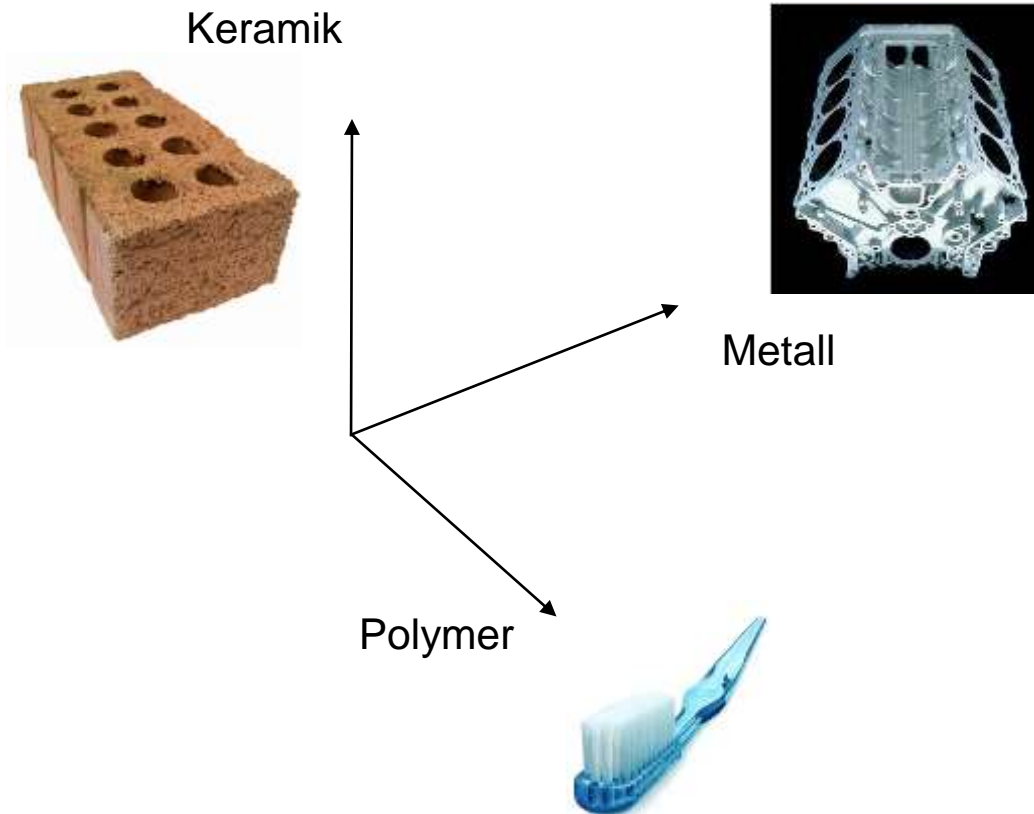


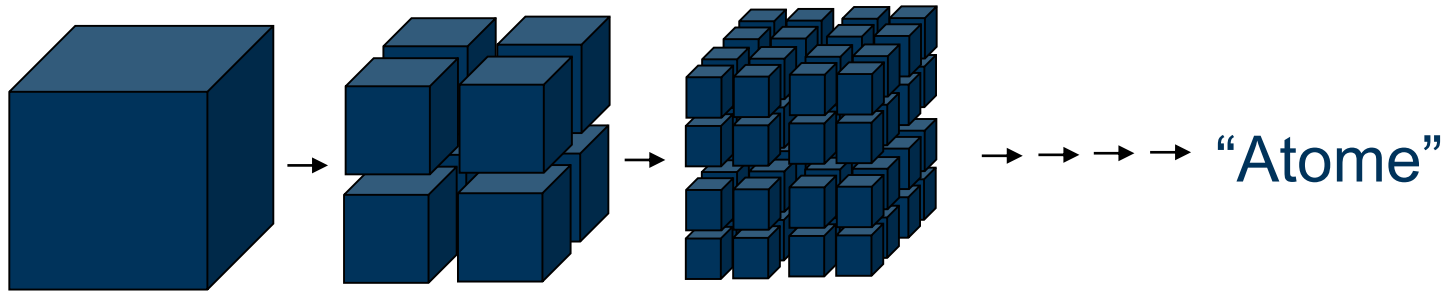
**Angewandte Nanotechnologie**  
**für sauberes Trinkwasser, schnellere**  
**Diagnostik und stabile Zähne**

Wendelin J. Stark, ETH Zürich

# Wie machen wir unsere “Dinge”?



# Aus was besteht...



**Was ist nano?**



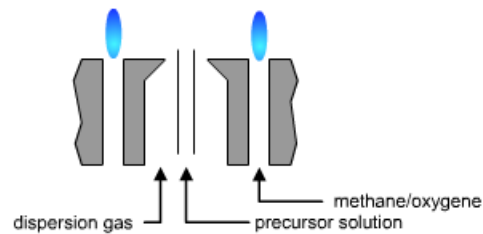
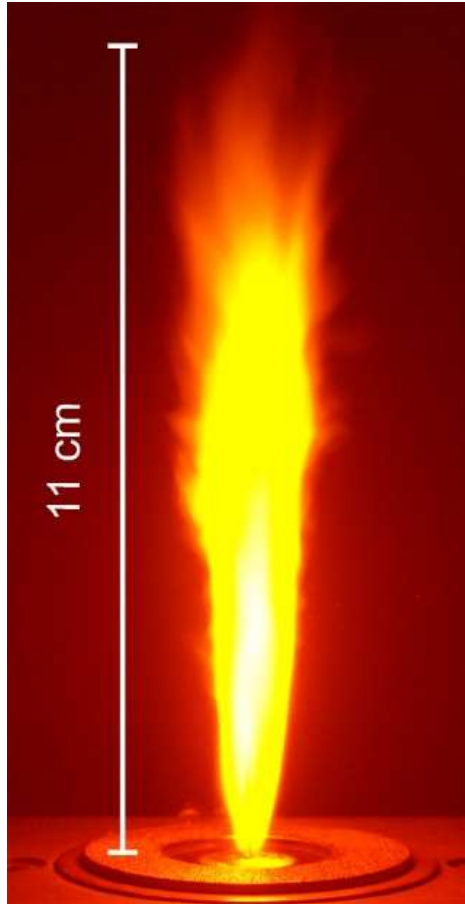


1 Nanometer ist  
1/1'000'000'000 Meter

$10^9$  Kirschen ergeben den  
Durchmesser der Erde

und bringt's etwas?

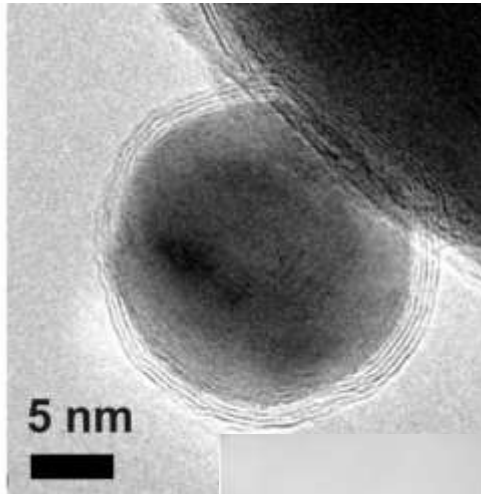
# Weisse Farbe und Russ für Reifen (1940-2002)



einige  
Mio t / Jahr

Animation: R. Strobel, 2002  
S. E. Pratsinis, *Prog. Energ. Comb. Sci.*, 24, 197-219, 1998

# > 1200 Sorten von Nanopartikel (ETH, 2004-2014)



injection moldable electrical  
engines

- Chem. Mater.* 17, 36-42, 2005
- Chem. Commun.* 14, 1767-9, 2005
- Chem. Commun.* 13, 1384-6, 2006
- Nanotechnology*, 17, 2054-61, 2006
- J. Biomed. Mat. Res. B*, 84, 350-62, 2008
- J. Mater. Chem.*, 18, 2679-84, 2008
- J. Mater. Chem.*, 18, 4460-69, 2008
- J. Mater. Chem.*, 18, 5669-75, 2008
- Biomaterials*, 29, 1750-61, 2008
- J. Dent. Res.*, 88(3), 235-8, 2009
- Polym. Eng. Sci.*, 50, 952-60, 2010
- Int. Endo. J.*, 43(3), 210-7, 2010
- Aerosol. Sci. Tech.*, 44(2), 161-72, 2010
- Nanotechnology*, 21, 215603, 2010
- Nanoscale*, 3, 401 – 409, 2011
- J. Phys. Chem. C*, 116, 16246-16270, 2012
- ACS Appl. Mater. Interfaces*, 4 (5), 2664, 2012
- Dent. Mater.*, 28(3), 304-311, 2012



### 3. Spin-off Firma ( heute > 1 Mio Verbindungen)

nanograde®

About Us Contact Us Links News Deutsch

Home Nanoparticles Suspensions Off-the-shelf

Nanoparticles

Dispersions & Suspensions

Materials

Off-the-shelf

**October 2014**  
Prices for N-10, N-10X & P-10 drop by 50% [More](#)

**March 2014**  
Two nanograde articles published on AZoMaterials [More](#)

**Contact**

**Postal address:**  
Nanograde Ltd.  
Laubisruetistrasse 50  
CH-8712 Staefa  
Switzerland

# 1. Click elements



H																							He
Li	Be											B	C	N	O	F							Ne
Na	Mg											Al	Si	P	S	Cl							Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br							Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I							Xe
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At							Rn
Fr	Ra																						
			La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu						
			Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr						

(ordering tool)

# Nano-Tinten (ready to apply)

nanograde

3 gefundene Ergebnisse für: nanograde

Sort By Relevance

### Aluminum-doped zinc oxide nanoparticle ink

1 Ergebnisliste | Match Kriterium: Beschreibung, Produktname

793388 (Aldrich) **NEW** | MSDS | Preisprüfung

### Zinc oxide nanoparticle ink

1 Ergebnisliste | Match Kriterium: Beschreibung, Produktname

793364 (Aldrich) **NEW** | MSDS | Preisprüfung

### Tungsten oxide (WO<sub>3-x</sub>) nanoparticle ink

1 Ergebnisliste | Match Kriterium: Beschreibung

793353 (Aldrich) **NEW** | MSDS | Preisprüfung



Buy nanoparticle e-shop  
dispersions

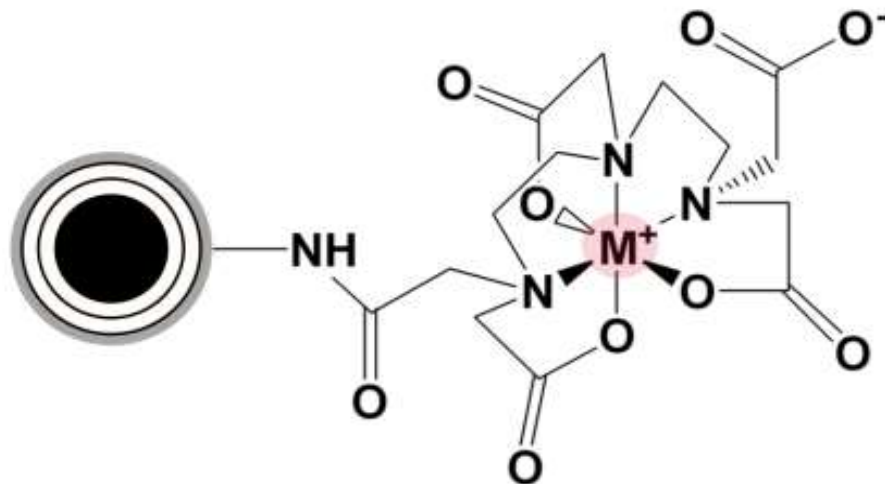
OFF-THE-SHELF

→ E-SHOP INKS

Al <sub>2</sub> O <sub>3</sub> in H <sub>2</sub> O, EtOH or Xylene ( 50 mL ; 10 wt%) = CHF 800
Al <sub>2</sub> O <sub>3</sub> in H <sub>2</sub> O, EtOH or Xylene ( 500 mL ; 10 wt%) = CHF 1675
ATO in EtOH or H <sub>2</sub> O ( 50 mL ; 10 wt%) = CHF 850
ATO in EtOH or H <sub>2</sub> O ( 500 mL ; 10 wt%) = CHF 2225
CeO <sub>2</sub> in H <sub>2</sub> O, EtOH or Xylene ( 50 mL ; 10 wt%) = CHF 825
CeO <sub>2</sub> in H <sub>2</sub> O, EtOH or Xylene ( 500 mL ; 10 wt%) = CHF 1925
Gd <sub>2</sub> O <sub>3</sub> in H <sub>2</sub> O, EtOH or Xylene ( 50 mL ; 10 wt%) = CHF 825
Gd <sub>2</sub> O <sub>3</sub> in H <sub>2</sub> O, EtOH or Xylene ( 500 mL ; 10 wt%) = CHF 1925
ITO in H <sub>2</sub> O or EtOH ( 50 mL ; 10 wt%) = CHF 920
ITO in H <sub>2</sub> O or EtOH ( 500 mL ; 10 wt%) = CHF 3125
MoO <sub>3</sub> in EtOH or Xylene ( 50 mL ; 5 wt%) = CHF 980
MoO <sub>3</sub> in EtOH or Xylene ( 500 mL ; 5 wt%) = CHF 3875
Nd <sub>2</sub> O <sub>3</sub> in DMSO ( 50 mL ; 5 wt%) = CHF 1110
Nd <sub>2</sub> O <sub>3</sub> in DMSO ( 100 mL ; 5 wt%) = CHF 1980
SiC in EG ( 50 mL ; 5 wt%) = CHF 840
SiC in EG ( 500 mL ; 5 wt%) = CHF 2125
TeO <sub>2</sub> in Butylcarbitol (DEGMBE) ( 50 mL ; 10 wt%) = CHF 1100
TeO <sub>2</sub> in Butylcarbitol (DEGMBE) ( 500 mL ; 10 wt%) = CHF 5375
Al <sub>2</sub> O <sub>3</sub> in H <sub>2</sub> O, EtOH or Xylene ( 50 mL ; 10 wt%) = CHF 800

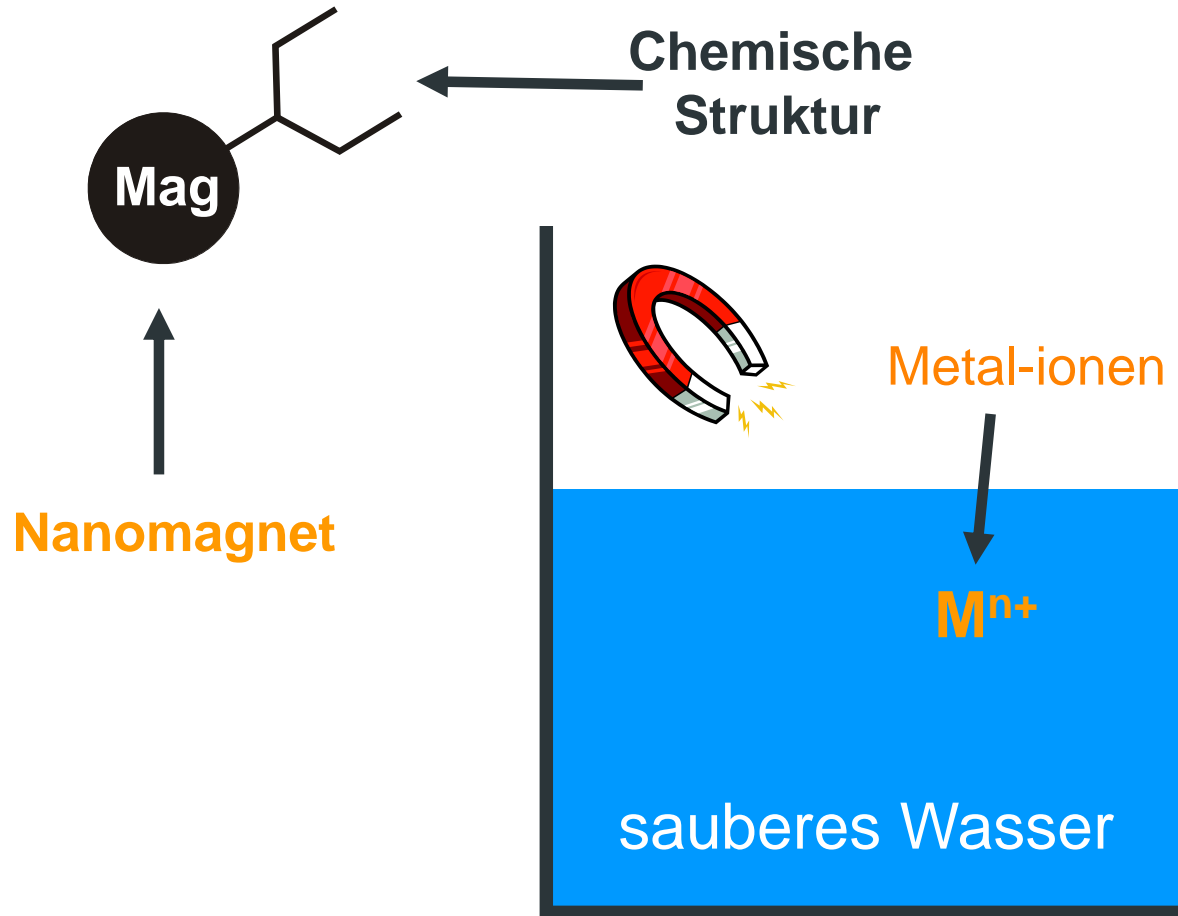
# Magnetische Nanochemikalien

(07- 15, seit 2012 auch als EU Projekt)



- Angew. Chem. Int. Ed.*, 46, 4909-12, 2007
- featured in *Nature Nanotechn.*, 2007
- Chem. Commun.*, 32, 4862, 2009
- Chem. Mater.*, 21, 3275, 2009
- Angew. Chem. Int. Ed.*, 49, 1867, 2010
- Chem. Mater.*, 22, 305, 2010
- Ind. Eng. Chem. Res.*, 49(19), 9355-62, 2010
- Chem. Eur. J.*, 16, 8950, 2010
- Adv. Funct. Mater.*, 20, 4323-4328, 2010
- J. Mater. Chem.*, 21, 2991, 2011
- Langmuir*, 27, 1924, 2011
- Org. Lett.*, 13, 8, 2011
- Nanomedicine*, 6, 1199-1213, 2011
- Chem. Mater.*, 23, 3606-3613, 2011
- Chem. Eur. J.*, 17, 10566 - 1057, 2011
- Chem. Eng. J.*, 175, 244-250, 2011
- Sep. Purif. Technol.*, 96, 68-74, 2012
- ACS Catal.*, 2 (6), 1267-1284, 2012
- J. Mater. Chem.*, 22 (24), 12064 - 12071, 2012
- Langmuir*, 28, 4565-4572, 2012

# selektiv fischen ?



magnetische **Seifen**

magnetisch **komplexieren**



1 2



3 4

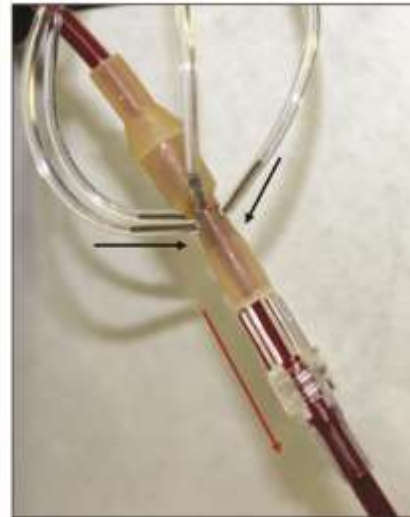
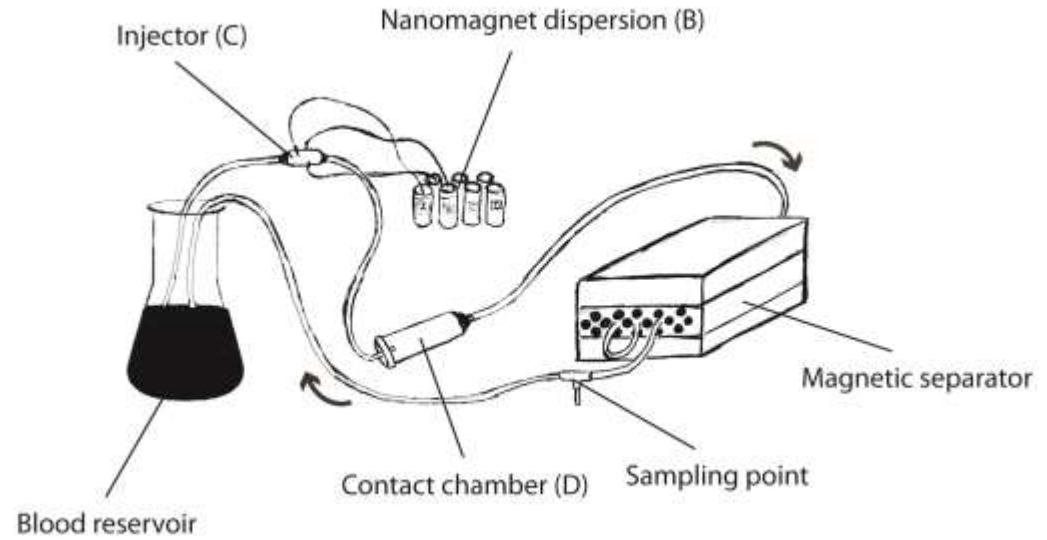


magnetische **Kats**

magnetische **Schutzgruppen**

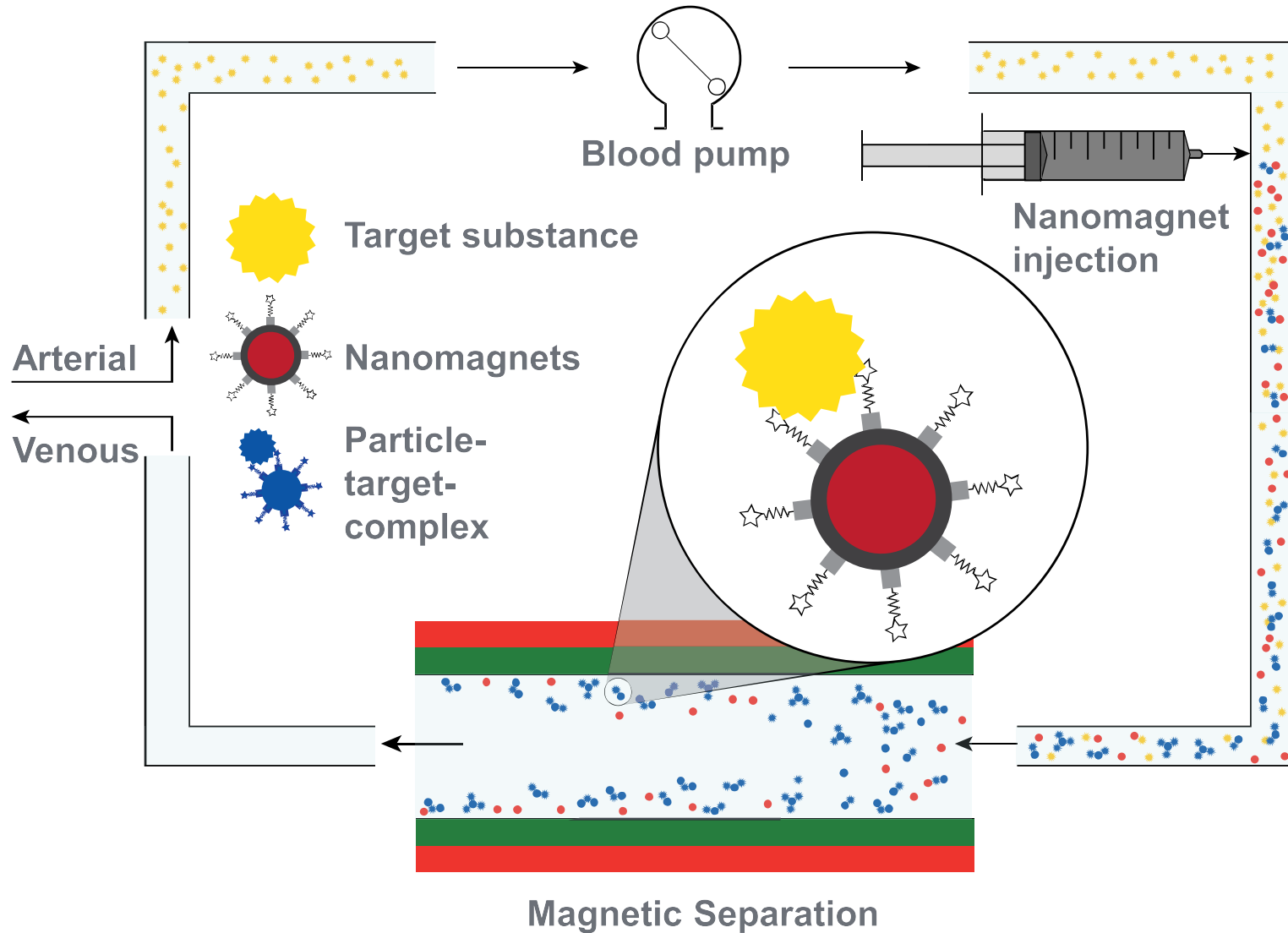
*Angew. Chem. Int. Ed.*, 46, 4909-12, 2007  
featured in *Nature Nanotechn.*, 2007<sup>14</sup>  
*Angew. Chem. Int. Ed.*, 48, 224, 2009  
*Angew. Chem. Int. Ed.*, 49, 1867, 2010

# HUMANBLUT, 1 LITER, AM USZ



*Nephrology, Dialysis, Transplantation*, 26, 2948, 2011  
*J. Mater. Chem. B*, 2, 3753-3758, 2014

# Anwendung in der Medizin: Blutreinigung





# Produkt (in Entwicklung)



**Antibody removal for  
TRANSPLANTATIONS**

**Overcome  
bloodgroup barrier**

**Increase organ  
availability**



**Endotoxin removal as  
SEPSIS treatment**

**Interrupt the  
inflammatio cascade**

**Increase patient  
survival**

# hemoTUNE Team (8te Spin-off Firma, in Gründung)



## **Carlos Mora**

MSc ETH Biology

Collaboration on the application of magnetic nanoparticles in neuro-regenerative biology

## **Corinne Hofer**

MSc ETH Chemistry

Collaboration with USZ on removal of circulating tumor cells

## **Lukas Langenegger**

MSc ETH Chem. Bio. Engineering

Master's Thesis at MIT (Cambridge, USA)

2 years traineeship in banking and finance

**Industriell..**

# Enorme Mengen Wasser (Millionen m<sup>3</sup>)

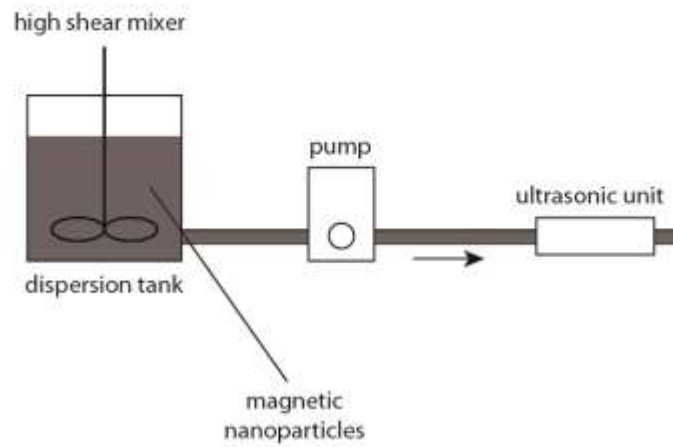


**Wer macht das Wasser ungeniessbar:**

**mg / m<sup>3</sup> Konzentrationen von giftigen Substanzen**

**→ Können wir nur den schädlichen Teil bewegen?**

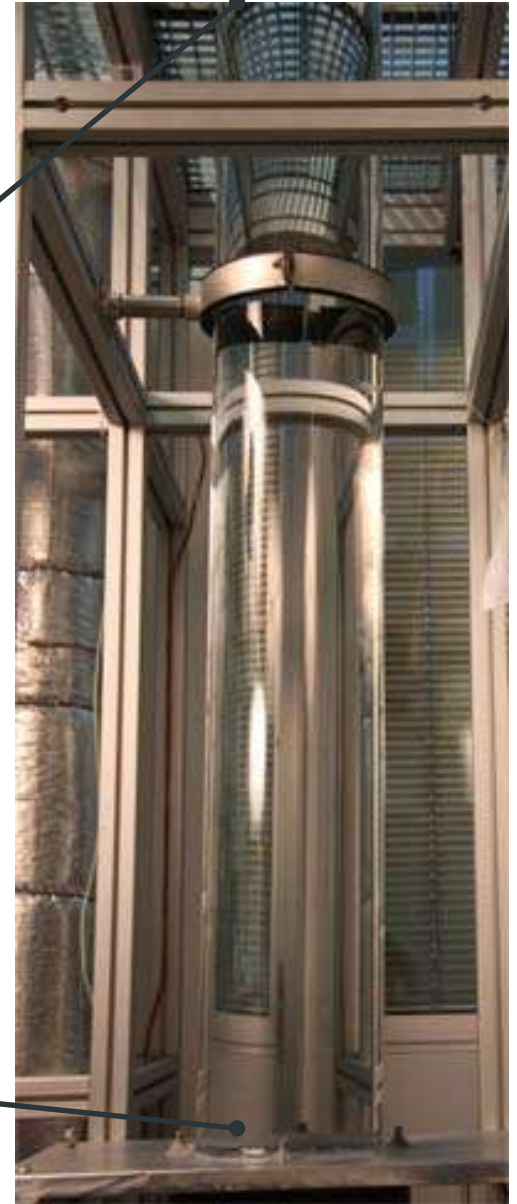
# MINI PILOT: AT 1 M<sup>3</sup>/H



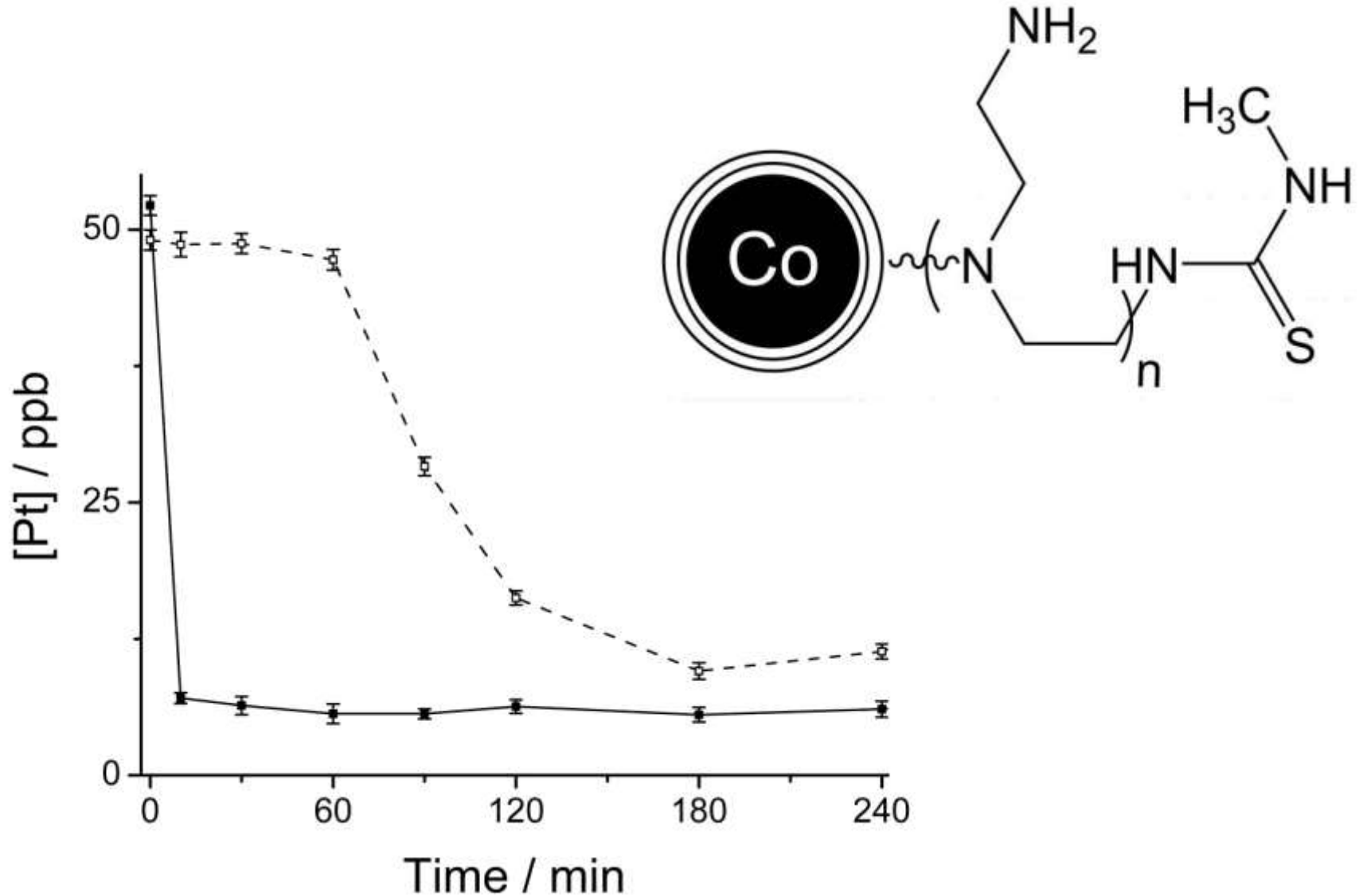
*Chem Eng. J.*, 175, 244, 2011  
*Sep. Purif. Technol.*, 96, 68, 2012

# Viel Wasser (1000 m<sup>3</sup>)

Vertikales Tanksegment => Test



# Minenabwasser, 50 ppb (milligrams / m<sup>3</sup> ) Pt



**Einen ganzen See?**







- Robert Grass, PhD
  - 8+ years technology experience
  - Co-inventor + key driver
  - Product development, production
- Martin Zeltner, PhD
  - 5+ years experience
  - Chemist; application development

**SIGMA-ALDRICH** 187000+ PRODUCTS 512+ SERVICES 24/7 SUPPORT Search

Switzerland Home > Suchergebnisse > TurboBeads

Showing: **Produkt Results**

Your Selections  
Suche: "turboBeads" ✕

Artikel Anzeigen:  
**Bestellert in Switzerland**  
Globally

Artikel Vergleichen:  
Wählen Sie durch Anklicken bis zu 4 Artikel und klicken Sie dann auf "vergleichen" für eine ausführliche Anzeige des Vergleichs.  
Compare

Haben Sie Das Gesuchte Gefunden?  
 Ja  
 Nein  
Bitte eine Angabe einfügen  
ANFRAGE ➔

8 gefundene Ergebnisse für: TurboBeads Sort By Relevance

**TurboBeads™ Amine**  
1 Ergebnisliste | Match Kriterium: Produktname, Beschreibung Eigenschaften +

42408 extent of labeling: ≥0.1 mmol/g loading (-Ph-CH<sub>2</sub>-NH<sub>2</sub>) (Aldrich) NEW M 8 D 8 | Preisprüfung

**TurboBeads™ Azide**  
1 Ergebnisliste | Match Kriterium: Produktname, Beschreibung Eigenschaften +

42827 extent of labeling: ≥0.1 mmol/g loading (-Ph-CH<sub>2</sub>-N<sub>3</sub>) (Aldrich) NEW M 8 D 8 | Preisprüfung

**TurboBeads™ Carboxy**  
1 Ergebnisliste | Match Kriterium: Produktname, Beschreibung Eigenschaften +

42611 extent of labeling: ≥0.1 mmol/g loading (-Ph-CH<sub>2</sub>-CH<sub>2</sub>-COOH) (Aldrich) NEW M 8 D 8 | Preisprüfung

**TurboBeads™ Complexon**  
1 Ergebnisliste | Match Kriterium: Produktname, Beschreibung Eigenschaften +

43082 extent of labeling: ≥0.1 mmol/g loading (-Ph-CH<sub>2</sub>-N(CH<sub>2</sub>-COOH)<sub>2</sub>) (Aldrich) NEW M 8 D 8 | Preisprüfung

**TurboBeads™ ScavAu**  
1 Ergebnisliste | Match Kriterium: Produktname, Beschreibung Eigenschaften +

43178 extent of labeling: ≥0.1 mmol/g loading (-Ph-SH) (Aldrich) NEW M 8 D 8 | Preisprüfung

**TurboBeads™ ScavPt**  
1 Ergebnisliste | Match Kriterium: Produktname, Beschreibung Eigenschaften +

43276 (Aldrich) NEW M 8 D 8 | Preisprüfung

**TurboBeads™ Silica**  
1 Ergebnisliste | Match Kriterium: Produktname, Beschreibung Eigenschaften +

42732 extent of labeling: SiO<sub>2</sub> loading (silica coating) (Aldrich) NEW M 8 D 8 | Preisprüfung

**TurboBeads™ TEMPO**  
1 Ergebnisliste | Match Kriterium: Produktname, Beschreibung Eigenschaften +

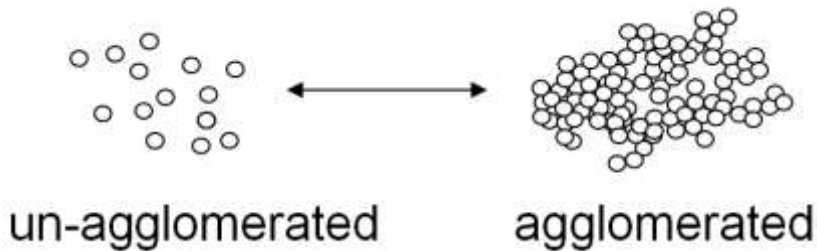
42946 ≥80% (Aldrich) NEW M 8 D 8 | Preisprüfung

**TurboBeads™ Vinyl**  
1 Ergebnisliste | Match Kriterium: Produktname, Beschreibung Eigenschaften +

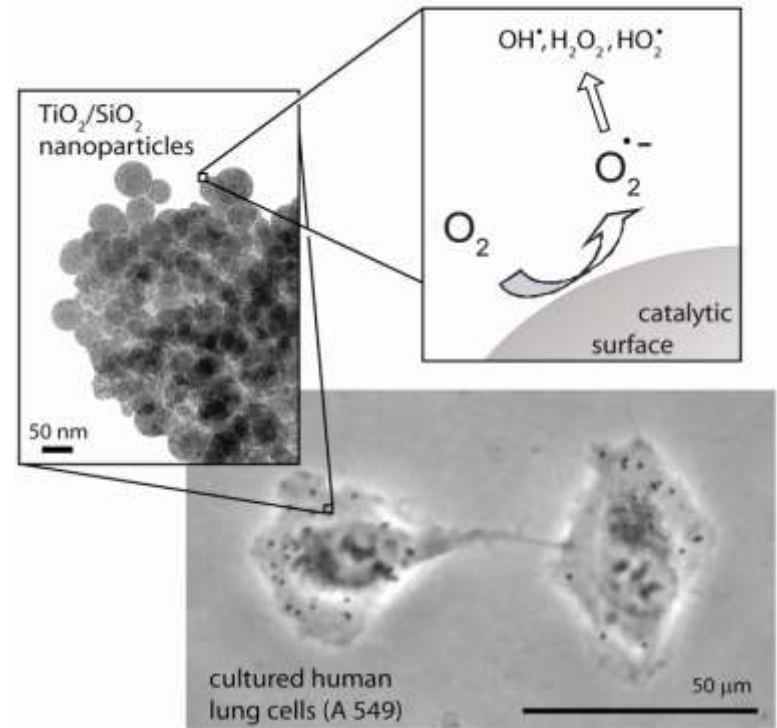
42848 extent of labeling: ≥0.1 mmol/g loading (-Ph-Ph-CH=CH<sub>2</sub>) (Aldrich) NEW M 8 D 8 | Preisprüfung

10 Magn. Chemikalien auf Sigma Aldrich

# Was ist sicher/giftig? (seit 2002)

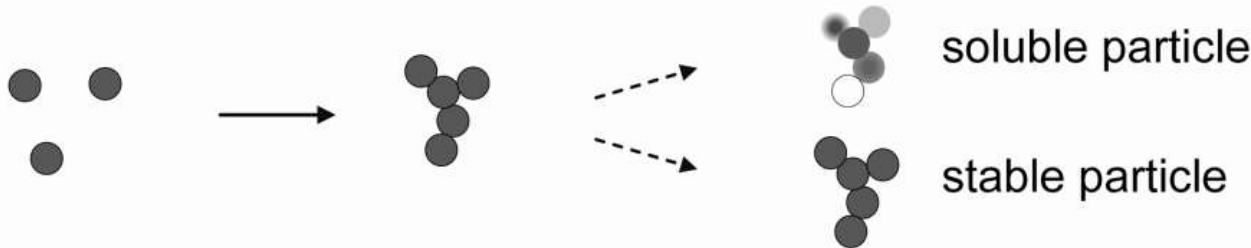


*Environ. Sci. Technol.*, 39, 9370-76, 2005



*Environ. Sci. Tech.*, 41, 4158-63, 2007

American Chemical Society:  
**2007 Top Science Paper**



*Environ. Sci. Technol.*, 40, 4374, 2006: **most cited article of >10'000 past articles**

# Gesellschaftliche Auswirkung



Nationales Forschungsprogramm 64 (SNF, 12 Mio CHF) auf Nanotoxikologie

Empfehlung für industrielle Handhabung (mit BAG, BAFU)

Synthetische Nanomaterialien: Risikobeurteilung und Risikomanagement. Grundlagenbericht zum Aktionsplan. Umwelt-Wissen Nr. 0721. Bundesamt für Umwelt und Bundesamt für Gesundheit, Bern. 284 pages, 2007

Vorsorgeraster für Synthetische Nanomaterialien. Bundesamt für Gesundheit und Bundesamt für Umwelt, Bern 2008

# Persistente Nanopartikel: Nicht in Konsumgüter!

Plastik im Ozean; Freon, DDT,  
Radioaktivität, Imprägniermittel...

*Angew. Chem. Int. Ed.*, 50, 1242, 2011

## Bayer: 150 Years – Science For A Better Life



Contact us | Sitemap | Deutsch

Home | 150 Years | About Bayer | Innovation | Products | Sustainability | **Media** | Investors | Career

Home > Media > News

Print | Share

Overview

150 Years

**News**

Biographies

Speeches

Photos

TV Footage

Publications

Video Center

Wednesday - May 8, 2013

Development know-how is made available to collaboration partners:

### Bayer MaterialScience brings nano projects to a close

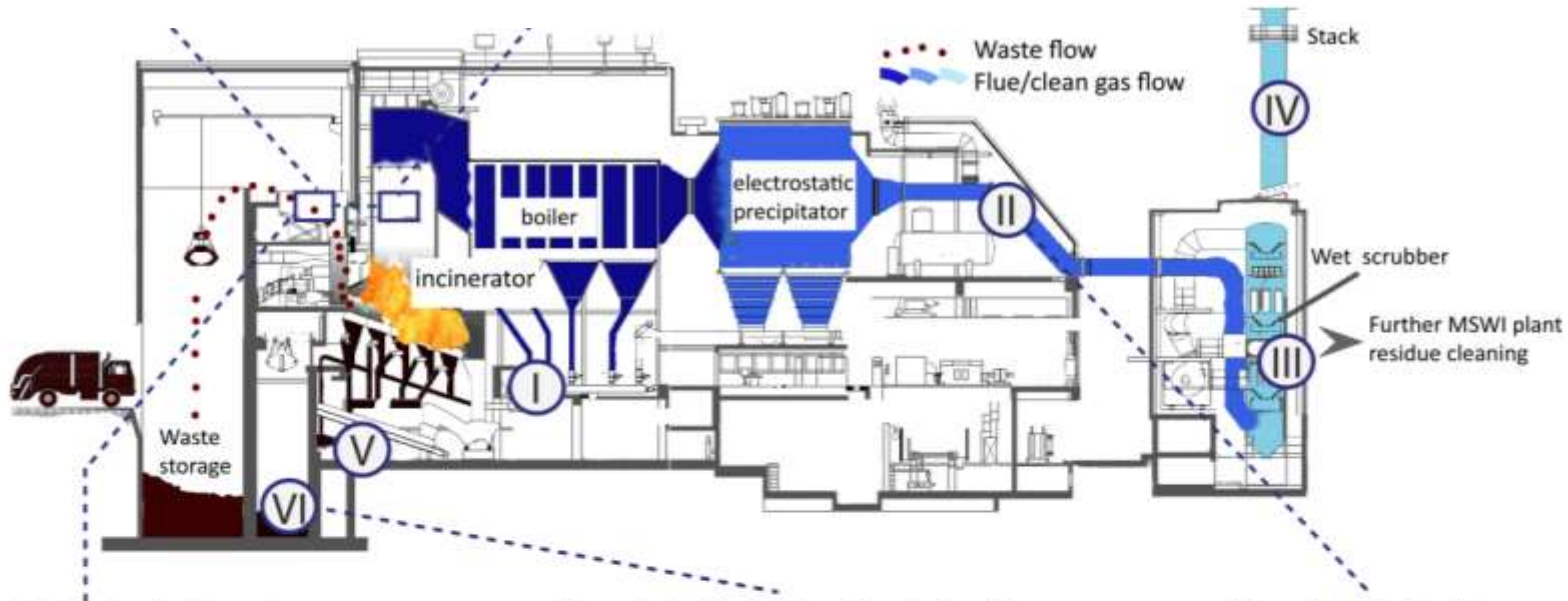
Leverkusen, May 8, 2013 – Bayer MaterialScience intends to focus its development activities more intently on topics that are closely linked to its core business. For that reason the company will bring its work on carbon nanotubes (CNTs) to a close. Precisely how the research results and know-how for the production and application CNT will be used further will be determined shortly.

Publications

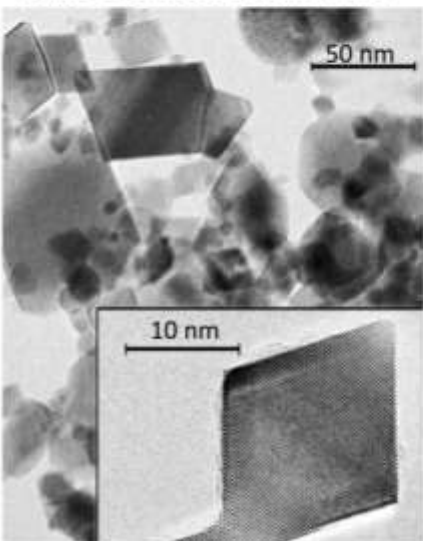
- ▶ Stockholders' Newsletter
- ▶ Annual Report
- ▶ research – The Bayer Scientific Magazine
- ▶ Sustainable Development Report
- ▶ Publications Overview

Newsletter

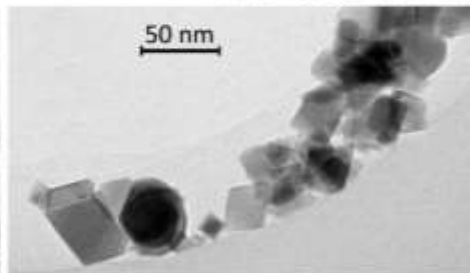
# Kehricht Verbrennungsanlagen (200'000 t / y) sind sicher



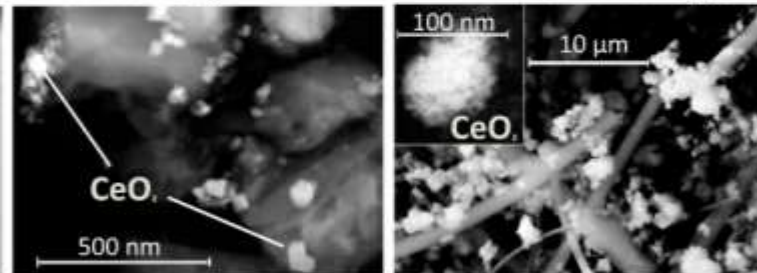
Nano-CeO<sub>2</sub> before incineration

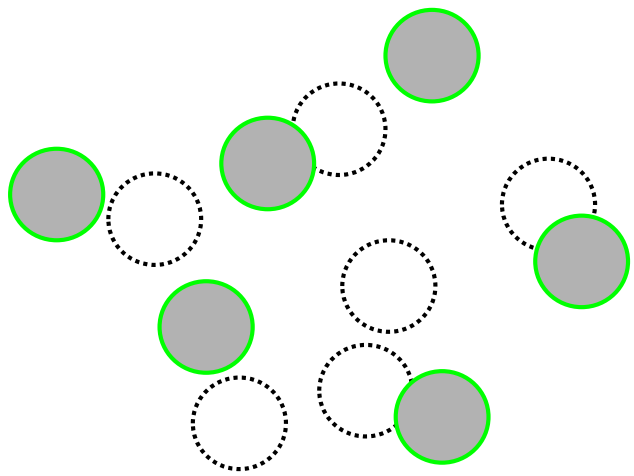


Nano-CeO<sub>2</sub> after incineration in the slag



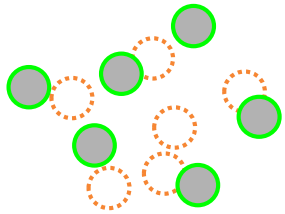
Nano-CeO<sub>2</sub> in the flue gas





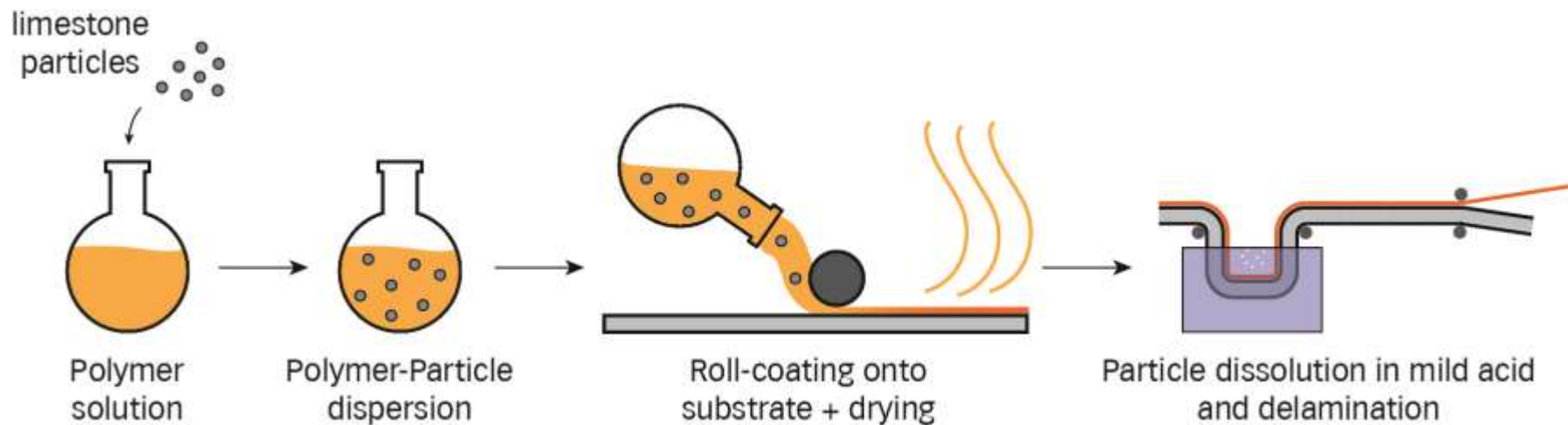
nano-particle => nano-hole

# Trinkwasser @ 1 cent/day?



World Health Organization report, **WHO/HSE/WSH/12.01**

PCT application, June 2010; **Chem. Mater.**, 22, 4980, 2010  
**J. Membrane Sci.**, 387, 76, 2012





# Umweltfreundliche Outdoor Jacken



*Mario Stucki, Doktorand, 2014*

# 2013: Gründung der 5ten Spin-off Firma



**novamem**  
advanced separations.



Christoph Kellenberger (Ph.D.  
Maschinenbau, Unternehmerfamilie)



Christoph Schumacher (Ph.D. Chemie  
Ingenieur, brillantes tech. Verständnis),  
wechselt 2015 zu Kabe Farben  
(Unternehmer von S. Bubenhofer, Diss im  
2013)

Michael Loepfe (Chemie Ingenieur,  
Unternehmerfamilie)



**novamem**  
advanced separations.

- 1.** REMOVE SAFETY PACK
- 2.** FILL YOUR BOTTLE
- 3.** SCREW, SQUEEZE, ENJOY!



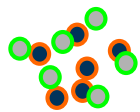
 **ISPO** MUNICH  
24.1. - 27.1.2016

 **EXPO**  
MILANO

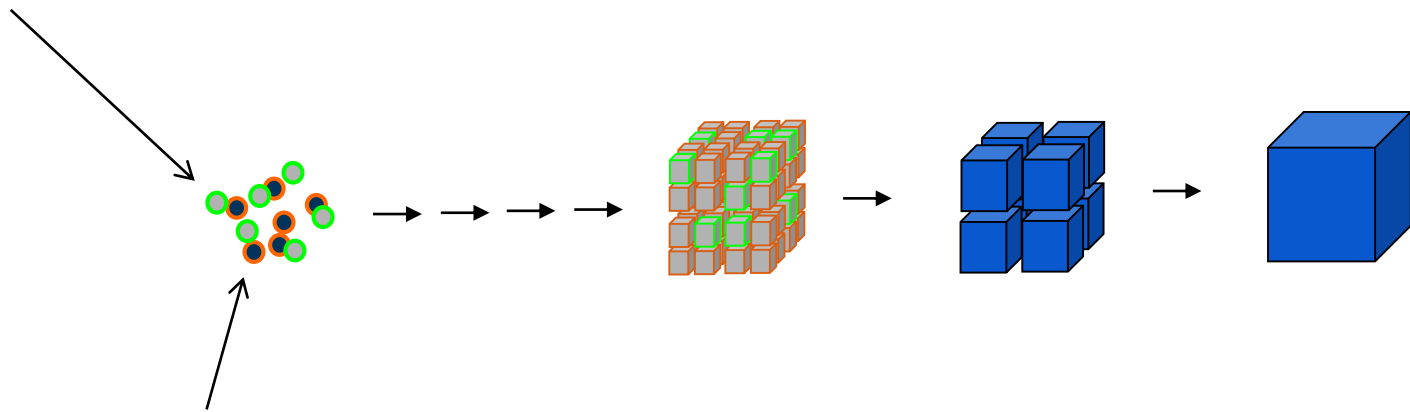
**in selektiven Sportgeschäften und online seit Frühling  
2015**



**Supergleber für Zähne und Knochen?**

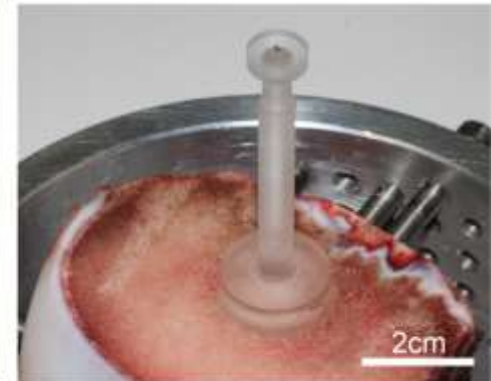
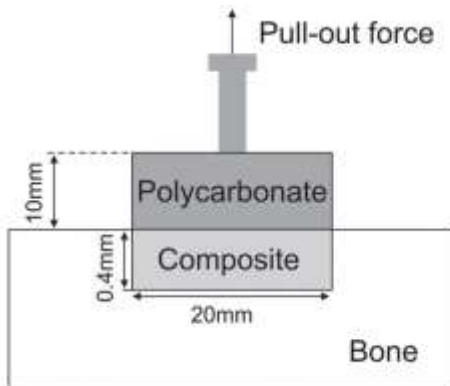
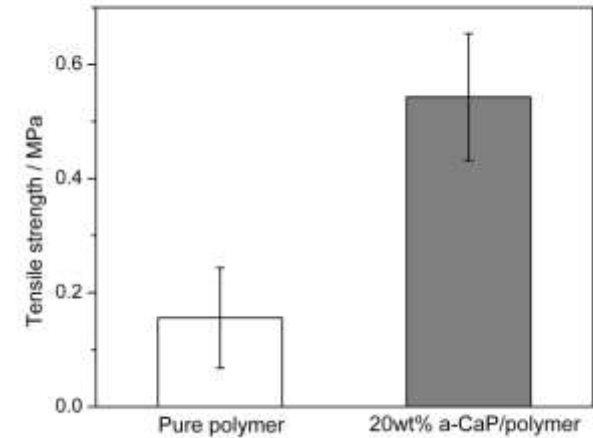


**Licht-härtender Zahnkleber (heute verwendet)**



**Reaktives Calcium phosphat (unsere Forschung)**

# Kleben auf nasse Oberflächen





# Technologietransfer in der Zahnmedizin

[www.smartodont.ch](http://www.smartodont.ch)



**ETH**

Eidgenössische Technische Hochschule Zürich  
Swiss Federal Institute of Technology Zurich

Materialwissenschaft &  
Engineering

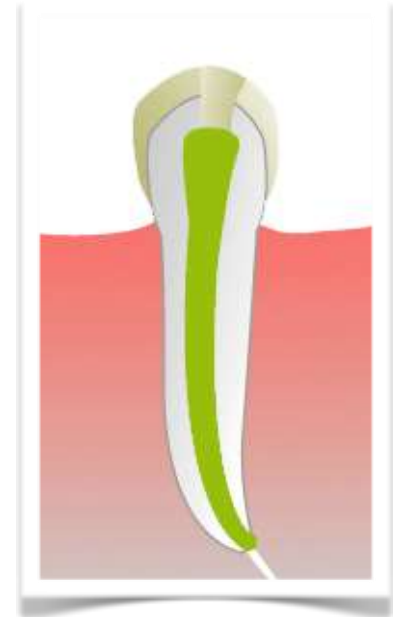


**University of  
Zurich** UZH

Zahnmedizin

# Entwicklung eines dental Produktes: der 2 in 1 Wurzelkanalfüller

- Wissen aus der Zahnmedizin  
kombiniert mit Materialwissenschaft
  - Regulatorische Hürden
  - Qualitätsmanagement
  - Zertifizierung: ISO & FDA
- Zusammenarbeit mit einem etablierten  
Partner in der Dentalbranche



# Zukunft

- Spülungen für den Wurzelkanal
- Neue Komposite
- Ausbildungstools für die Zahnmedizin  
→ eigener Vertrieb

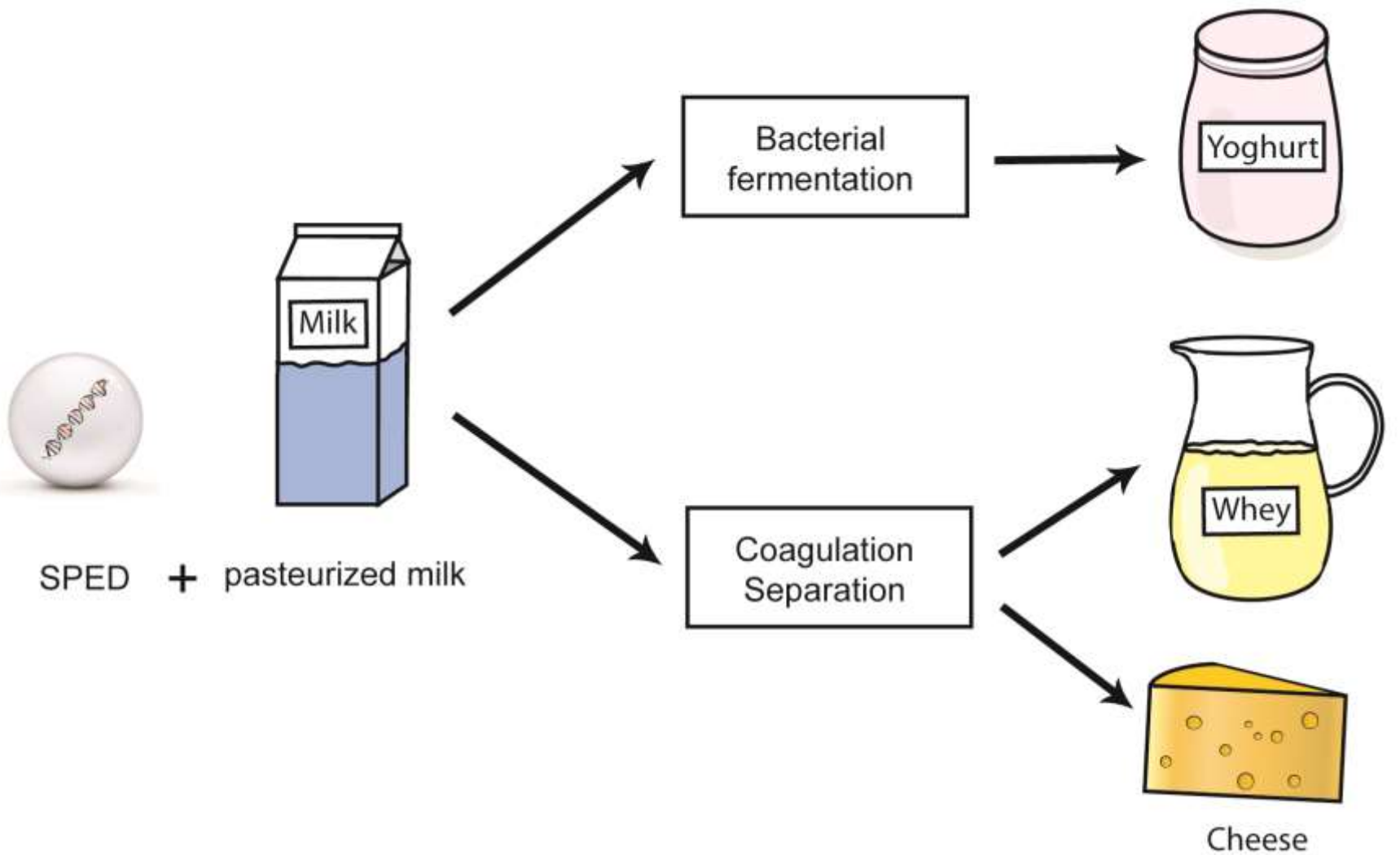


# Identität eines Materials, Haftung, Herkunft

# Woher kommt unser Nahrung?







# traceability of food origin → DNA



→ DNA → PCR



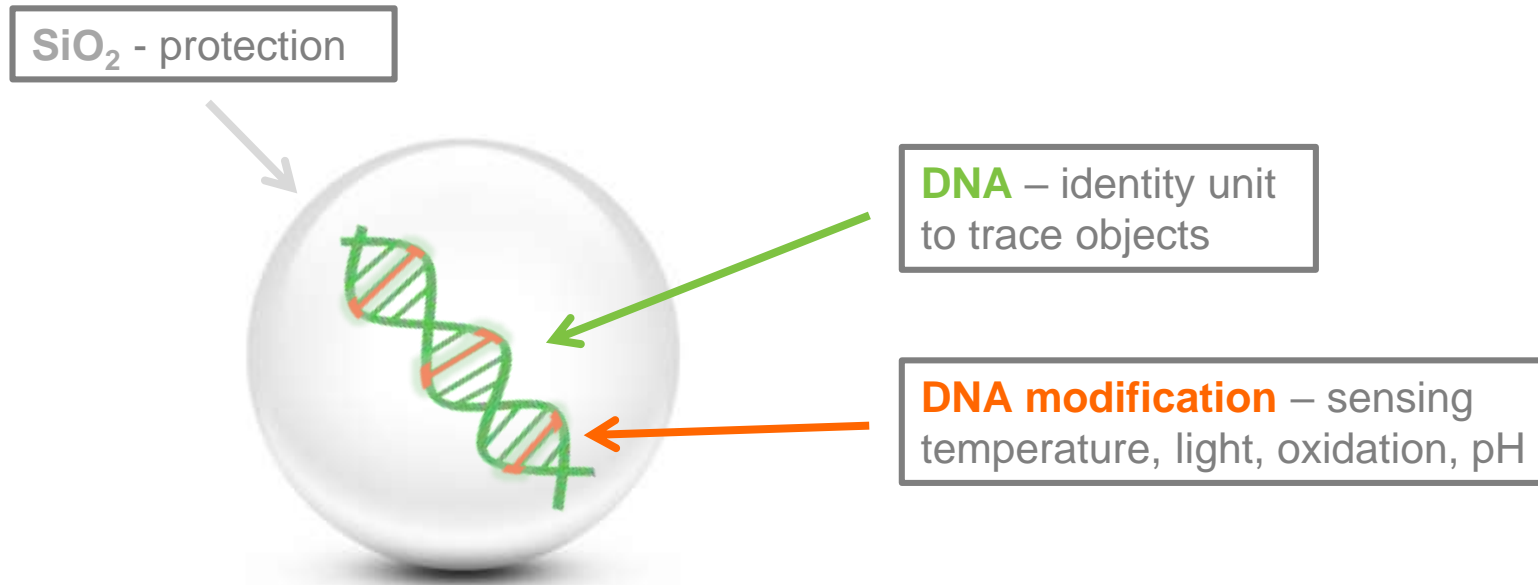


# < 1 ppb particles required



- **1 ppb = 1 mg per ton**
- 1 ppb = 0.3 kg of particles for total German pasta production (= 334'000 tons / year)
- 0.3 kg Particles = 0.6 g of DNA
- ca. 5'000 USD

# Materialwissenschaft trifft Informationszeitalter



# “password”-geschützte Barcodes für Materialien

- temperature resistant, artificial DNA fossils-like submicron tags
- 512 bit encoding + higher
- **ETH Spin-off: [www.haelixa.com](http://www.haelixa.com)**



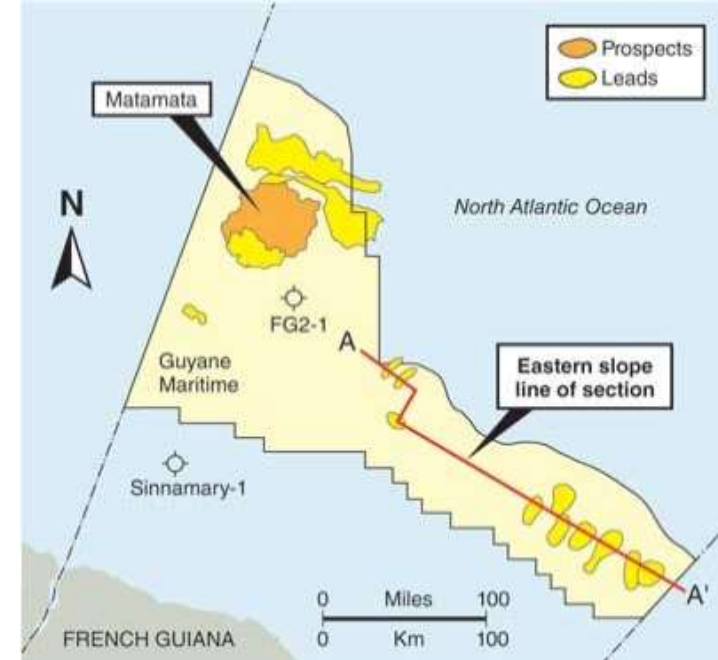
# Nachverfolgbarkeit und Haftung



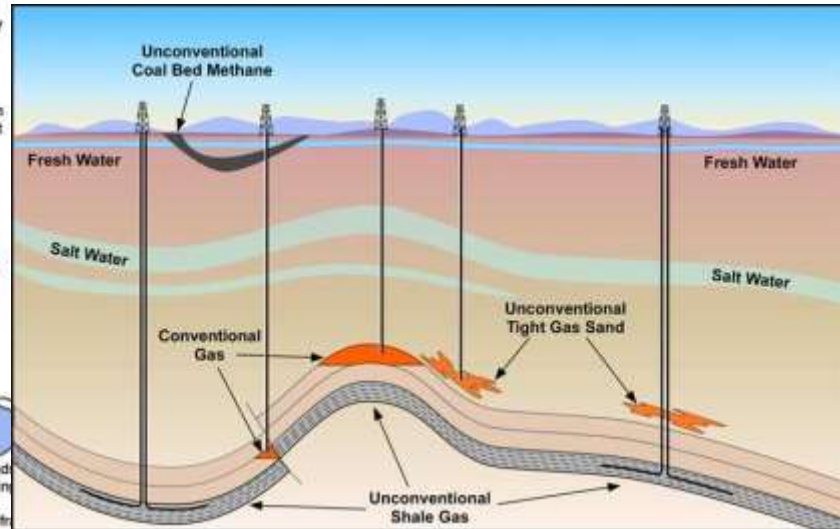
«UK and other governments oppose EU regulations aimed at preventing oil leaks at deepwater drilling operations»

F. Harvey, *The Guardian*, 19 April 2011

# Sichtbarmachen (z.B. Oel und Gas)



## Fracking in Europe - the Rebellion Grows





# 2016: making the 7th spin-off

Haelixa

[Home](#)

[Tech](#)

[Solutions](#)

[About Us](#)

[News](#)

[Contact Us](#)



## Industrial Tracing

High performance tracers to track fluids and assess connectivity.

# Nanotags anwenden

- 1 mg des Nanolabels pro Tonne Material
- Auslesen mittels einer Standardmethode aus der Medizin (PCR)
- Verwenden von Online-Banking artigen Codes und Verschlüsselung, 256 oder 512 bit Codes
- Kosten: 0.05 bis 10 CHF pro Tonne Anwendung, je nach Matrix und Verfahrenstechnik

**wie geht es damit weiter?**



# Speichern von Information in DNA



DNA- Barcode in Silikathülle, ca. 256 bit, stabil gegen Zerfall

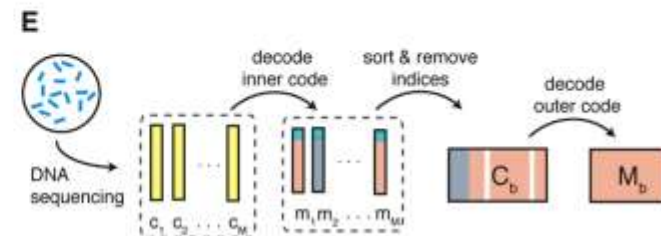
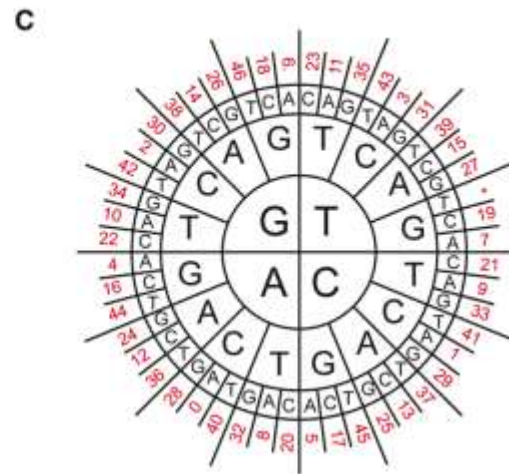
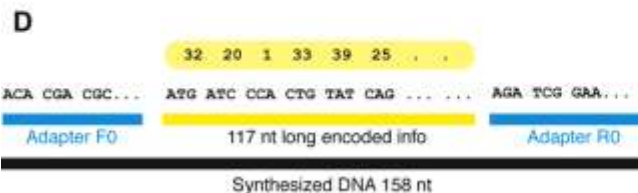
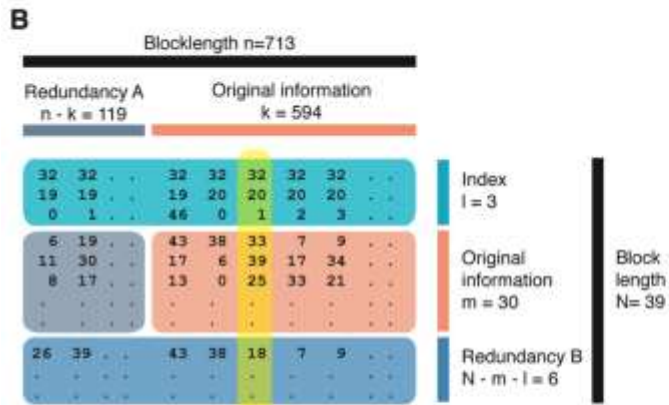
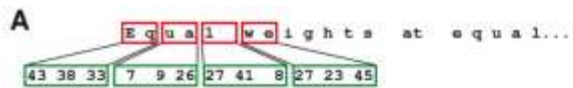


# Speichern von Information in DNA

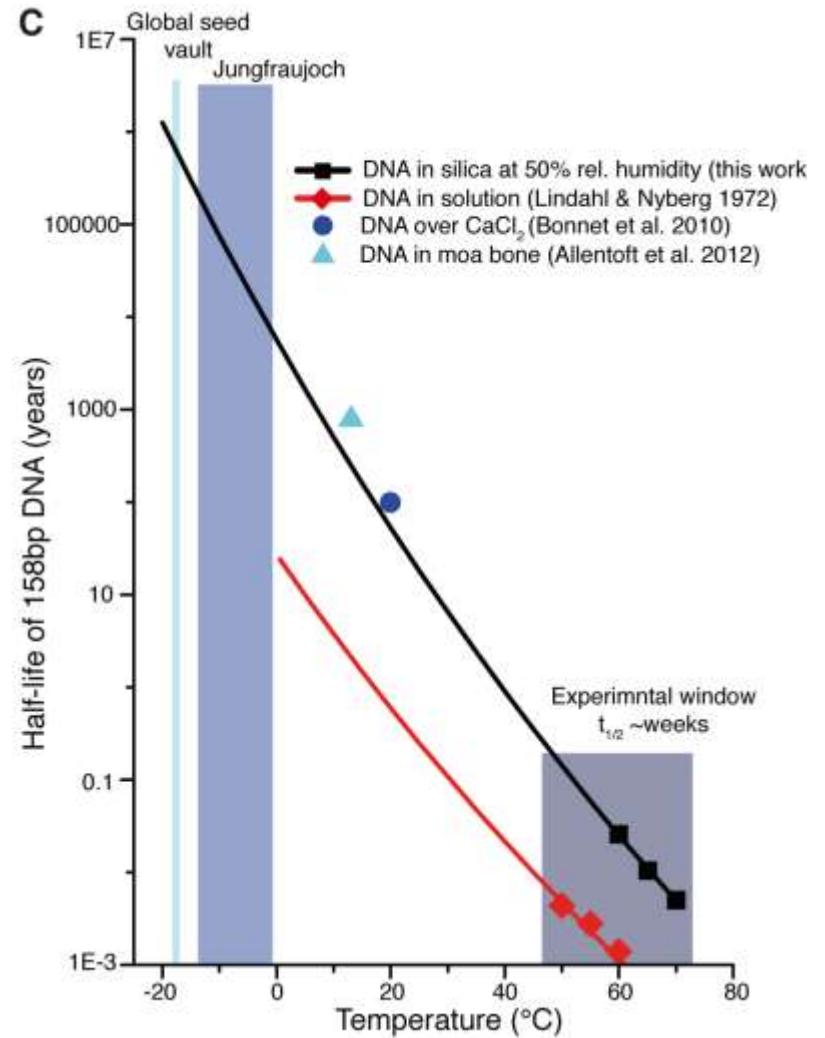
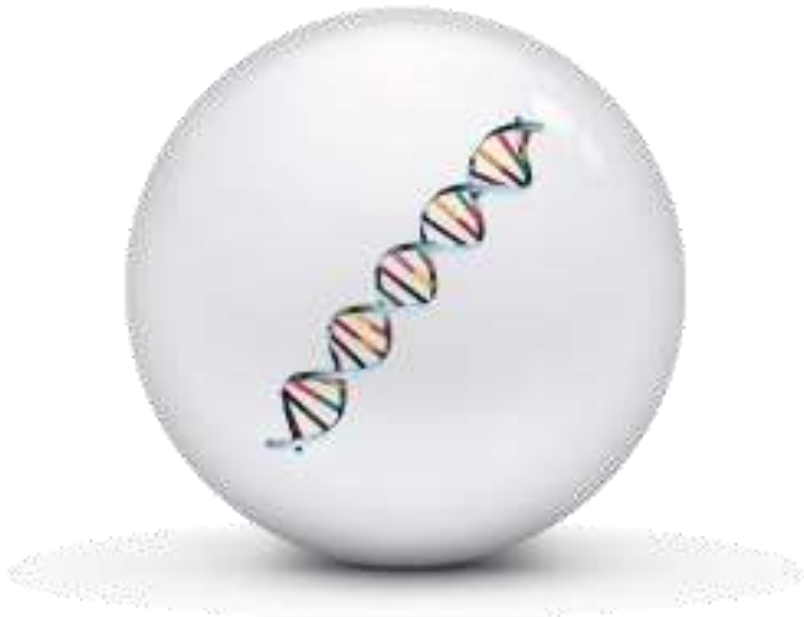
- 1.) Codieren mit Fehlerkorrektur
- 2.) DNA Synthese



# Übersetzen und Fehlerkorrektur



# Kinetik von DNA Zerfall



**wie geht es damit weiter?**

# “safety by design” – Empfehlung (1), keine persistenten in Konsumgütern anzuwenden

(1) *Angew. Chem. Int. Ed.*, 50, 1242, 2011

**United Nations**, GEO-5, 2012

caveat:

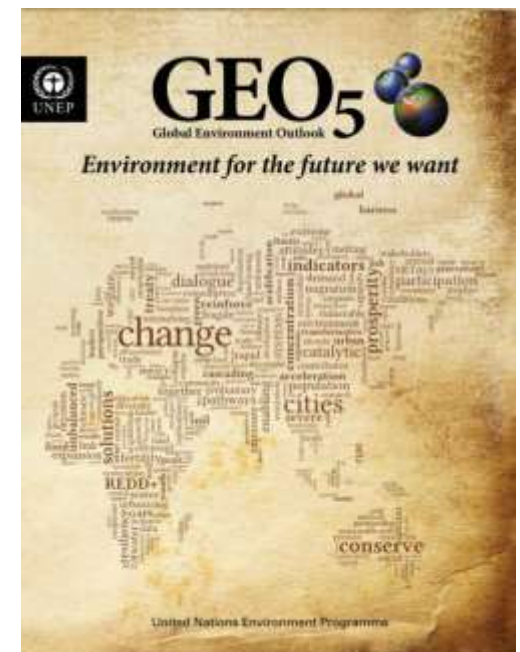
Plastik in den Ozeanen

Ozonloch ⇔ Freon

Nahrungskette ⇔ DDT

Radioaktivität

Fluorierte Imprägniermittel, Textilien





## Herbst 2014, UN entscheidet, die globale Umwelt quantitativ zu erfassen



United Nations



Framework Convention on  
Climate Change

FCCC/CP/2015/L.9/Rev.1

Distr.: Limited  
12 December 2015

Original: English

---

### Conference of the Parties

Twenty-first session

Paris, 30 November to 11 December 2015

Agenda item 4(b)

**Durban Platform for Enhanced Action (decision 1/CP.17)**

**Adoption of a protocol, another legal instrument, or an agreed outcome with legal force under the Convention applicable to all Parties**

**ADOPTION OF THE PARIS AGREEMENT**



United Nations Environment Programme  
environment for development

Google Custom Search



Climate Change



Disasters & Conflicts



Ecosystem Management



Environmental Governance



Chemicals & Waste



Resource Efficiency



Environment Under Review



HEALTHY  
PLANET  
HEALTHY  
PEOPLE



English Français Español 中文 Русский عربي



GEO 6 Stage 2  
Review of Regional  
Assessments

High Level Intergovernmental Panel (50 members), Scientific Advisory Panel (30 members), 850 Authors



# global materials responsibility

---



**who's oil is this?**

imagine, all global oil, fuel, large food stuff and intermediate streams **«have an address»**

(we could stop the anonymity of the ocean, biosphere,...)

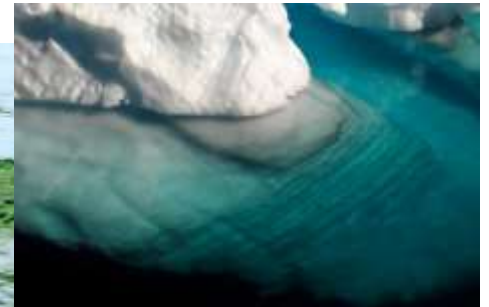
# global biomass/food tracking

---



Where does this fish  
come from?

Is it healthy?



# personal «international» trade



Imagine, consumers could connect to local farmers in the developing world

(you know who grew your chocolate's cacao)



## material labeling

... stops anonymous transfer of «bad processes» from high income countries to developing world

*ACS Nano*, 9.10 9564-9572, 2015  
*Adv. Health Mater.*, 4.9, 1332-1338, 2015  
*Angew. Chem.*, 54.8, 2552-2555, 2015  
*Environ. Sci. Technol. Lett.*, DOI: 10.1021/acs.estlett.5b00312  
*Environ. Sci. Technol. Lett.*, 1.12 (2014): 484-489  
*Small*. Doi:10.1002/smll.201502883  
*ACS Nano*, 8, 2677-2685, 2014  
*J. Agric. Food Chem.*, 62.43, 10615-10620, 2014  
*Mol. Ecol. Resour.*, 15.2, 231-241, 2015  
*Chem. Commun.*, 50.73, 10707-10709, 2014  
*J. Mater. Chem. B.*, 2.48, 8504-8509, 2014  
*Angew. Chem.*, 52.15, 4269-4272, 2013

# Forschungsteam heute



## Grundlagenwissenschaft:

- 20 papers/year, > 1200 times cited/y (2015, ISI Thomsen Scientific)
  - UN Scientific Advisory Panel for GEO-6

## Jobs und Firmen:

20+ products commercialized, 4 (+ 2) spin-off companies

**Vielen Dank fürs Zuhören!**