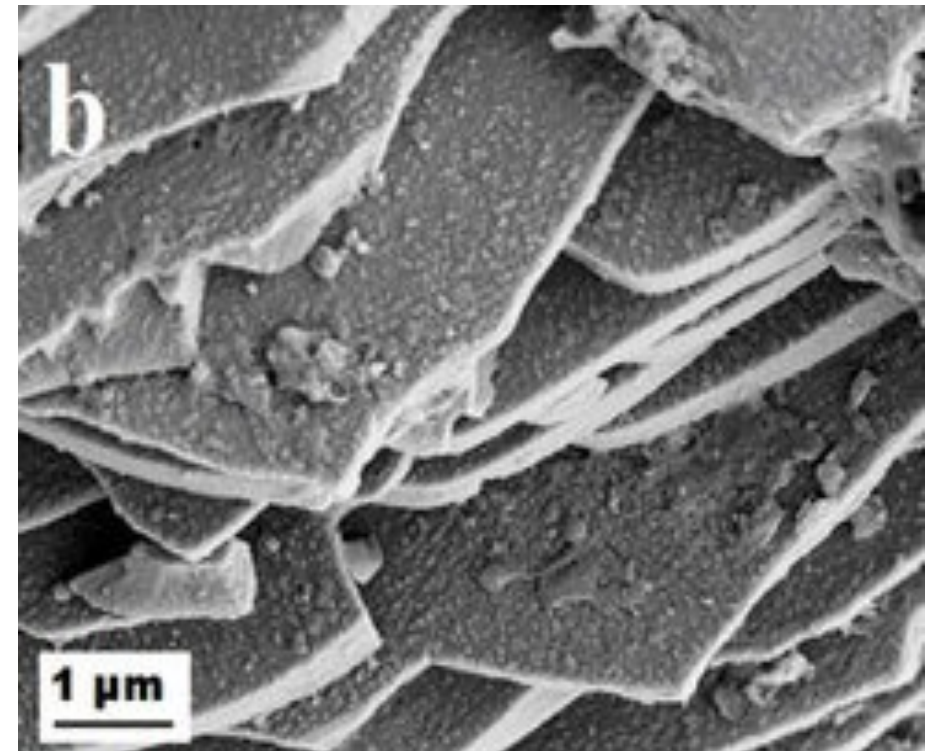
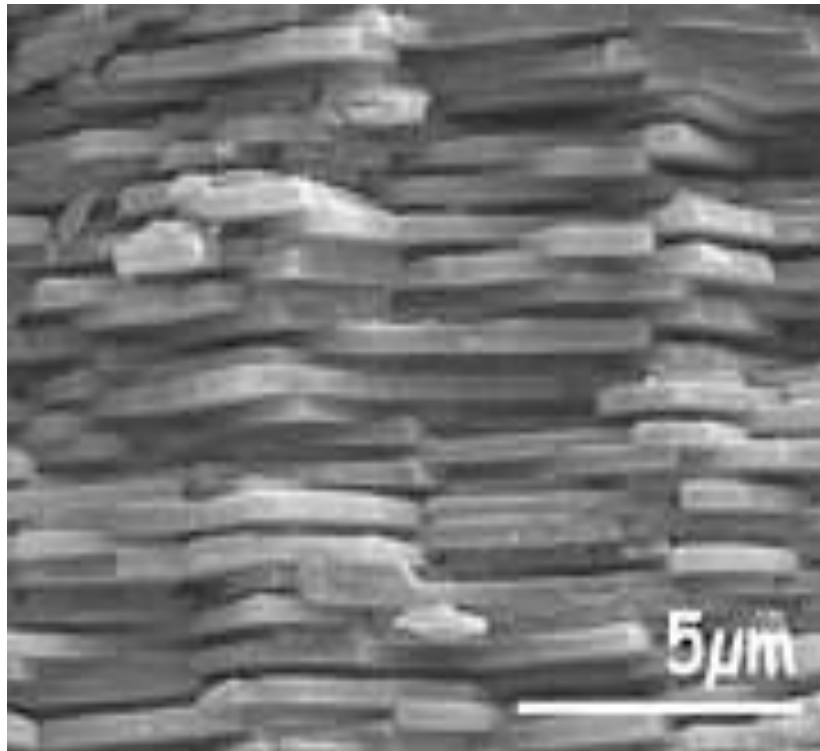
- Abrasion-proof touch-screens
- Abrasion-proof plastic bottles
- Abrasion-proof paint (cars, ships, ...)
- Friction-reduced mechanical seals
- Friction-reduced cylinders (engines)
- Friction-reduced pipelines

Source: <http://www.reallynatural.com/pictures/brightsource-thermal-solar.jpg>



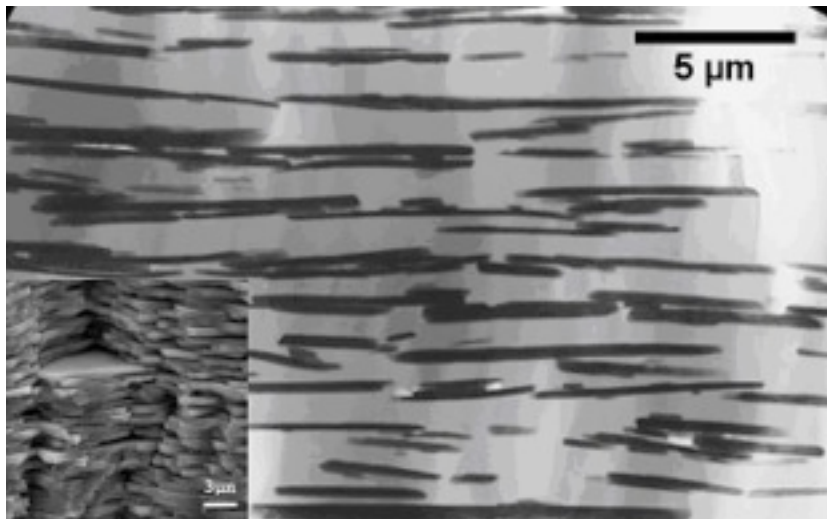
7. Nacre as an ideal composite material





Aragonit and Chitin like a Brickwall or Composites and mortar structur

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ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

**New composite material
Almost better than
mother-of-pearl**

**Strong, tough but light is
the rare but desired
combination of properties
for numerous artificial
materials. Now a new
material is similar to
natural mother-of-pearl,
but twice as strong.**



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8. Spider silk as high-tech material



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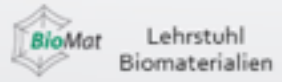
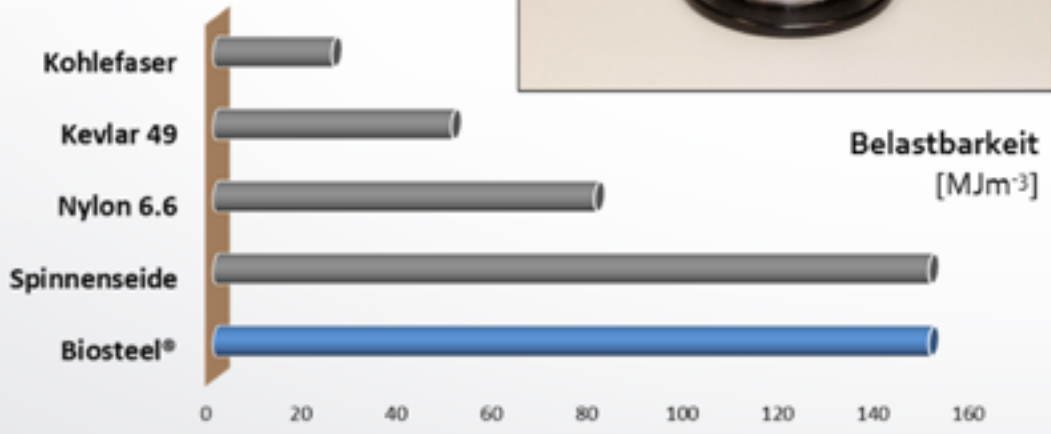
Compare with other devices

| | tensile strength | elongation propert. | max. load |
|---------------------|---------------------|---------------------|------------------------------------|
| Material | Zugfestigkeit (GPa) | Bruchdehnung (%) | Belastbarkeit (MJ/m ³) |
| Drag line | 10 | 30 | 160 |
| spider-web thread | 0.5 | 270 | 150 |
| Silkworm thread | 0.6 | 18 | 70 |
| Rubber | 0.05 | 850 | 100 |
| Nylon ¹ | 0.95 | 18 | 80 |
| Steel ² | 2 | 26 | ? |
| Kevlar ¹ | 3.60 | 2.7 | 50 |

1 Quelle: http://daten.didaktikchemie.uni-bayreuth.de/umat/proteine_spinne/spinnenseide.htm

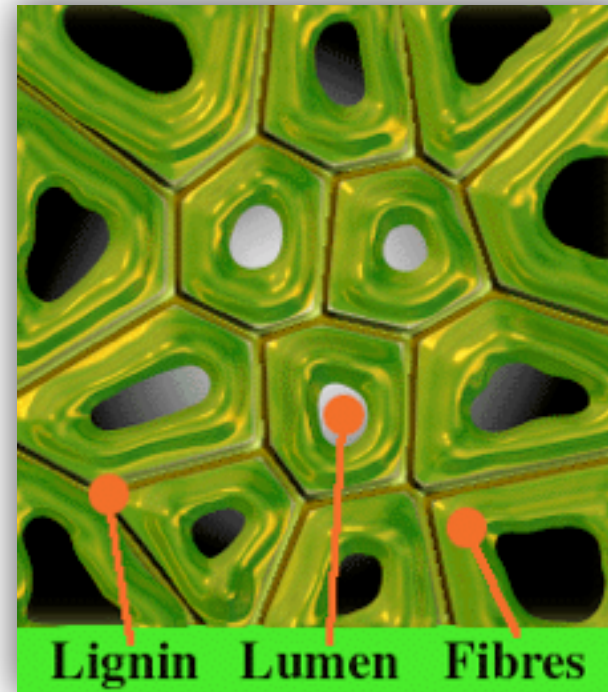
2 Quelle: <http://www.swiss-composite.ch/pdf/i-Werkstoffdaten.pdf>

Biosteel®



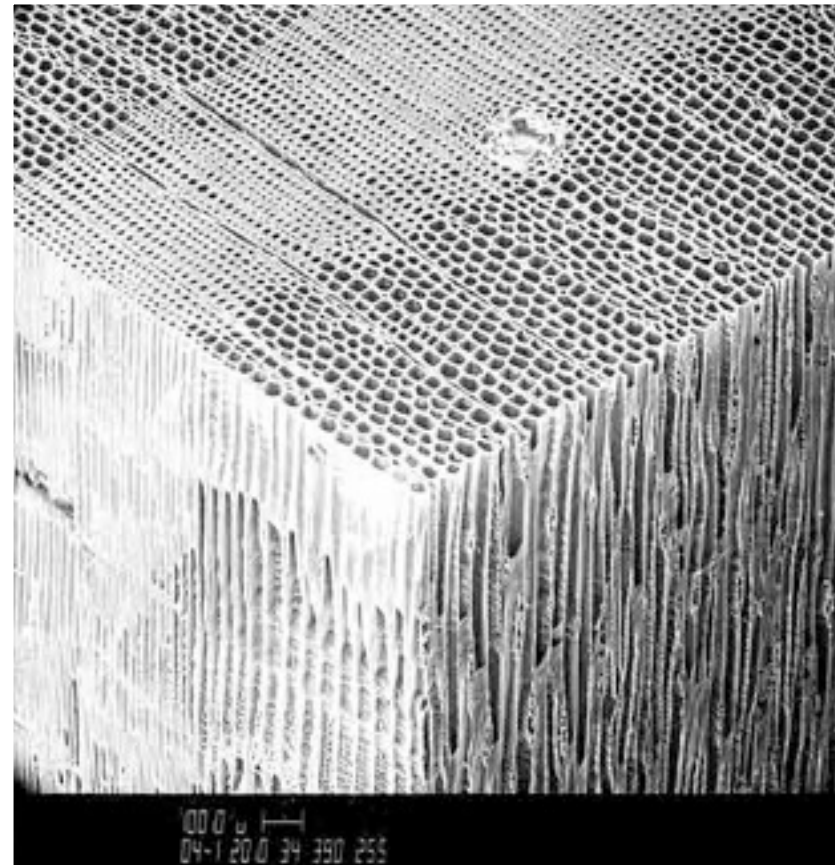
9. Lignin as an alternative to plastics

- Cellulose fibers:
 - Tearproof
 - Give tensile strength
- Lignin:
 - Keeps fibers together
 - Gives compression strength



9. Lignin as an alternative to plastics

- Cellulose fibers:
 - Tearproof
 - Give tensile strength
- Lignin:
 - Keeps fibers together
 - Gives compression strength



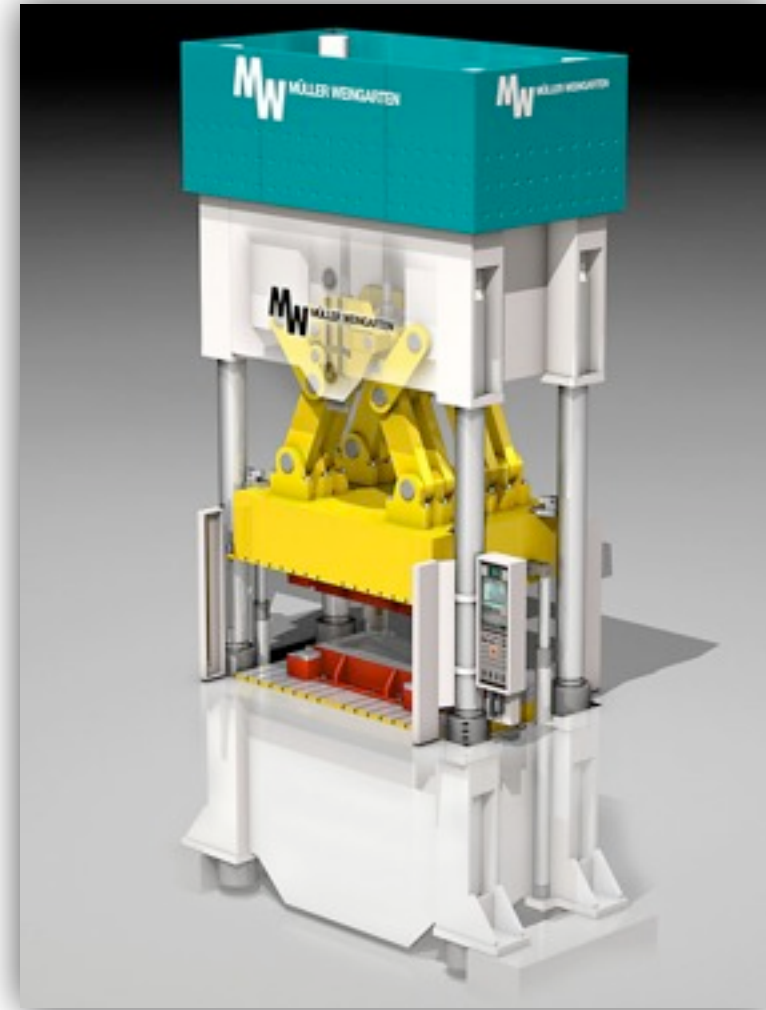
ARBOFORM – “Liquid Wood”

- New bionic material
- Competitor of plastics
- On the basis of 100% natural ingredients



Finishing

- ARBOFORM can be handled like classic plastics:
 - Injection molding
 - Deep drawing
 - Extruding
 - Compression molding



Properties

- The combination of natural fibers and Lignin makes ARBOFORM very strong
- The wooden expansion coefficient causes ARBOFORM excellent lamination properties

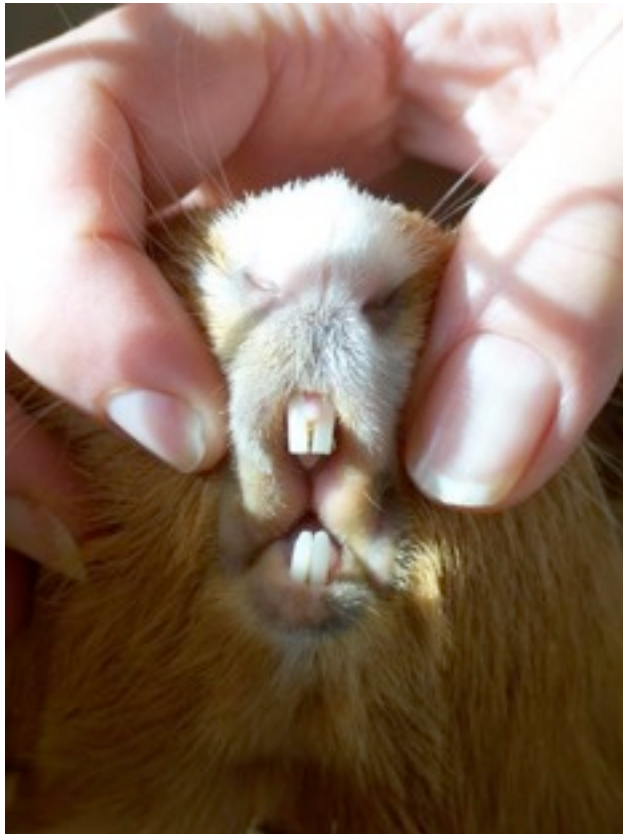
| | Polypropylene | ARBOFORM | Wood (beech) |
|--------------------------------|----------------------------|--------------------------------|-----------------------------|
| E modulus [N/mm ²] | 600–1700 | 2000–6000 | 1500 |
| Expansion coefficient [1/K] | 100–200*10 ⁽⁻⁶⁾ | 18–50*10⁽⁻⁶⁾ | 45*10⁽⁻⁶⁾ |

Car dashboard inlays



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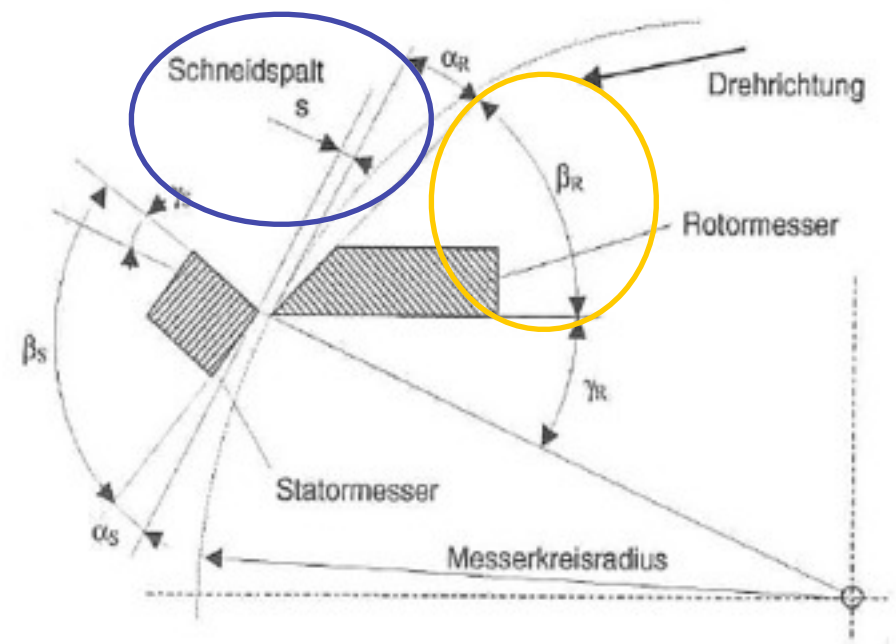
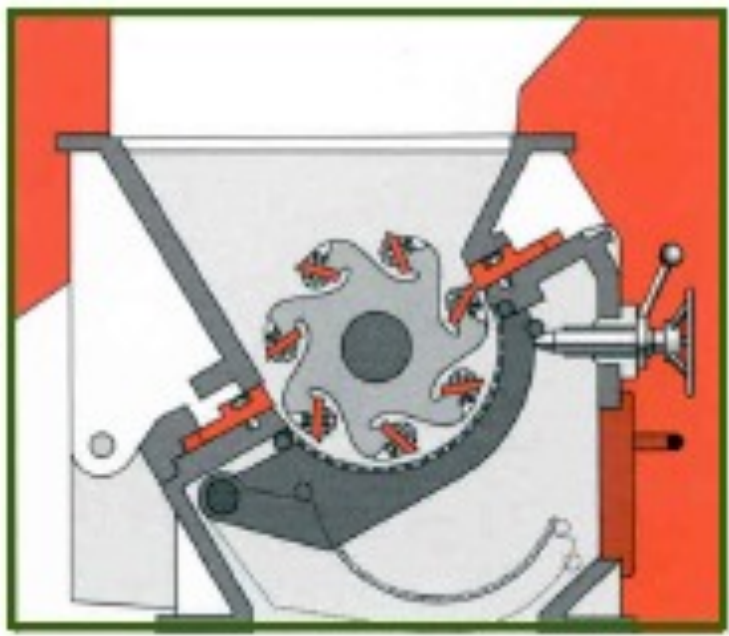
10. Self-sharpening knives following the basic patent of beaver teeth



- **Bionicproject Fraunhofer Institut, Marcus Rechenberger**
- **Patents of Nature**
- **Materials and technical adaption**
- **First technical system: cutting mill**
- **Cutting knife**

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cutting mill



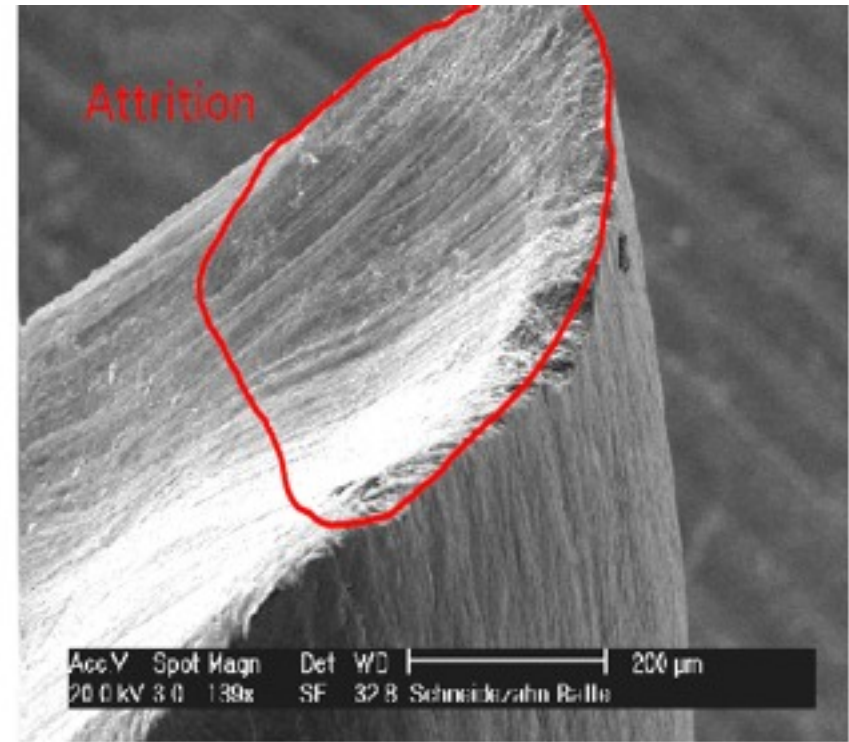
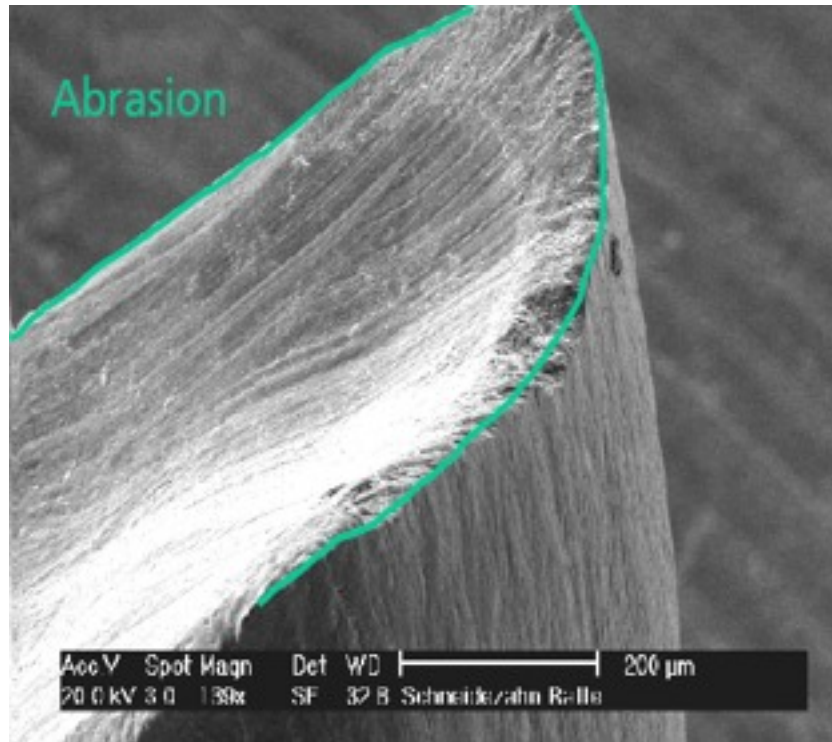
Problem

- Cutting edges loose its sharpness and has to be sharpen
- new adjustment of the tool
higher cost, loosing time

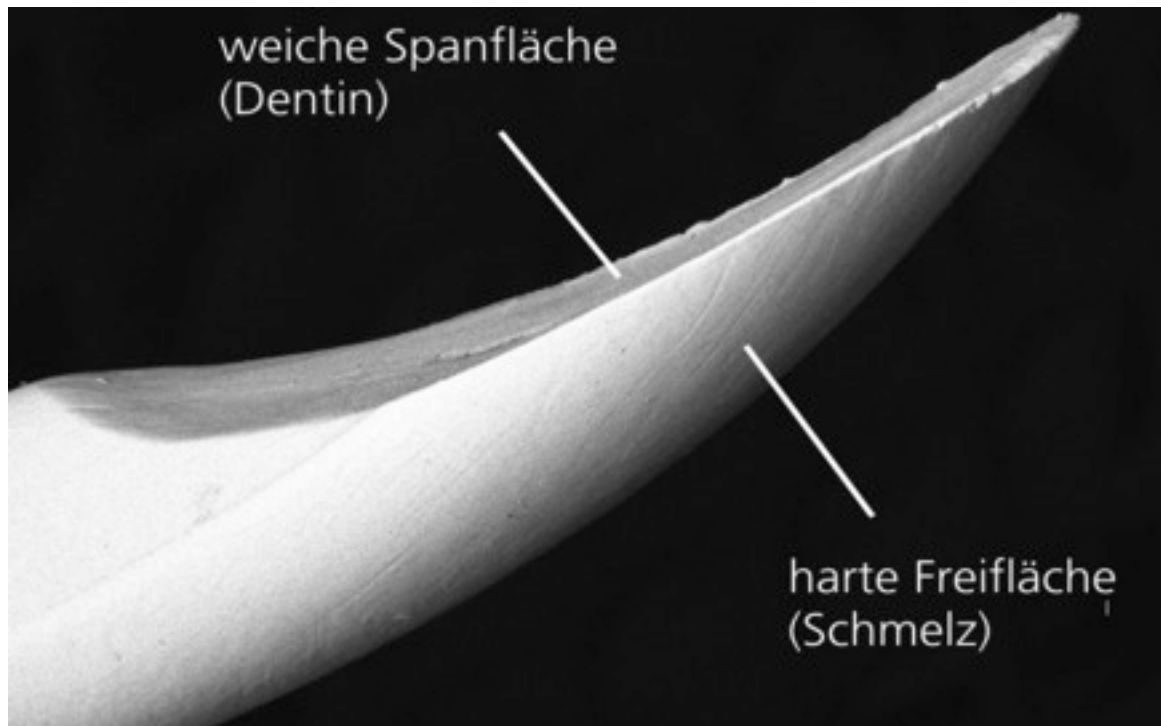


Rodent-Tooth

permanent sharpness through
permanent useage



Soft Dentine



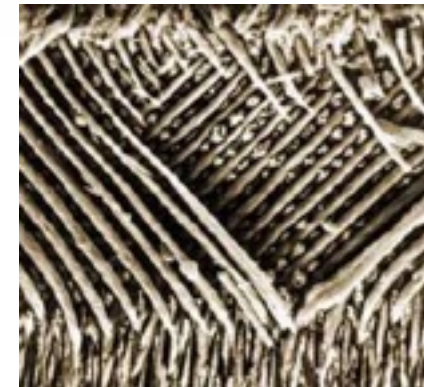
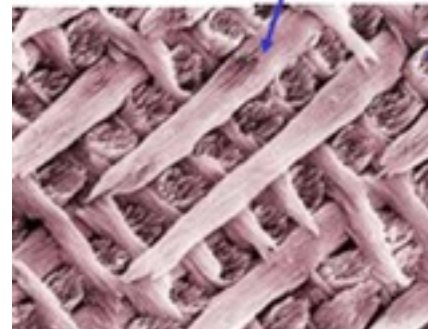
Extrem hard enamel

Enamel Typ 1:

Hunter-Schreger-Ligaments

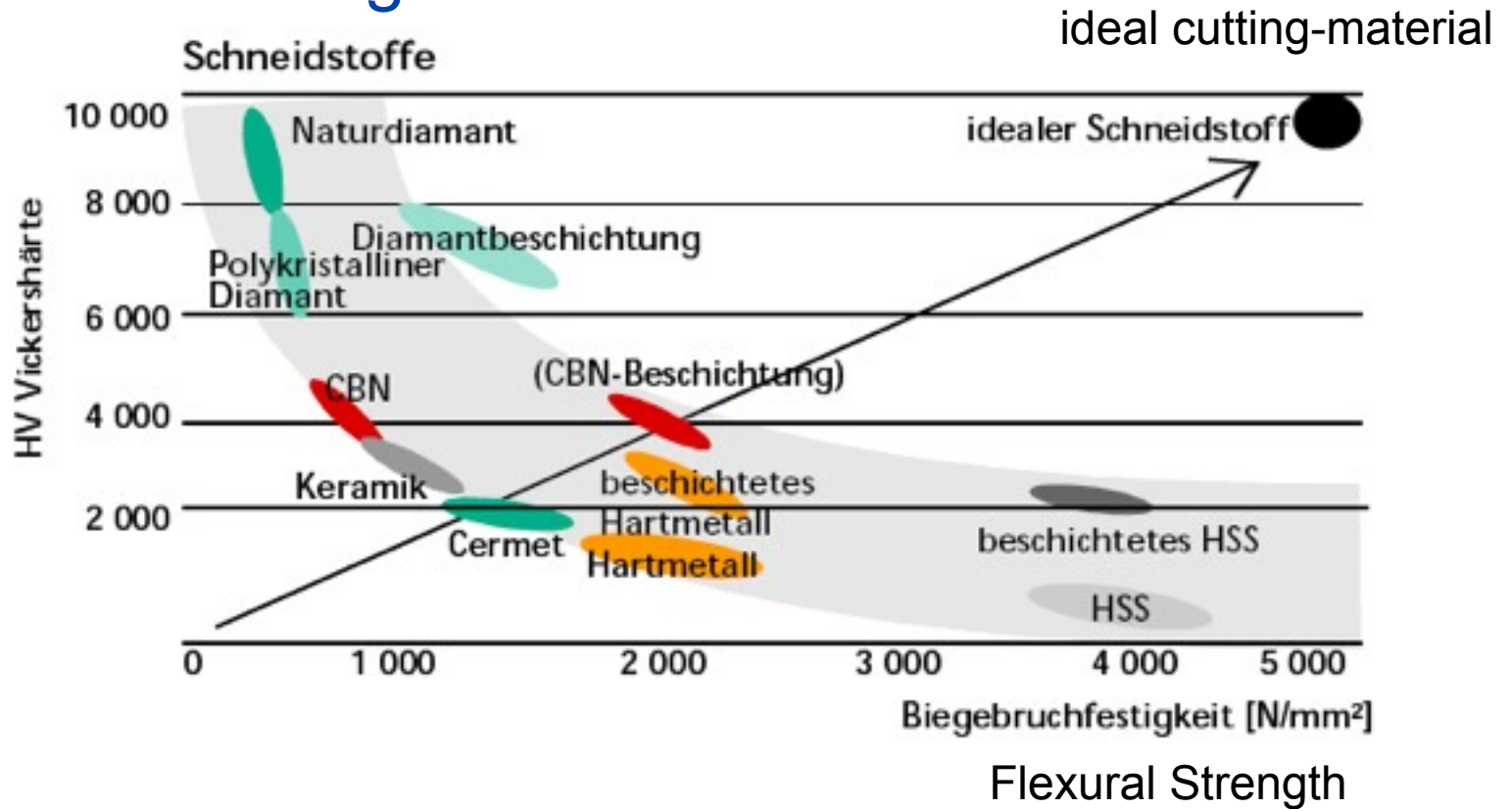
Schmelz bestehend aus
- Prismen
- IPM - Interprismatische Matrix

nadelartigen
Hydroxiapatit-Kristallite

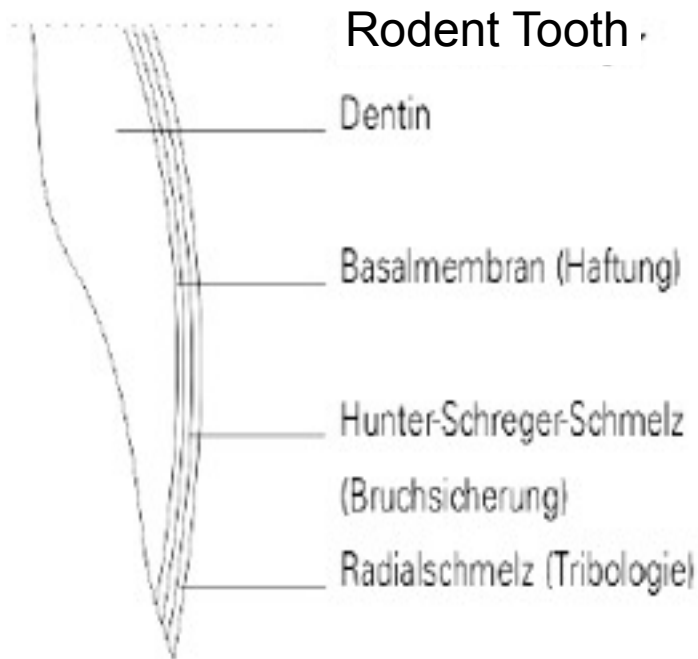


Cutting Material

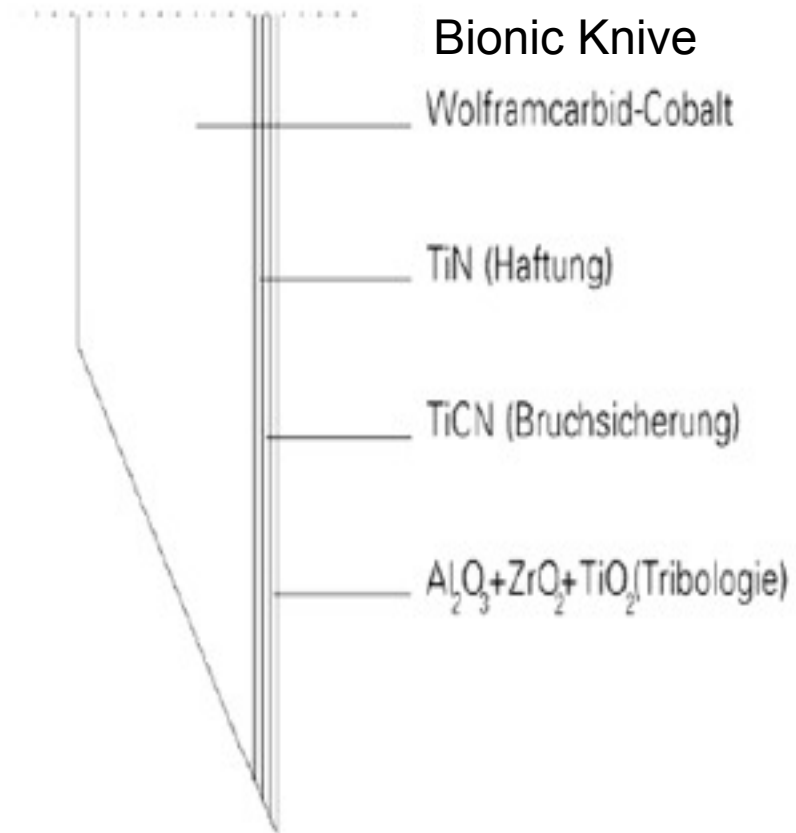
Vickers-Hardness



Rodent-Tooth



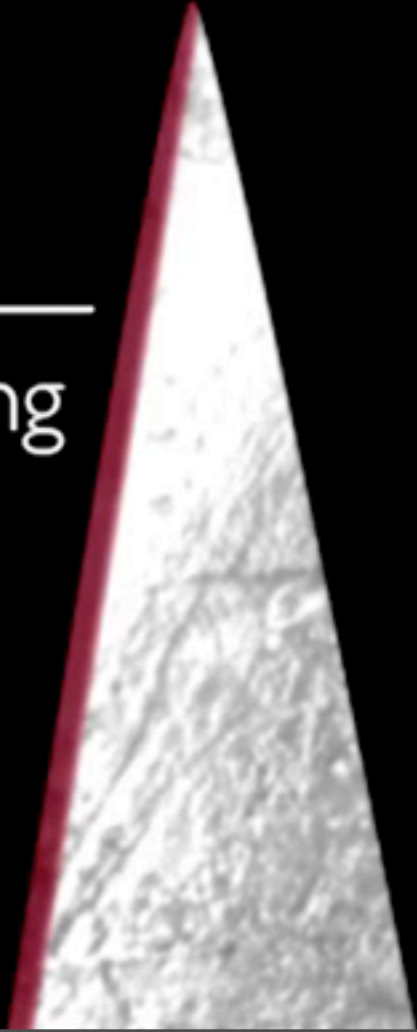
Self-sharpening cutting knives







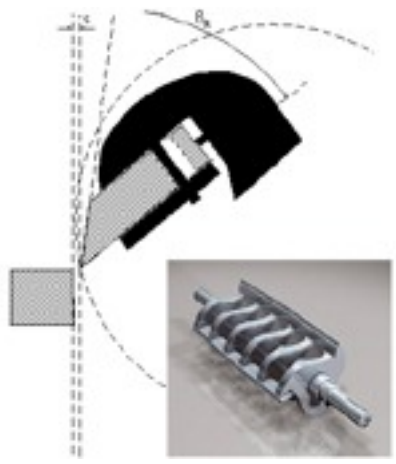
ultraharte _____
High-Tech Beschichtung



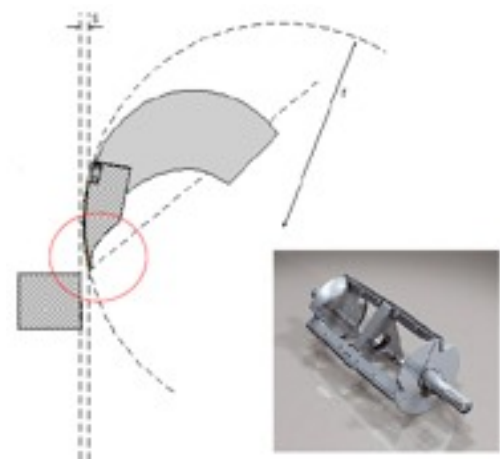
Konstruktionsprinzipien mit Darstellung der Klingenschnitts und der unterschiedlichen Stahllagen



conventional cutting-mill



bionic cutting-mill



30 Times longer sharp!



© Ryo Mizuno/Jan 14/07/2009



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SCIENCE

TOPICS

Space

Environment

Innovation

Weird science

search topics

WEIRD SCIENCE

How plants use quantum physics to boost photosynthesis

How plants use quantum physics to boost photosynthesis

SPACE-TOURISM

Bezos in space? 'I definitely want to go,' says billionaire

Katia Moskvitch, LiveScience,

June 27, 2013 at 9:45 PM ET

COMETS

NASA to keep protective eye on Mars spacecraft as comets buzz by

Humans can't teleport or reside in multiple places at once — but the tiniest particles of matter can.

EARTHQUAKE

Pakistan earthquake creates new island, 'mud volcano' to blame

These **eerie quantum effects** have traditionally been studied and observed only under the strictly controlled conditions of a physics lab. That is, until some scientists suggested that such weirdness also

AQUARIUS

Age of Aquarius: See the famed constellation in night sky this week



ICFO

This molecular diagram shows how "antenna proteins" capture photons from the sun. Researchers say the

23.09.13

BIOKON - Bionics Competence Network



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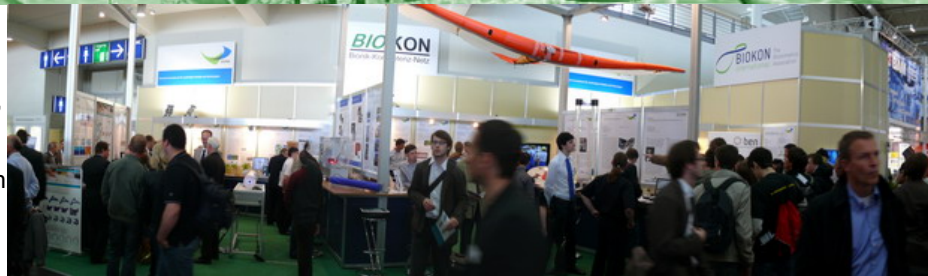
Bionics/Biomimetics
 The word bionics is made up of the terms **biology** and **technics**, which means engineering in this context. The approach of combining biology and engineering is often also called biomimetics in English. As a scientific discipline, bionics aims at analyzing biological systems and transferring the underlying principles into technical implementations.

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BIOKON
 The Bionics Competence Network **BIOKON** is an association of the most important research groups in the field of bionics in Germany.

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BIOKON e. V.
 The registered society **BIOKON e.V.** is the organisational body which coordinates all



BIOKON - Competence in biomimetics

Bionics



Are you looking for competent information on bionics?

- **Definition**
- **Literature (approx.100 books)**
- **Products**
- **Projects**
- **Universities**
- **Schools**
- **People**
- **Centers**
- **Examples**
- **Research**
- **Competences (approx.500 catchwords)**
- **Solutions - Examples**
- **Exhibitions and Shows**
- **FAQ and Jobs (approx.30 offers)**
- **Advisory board**
- **Sitemap**

Industry



Is it worthwhile for your company to develop bionic products?

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Would you like to study or teach bionics?

Members



Are you looking for a particular person or member of *BIOKON*?

The nationwide Bionics Competence Network (*BIOKON*) is the ideal forum for anyone interested from business and industry, the field of education, or the media to find a

Research

Wie ein Haifisch im Wasser Ein perfekter Nässeschutz Wer nicht sehen will, muss fühlen

[► Read on](#)

Events

vom 20.09. bis 23.09.2012
BIT Congress Inc.- 2nd Annual World Congress of Marine Biotechnology (WCMB-2012) vom 16.06. bis 20.06.2013
Fourth International Conference on Self Healing Materials (ICSHM2013) 13.08. - 16.08.2013
4th International Conference of Bionic Engineering (ICBE 2013) 13th to 16th August 2013
4th International Conference of Bionic Engineering (ICBE 2013) vom 03.09. bis 05.09.2013
9. Thüringer Grenz- und Oberflächentage, ThGOT 14 - 15 September 2013
Annual Int. Conf. on Biologically Inspired

THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS?



Thomas Brodbeck 25.Sept. 2013

INDICATION OF SOURCE

www.youtube.com