NanoAlb

ACADEMY OF SCIENCES OF ALBANIA

WORKSHOP

"NANOALB & CONSTRUCTION INDUSTRY"

Nanotech cooperation opportunities with Zoz GmbH Germany

Organized by

NANOALB-ALBANIAN UNIT OF NANOSCIENCE AND NANOTECHNOLOGY

ACADEMY OF SCIENCES OF ALBANIA

August 2nd 2021 Tirana, Albania

Venue: Academy of Sciences of Albania, Sheshi "Fan Noli", No 7, Tirana, Albania

people | thin(k)gs | people

July 14, 2021

make more with less

HKP nanomaterials / nanostructures in non-religious clean- green- & hightech for transportation, energy & economy, from super-concrete to nuclear.

How to make, how to manufacture and how to bring it to the market. Why & how Albania should become a major player.

henning zoz
Zoz Group, D-57482 Wenden, Germany

NanoAlb

Workshop at Tirana # 02.08.2021
NanoAlb & Construction Industry

FuturZement | FuturBeton

Sustainable construction materials containing Highly Reactive Ground Granulated Blastfurnace Slag activated by High Kinetic Processing

FuturBeton ASTM-sample processing





44-49 Mpa after 22 hours !!

ZTC Olpe

R/D Division@Zoz

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

Fraunhofer IME

Continental

MATSYS Materials and Manufacturing Systems

Fine Polish TDC

Zoz Group

Zoz Group D 57482 Wenden · Germany

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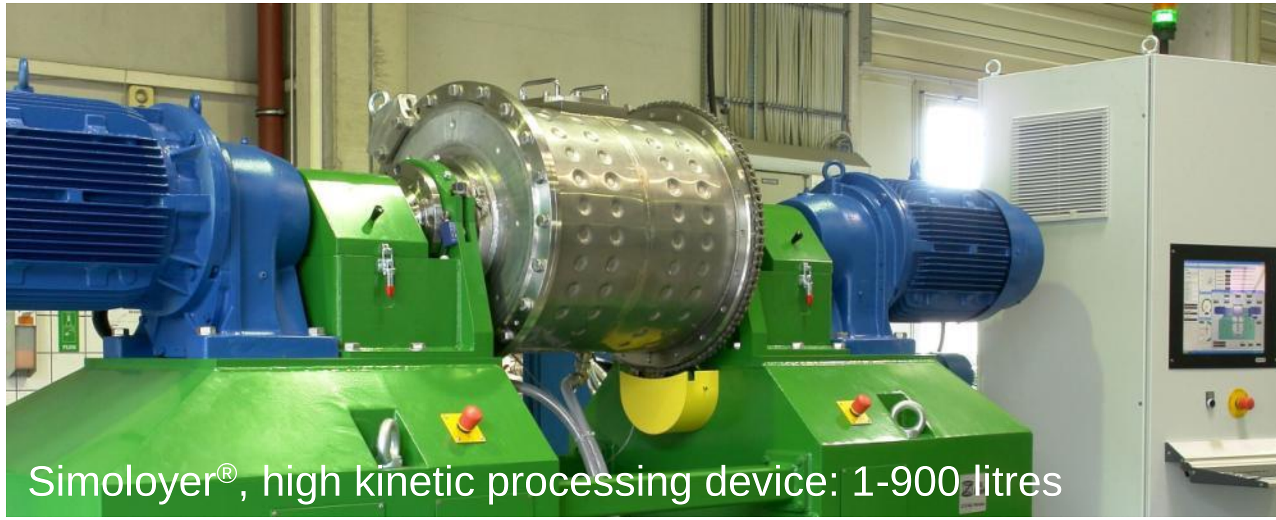
Zoz
GmbH
Nanostrukturierte Werkstoffe
www.zoz.de


Simoloyer®, high kinetic processing device: 1-900 litres


10nm
www.zoz.de
Anticorrosive Paint
ZN-CP301
ZoLiBat®
Zoz Lithium Battery

Zoz Energy

- opportune utilization of EEG
- shaping future energy
- renewable and baseload-able
- Power to Gas to Fuel (P2G2F®,P2H®)

Zoz Energy is active since 2010 and to date operates seven photovoltaic fields and holds about 12 hectares land for the construction of wind turbines. Assigned are a PEM fuel cell plant in Siegen ZCS for electricity and heat supply (hydrogen reforming from city gas) and an electrolysis plant at ZTC in Olpe to supply hydrogen for vehicle operation on success of the Zoz-ZEV fleet.

Power to Gas at Zoz Technology Center (ZTC) + Zoz ZEV-fleet = Power to Gas to Fuel (P2H®, P2G2F®)

IronBird/power-box remains on vehicle, H2Tank2Go® are replaced at the next tank vending machine or home depot

Power to Gas to Fuel

Zoz ZEV fleet, OE-OZ-21 through OE-OZ-30

ZTC with 0,2 MW solar power

40 kW Electrolyser at ZTC

P2G2F® is a registered trademark of Zoz Group

Zoz Group

D 57482 Wenden · Germany

You may believe in:

CO2-Horror-Scenario of IPCC

but please don‘t take it as a given fact

Why do we need green religion if we can have green science !

RE think nature

? what if we don't have enough (material) ?

Recycle & Performance

performance of application

performance of material

ref. Dr. Chien-Yung Ma, OZ10, Germany, proc. V4-S02

today & tomorrow

NANOSTRUCTURE

making more with less

what a Simoloyer® is and does

HighKineticProcessing-device

- mechanical alloying (MA)
- high energy milling (HEM) and
- reactive milling (RM)

→ HKP

$24\,Ti + Al_{11}Nb \rightarrow Ti_{24}Al_{11}Nb$

rapid flake formation
rapid particle size reduction

$Ag_3Sn + 2\,Ag_2O \rightarrow 7\,Ag + SnO_2$

auto-batch-operation

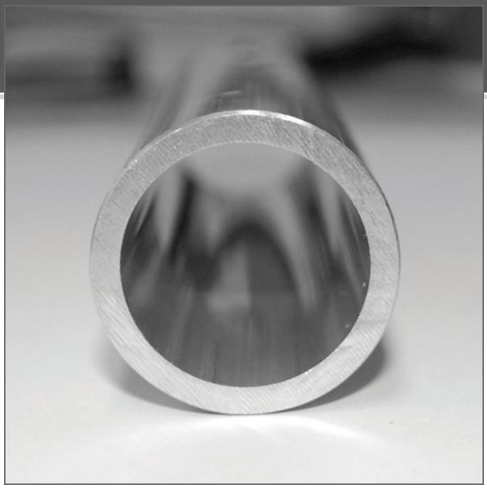
no limit in size, CM01-CM900

CM100-100lm-s2

CM100-100lm-s2x

Zentallium®

grain-size control by nanostructure



lighter than aluminium and as strong as steel [Al-CNT composite]

cooperative development Zoz & Bayer

What is available

Zentallium® consolidated by Hot Extrusion, semi-finished products, fasteners and transmission shafts;

What is new

Pressing and Sintering of Zentallium®

project-no. EP120573, BMWi

Development of Zentallium® powder material for conventional Pressing & Sintering consolidation process for high strength and hardness.

PUNALKO

project-no. 03FH054PX2, BMBF

Powder Metallurgical Fabrication of nanostructured Al-based high-performance materials for structural elements under high thermal stress.

HIP and Hot-Extrusion of Zentallium®

project-no. EP121019, BMWi

Development of Zentallium® at high strength and high elongation by modified grain-size control agents for HIP & Hot-Extrusion consolidation.

Federal Ministry of Economics and Technology | Zoz GmbH | ZIM Zentrales Innovationsprogramm Mittelstand | DLR | Bayer MaterialScience | EADS | Fachhochschule Osnabrück University of Applied Sciences | Carl von Ossietzky universität Oldenburg | DIEHL | Westfälische Wilhelms-Universität Münster | Universität Siegen

Nominiert für **Deutscher Umweltpreis 2013** durch DIE FAMILIEN UNTERNEHMER ASU

Power to Gas to Fuel P2G2F®

Zoz Hydrogen Technology

Nanostructures for Zero Emission Future Transportation & Energy

nanostructured H2-storage Hydrolium® - environmentally friendly and cost effective

solid-state absorber tanks H2Tank2Go® - virtually pressure-less, safe, clean and lasting

click'n'go system H2Tank2Go® - replacing tanks within seconds

exchange at a tank vending machine - refueling e. g. at any home depot

automotive future names Hydrogen - with 20 tanks you can drive your car

Power to Gas to Fuel & Zero Emission Mobility - only makes sense if energy is provided fossil-free

Hydrogen-Storage-Tank H2Tank2Go®
Reasonable energy storage for mobile & stationary use, superior safety level, existing infrastructure, brilliantly simple, flexible multi-tank-operation, MOT-approval pending, no one has come so far.

Zoz Hydrogen Technology – Power to Gas to Fuel - P2G2F®
Make hydrogen mobility available, create an infrastructure, win new customers, generate energy emission-free, produce & store hydrogen, drive with hydrogen & supply electricity.

isigo®H2.0

P2H® | P2G2F® | Hydrolium® | H2Tank2Go® | isigo ® | are registered trademarks of Zoz Group

Zoz Group **D 57482 Wenden · Germany**

H2-OnAir+

nanostructure in Zoz-Tanks
[Hydrolium®, H2Tank2Go®] and PEMFC's (Zentallium®)

Electric Aircraft with Hydrogen Range Extender

project-no. EG 906, EUROGIA+/EUREKA

What is new

advanced and environmentally friendly aircraft propulsion by a combination of solar cells, battery and hydrogen fuel cell;

solid state hydrogen storage as well as the physical combination with pressurized hydrogen for aviation;

fuel cell system provides electrical power for all flight phases (not only for cruise);

cost-effective, lightweight fuel cell system;

standardized connectors for all kinds of hydrogen tanks;

same tanks for aviation and ground transportation;

quick replacement of tanks rather than refueling on board (new infrastructure strategy at revolutionary logistics and operative way of refueling);

platform for later High Altitude Pseudo Satellites (HAPS) at combined Battery-Solar-FC-technology for very long term flight missions;

AIRBUS GROUP

AIRBUS AN EADS COMPANY | Zoz GmbH | eurogia+ | EADS | IFB | MaHyTec | cnrs | IIChPAN

eGenius won the Lindbergh prize for being the quietest aircraft during NASA's Green Flight Challenge in 2011

THE BEST IS YET TO COME

The rapid development of alternative energy sources over the last decade is helping solve the question as to how to achieve a similar or better performance without carbon dioxide emissions. With air traffic growing faster than any other transport sector, EADS is examining the long-term potential of electricity and hydrogen as complementary on-board energy sources.

Hydrogen is a clean energy source which is constantly evolving, with 50 million tonnes produced annually and global demand increasing by five to 10% per year. It is primarily used to refine heavy hydrocarbons, but could also be a complementary energy solution for air transport. This potential is the reason why EADS has decided to launch a project based on a fully electric aircraft, partly powered by on-board hydrogen fuel cells, devices that transform the energy contained in hydrogen and ... three-year programme is being develo... of EUROGIA+, a European Union p... international partnerships to advance ... energy technologies.

While this light plane will be equip... solar cells in its wings to provide the ... hydrogen fuel cell system will help e... range, allowing it to fly for 40 minu... 120 km/h. “The key enabler for such a demonstrator is the development of a solid-state hydrogen storage system,” emphasises Dr. Agata Godula-Jopek, Fuel Cells Expert at EADS Innovation Works (IW), the Group’s research network. “This system can achieve higher energy densities, meaning more efficient performance and potentially longer runtimes, but currently has a more complex development path,” she adds.

To overcome these difficulties, the storage system will be based on an innovative technology which improves the kinetics of hydrogen storage by incorporating novel nanostructured materials. Such structures at refined grain size and at the same time enlarged grain boundary surface favour the sorption migration – in and out – of hydrogen atoms. This system will be provided by the Zoz Group (see box), along with two fuel cells, while IW will be responsible for integrating the system in the flying platform and testing this in flight. The flying platform itself, known as Icaré II, ...ute of Aircraft Design at the Univer... ...ect team will also include the French ... Research (CNRS).

AIRBUS
GROUP

...ch of genius

...ute of Aircraft Design is also a factor ...ly designed for full electric flight de... ...essor Voit-Nitschmann (see box). Airbus is the main sponsor of this aircraft, which took its first flight in May 2011, while IW is also involved. “The purpose of this project is to better understand electric propulsion, which could become relevant for commercial aircraft,” says Nikolai Kresse, manager at Airbus Future Projects. Looking at the long term, the company reaffirmed its commitment to sustainable mobility this September by engaging in the Clean Sky 2 programme from 2014 to 2020, during which €3.6 billion will be invested by the industry and the European Commission.

“Not many years ago there were no electric aircraft on the market, but since around 2000 there have been dozens of projects and the trend is developing quickly,” says Kresse. The eGenius is a two-seat, high-wing aircraft manufactured from fibre composites. The electric motor, integrated in the vertical tail, has a maximum continuous power of about 30 kW and a peak performance up to 72 kW at a weight of just 27 kilograms. And directly behind the pilots are four lithium-ion battery packs integrated in the fuselage. “In the last year, we’ve learnt that electric propulsion is very efficient: eGenius only needs a few kilowatts for a half-hour flight – you would use more fuel just to power on a conventional aircraft engine! Despite being a prototype, it is flying without a hitch,” underlines Kresse.

Airbus is analysing the technical data from the flights together with IW, who also have another team focusing on the performance of the high-energy lithium-ion batteries. “Industrialisation will depend a lot on battery technology, and you can only guess how this will develop 30-40 years from now. But flying up to 500 kilometres with two people on board on a full electric aircraft was only a dream a few years ago, and now it is a reality with eGenius,” enthuses Kresse. And while the transition to commercial aircraft is still decades away, these alternative propulsion methods are already making an impact in the aerospace industry. Their use for next-generation UAVs or High Altitude Platforms, for example, is currently being studied. “To understand the real problems you cannot just work on paper, you have to put your feet on the ground. Demonstrators can be an efficient way to mature and promote radical steps in technology, motivating researchers, showing what is possible today and collecting data to learn what may be feasible in the future,” concludes Kresse.

Álvaro Friera

"HYDROGEN IS THE ANSWER"

Prof. Dr. Henning Zoz
President and CEO of Zoz Group

Could you explain the hydrogen storage system for the Icaré II flying platform?

With the scooter and car industry in mind, we are developing a simple and conveniently interchangeable system of small tanks of 0.9 litres each, where our goal is that 23 of these H2Tank2Go® bottles could offer 2.25 kilograms of hydrogen. This would equal 75 kW/hour, which moves a one-tonne vehicle 300 kilometres. Now at the halfway stage, we can guarantee 50 grams of hydrogen per tank. For the flying platform, however, we will probably supply just six or eight bottles and the fuel cells in a parallel back-up system. Already on the 50g/tank basis, this will be enough to triple aircraft's current range. Our plan is to have around 10 flights in 2013 and 2014 and I wish I could be the pilot on one of these flights.

A kilogram of hydrogen today costs between €6 and €15 and there are only around 200 hydrogen-fuelling stations worldwide. What could be done to make this market more attractive?

My company makes a good part of its profits from third-generation advanced lithium battery technology now, but hydrogen is the answer for humanity's energy problem. We believe we have the solution to revolutionise the hydrogen refuelling infrastructure thanks to our simple and small interchangeable bottle system. Using this, we wouldn't need refuelling stations; we could replace and recycle the bottles in vending machines, bringing the refuelling time almost to zero.

"WE'LL SEE ELECTRICAL BUSINESS AVIATION"

Prof. Dipl.-Ing.
Rudolf Voit-Nitschmann
Institute of Aircraft Design, University of Stuttgart

What can you tell us about progress on electric propulsion?

We started electric flight in 1996, when nobody was doing it. While Icaré II derives from a solar-powered plane designed in 1994, eGenius is a follow-up of an aircraft powered by a fuel cell system. We optimised the whole system for electric propulsion, integrating the electric motor in the vertical tail to further increase energy efficiency. The main advantage is that we have reduced power consumption to 80%, as well as lowering noise and emissions. I think this technology could be available for business aviation in 10 years, while for larger aircraft we will have to wait over three decades.

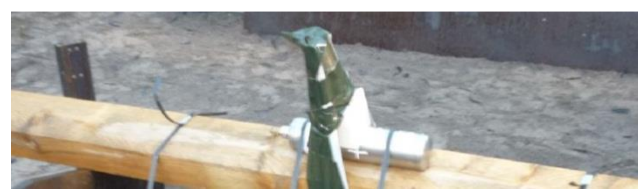
What are the advantages of collaborating with EADS?

It is important that industry, research institutes and academia partner to drive technological evolution. Airbus won't build an airliner with electric propulsion in the medium term, but will use our findings for further electric systems integration in their aircraft. Moreover, EADS researchers are also interested in transforming this technology into products like UAVs. These vehicles could fly into and out of the target area using a hybrid engine, while fulfilling the mission in electric flight: a very low noise operation with no emissions and no heat, making the UAV virtually undetectable.

Reporting here and above by ÁF

H2Tank2Go® - shelling test by German armed forces (Bundeswehr)

- Shelling tests of H2Tank2Go®, done by the German armed forces (Bundeswehr) early November 2012 at the „Wehrtechnische Dienststelle für Waffen und Munition 91 (WTD 91 or „Schießplatz Meppen“)“ in the city of Meppen
- Tests were done with 12,7 mm charge and with 44 mm hollow charge
- *…“Bei einer Hochdruck-Tankbatterie hat es die komplette Anlage zerlegt. Mit so einer gewaltigen Explosion hatten wir nicht gerechnet. Sogar Sicherheitsglas wurde durchbrochen und einige Leute erlitten Schnittverletzungen.“….*
  Other H2-tanks were shelled as well during these tests – one of which (high-pressured H2-tank-array) caused an explosion so severe, that even safety glass was pierced by debris and people got injured.
  (details of this incident remain confidential)
- No safety issues with the H2Tank2Go® (as expected)

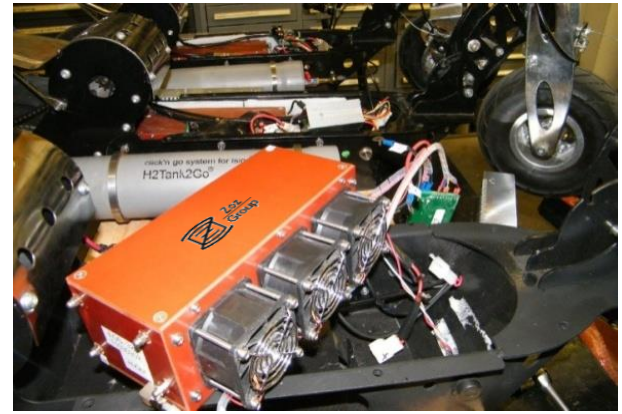


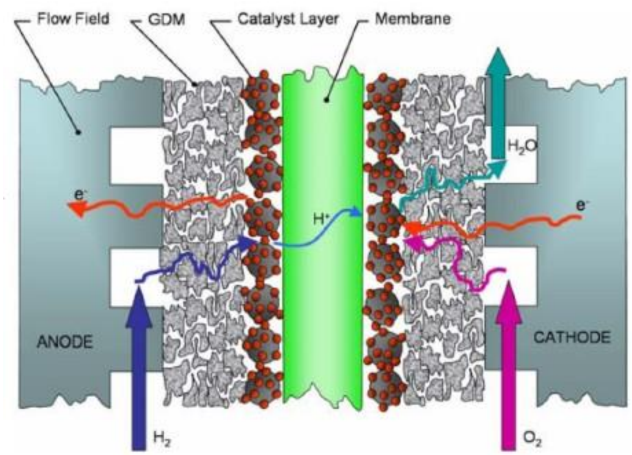
- Economic FuelCells (PEM) for tomorrow:

  Target Cost: 1.000 USD / kW electrical power (small scale, air-cooled up to 2 kW)

- Goals & Requirements
  - precious metal saving
  - prefabricated C-layer
  - high performance CCM (1W/cm²)
  - cost effective most simplified BPS
  - automatic manufacturing
  - strategic market impact

- …this is formed at Wenden !





ref.: SGL Group, „Gas Diffusion Layers“, SGL Shanghai, September 2011

Die Landesregierung Nordrhein-Westfalen

EFRE.NRW
Investitionen in Wachstum und Beschäftigung

LOCOPEM

Projektträger Jülich
Forschungszentrum Jülich

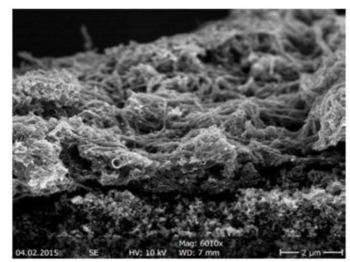
German Federal Ministry of Education and Research
project no.: NW-1-1006 // 01.01.2016 // 3 years // total cost: 1.318.977,00 €

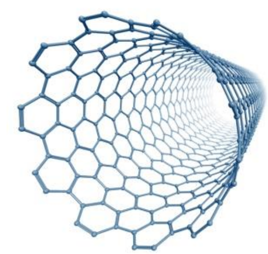
Development of low cost gas-diffusion-electrodes on the basis of CNTs/CNFs for application in PEM fuel cells

*Entwicklung von **Lo**w **Co**st Gasdiffusionselektroden auf Basis von CNTs/CNFs für den Einsatz in **PEM**-Brennstoffzellen*

Zoz Group

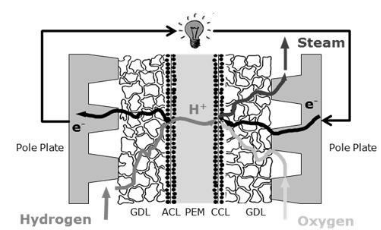
Westfälische Hochschule
Gelsenkirchen Bocholt Recklinghausen
University of Applied Sciences

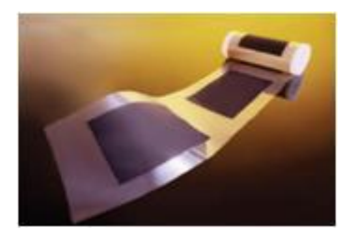




Z B T
Zentrum für BrennstoffzellenTechnik

thermico



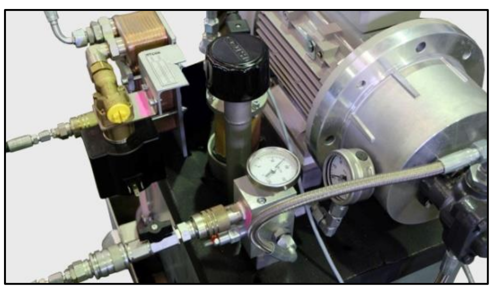


2019-12, LOCOPEM membrane forming & assembly device

Hydraulic hot press for the production of
***LO**w **CO**st **P**roton*
***E**xchange **M**embranes*
(PEM)

Hot pressing

- semi-automatic
- easy handling (25cm space)
- pressure control
- temperature control
- easy cleaning and maintenance
- pressure range
  - 2-25 bar
- temperature range
  - 20-150° C



Funded by the European Union
EUROPÄISCHE UNION
Investition in unsere Zukunft
Europäischer Fonds
für regionale Entwicklung
EFRE.NRW
Investitionen in Wachstum
und Beschäftigung

Zoz Group
D 57482 Wenden · Germany

H2-tank system B4S-SM/MM

nanostructured reactive complex metal hydride

single/multi module ● solid-state > 8 wt.%

high potential energy storage for the future

$$2LiBH_4 + MgH_2 \rightarrow 2LiH + MgB_2 + 4H_2$$

H2-storage: > 8 wt.%, > 80 kg H_2/m^3 storage material

H2-loading completely reversible, H2-release thermally activated only !

H2 single-module tank B4S-SM

consortium: *www.bor4store.eu*, EU-project FCH JU 303428 [2012-2015]

H2 multi-module tank B4S-MM

complex metal hydride processing unit Simoloyer® CM100-s2; H2-tank system B4S-SM outside ZTC; and inside at HZG - Hydrogen Technology Centre

P2H® | P2G2F® | Hydrolium® | H2Tank2Go® | Zentallium ® | Simoloyer ® | are registered trademarks of Zoz Group

D 57482 Wenden · Germany

phase I (11-2013 through 02-2014)

- Zoz has acquired 10 vehicles (ZEV-Battery) from own funds
- generation of 10 local charge terminals (Zoz & Partner > list)
- distribution of 10 vehicles (list)
- setting up of 2 E-charging stations by Zoz (Siegen)
- [4]setting up of 10 E-charging stations (Sauer-/Siegerland > list)

phase II (2014-2015)

- Fleet- and infrastructure data > project [5]REMONET/City of Siegen/BMBF
- upgrading of the 10 Zoz-ZEV's with H2-drive (Iron Bird from H2-OnAir)
- setting up of 10-15 tank vending machines H2Tank2Go®

[3-4, 6-7] RWE, Kirche and Stadtverwaltung Olpe, to date only declaration of intent, no commitment yet
[5] REMONET = Regional E-Mobility Network (01.11.2013 - 30.04.2018)

Die Landesregierung Nordrhein-Westfalen

Olpe

H2Fuel2Go

Clean Energy Partnership CEP

NOW Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

01.01.2017 // 3,8 years // total cost: 3 M€

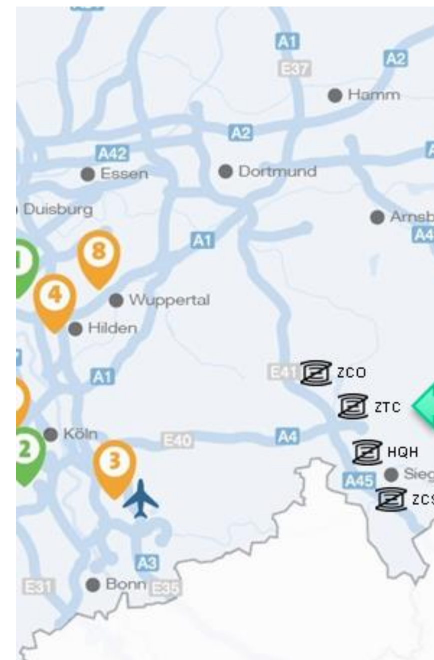
vollständige Demonstration einer Wasserstoffkreislaufwirtschaft mit neuartigem, wartungsfreiem und energieeffizientem Feststoffspeicherkompressor

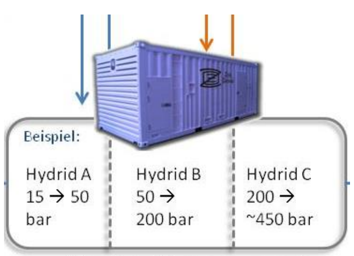
complete demonstration of a hydrogen circulation economy with a novel, maintenance-free and energy-efficient solid-state storage compressor

H_2 MOBILITY WASSERSTOFF TANKEN

Zoz Group

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research





Wasserstoffkompressor auf Metallhydridbasis

BURGEN LANDKREIS

Bundesministerium für Wirtschaft und Energie

H2-BLK

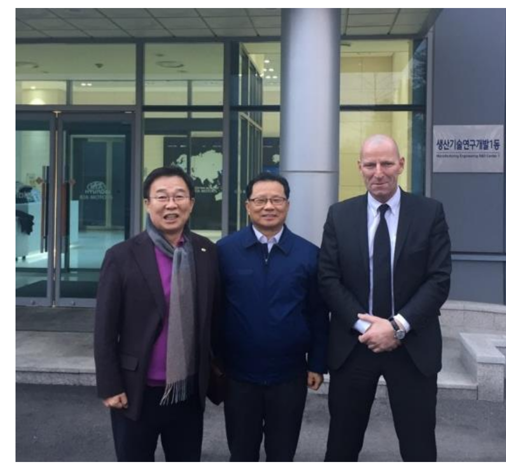
Wasserstoffregion Burgenlandkreis

Power-to-Gas-to-Fuel P2G2F®, H2-Circular-Energy-Economy H2C2E, P2H®

Zoz Group | Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research | FRAMO | schuon | Baukontor GmbH Schmidt | ? HYUNDAI ?

22 MWp PV + 40 WEAs ea. 250-500 KW to the right, total installed power ~ 40 MW. LEUNA-Werke in the back.

Naumburg (Saale)
Sachsen-Anhalt, Germany
brown-coal region, wine & beauty



Dr. Young-Lib Kim (KAMI CEO),
Dr.-Ing. InSung Chang Hyundai VP,
Prof. Zoz, 21.01.2019

H2-Truck2Go

Wasserstoffregion Burgenlandkreis

BURGENLANDKREIS

Bundesministerium für Wirtschaft und Energie

Heavy Duty Road Trucks - Diesel vs. Hydrogen

Hydrogen fuel cell vehicles are sustainable once hydrogen is produced from renewable energy. H2 offers a much higher specific energy than batteries and the lighter weight contributes to solving range and payload issues inherent with a 100% battery-powered propulsion. Hydrogen provides on-board energy that powers the electric engine, significantly extending the vehicle's range capabilities compared to a straight battery solution and refuelling times are virtually the same compared to diesel. Fuelcell electric heavy-duty trucks are otherwise-conventional multi-ton trucks using compressed H2 gas to generate electric power via PEM fuelcells.

The particular more attractive H2-storage route utilizing hydrogen solid state absorber systems RTMH such as Hydrolium® / H2Tank2Go® (e. g. in multitank or large-tank arrangement), has not been demonstrated yet, thus represents an important future goal. No high pressure of H2 required (<10bar).

Power-to-Gas-to-Fuel P2G2F®

H2-Circular-Energy-Economy

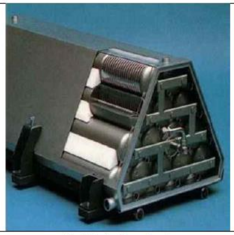
H2C2E, P2H®

type of truck	MAN TGX 26.440 44to unit	e.g. MAN rebuilt to H2		
power system[1]	diesel engine	electric engine & fuelcell & buffer battery		
power	295kW (401hp) @ 1900 rpm	synchronic engine 250KW constant		
fuel	diesel	hydrogen		
energy density	12 kWh/kg	16.3 kWh/kg at 50% FC-efficiency		
energy conversion	direct	3x 116,66kW = 350kW (HT-PEMFC e. g. from Toyota Mirai)		
fuel consumption / 100 km	45 kg diesel (~53 liters)	15 kg H2[2]		
tank	2nos Al-tank (300l+250l)	H2-RTMH solid state absorber		
tank volume	550 l	215 l	425 l	640 l
range	1.000 km	100km	200km	300km
tank weight (full)	~1.0to	~1to	~2to	~3to
weight H2-RTMH	no	850 kg[2)]	1.700 kg	2.550 kg
refuelling time	30min	~1h	~2h	~3h
investment cost	today low	today high, tomorrow medium		
maintenance cost	medium	today medium, tomorrow low		
fuel cost	today high, tomorrow higher	today high, tomorrow lower		

(1) *"Development of Business Cases for Fuel Cells and Hydrogen Applications for European Regions and Cities"* commissioned by the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH2JU), N°FCH/OP/contract 180, Reference Number FCH JU2017 D4259

(2) 15kg H_2 is required to run 40 t truck for 100km (15/0.018 = 840kg) of RT-MH required to adsorb 15kg H_2


class 212 submarines, HDW, RTMH-tanks


early Daimler design

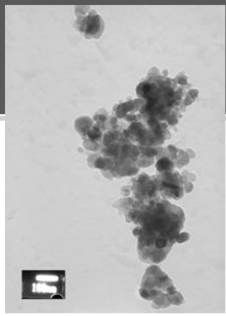

H2Tank2Go®

charging unit CM100-DN100m (mono)

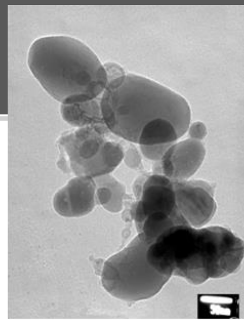
Simoloyer® CM100-s2, Carrier-gas discharging unit TGD100a (on right)

3rd gen. Li-Ion Bat. Cathodes

LFP & LMP, ZoLiBat®



— 100 nm



— 50 nm

new Li-Mn-phosphate | Li-Fe-phosphate materials

high performance by nanostructure

cooperative development HPL/DOW & Zoz | processing supply Zoz Prayon

Dr. Ivan Exner, Dr. Thierry Drezen, HPL, OZ-10, 3rd German-Japanese Symposium on Nanostructures (2010), Wenden, Germany, proc. S06 p-no. V21

F. Renard, Prayon, OZ-10, 3rd German-Japanese Symposium on Nanostructures (2010), Wenden, Germany, proc. S03 p-no. V07

Sophie Mailley, CEA, Advanced Materials for Li-Ion Batteries EuroNanoForum ENF2017, European Commission, Valletta, Malta, 21.06.2017

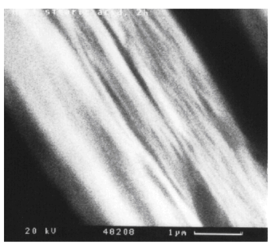
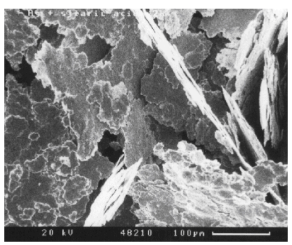
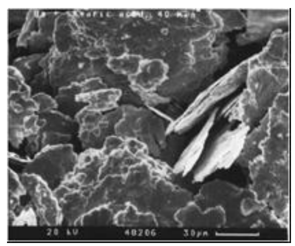
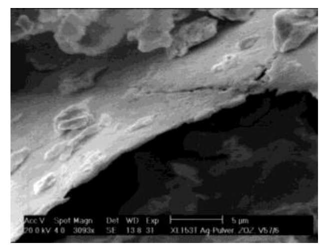
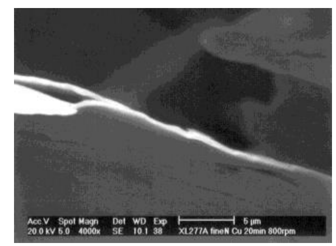
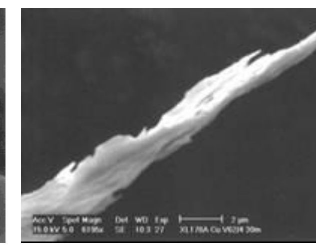
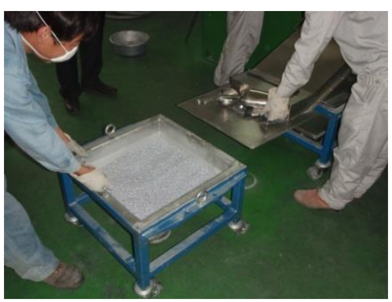
longo®1.0-ZLB (needs 4 ZoLiBat®-battery packs)

isigo®1.0-ZLB (needs 1 ZoLiBat®-battery pack)

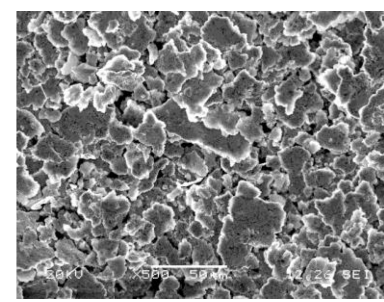
ductile metal flakes

[Al], [Ni], [Cu], [Pd], [Ag], [Au], [Pb] ● [Ti], [Fe], [Co], [Zn], [Mo]

and insitu composites of all

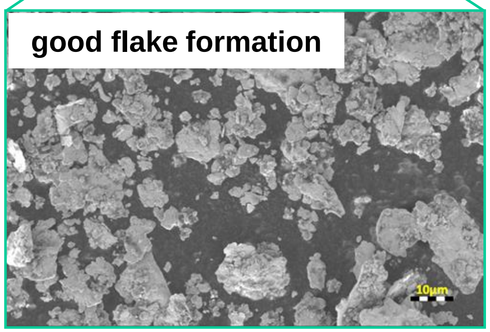




Zinc Flake Paint – ZN-CP301

2K-EP ZF anti-corrosion coating

high corrosion resistance ✦ CO2-low ✦ long shelf-life



ZN-CP301 provides excellent protection.

ZFP paint ZN-CP301 is conform to standards:

- DIN EN ISO 9227:2006 (salt spray test, deg. 1 after 10 weeks)
- DIN EN ISO 6270-2 (condensation climate test, deg. 0 after 10 weeks)
- DIN EN ISO 2812-2 (water storage, deg. 1 after 9 weeks)

cost-effective high performance stirr-in zinc flake pigments (ZFP) by high kinetic processing (HKP)

PRO INNO II-project-no. 0078402WZ7 and ZIM-project-no 2435404SU2

Zoz Group · Hochschule Niederrhein University of Applied Sciences · Chemie Faculty of Chemistry · Bundesministerium für Wirtschaft und Technologie · EVONIK INDUSTRIES · impulse ZIM für wachstum Zentrales Innovationsprogramm Mittelstand

solvent-free manufacturing > less CO2

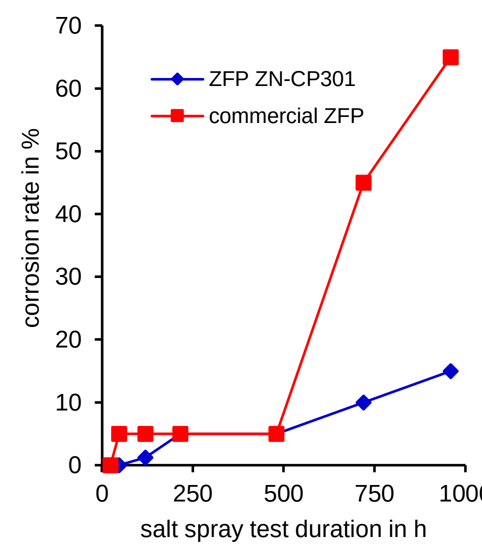
product comparison: salt spray test

ZFP ZN-CP301		commercial ZFP	
coating	after test	coating	after test

coming up next:
water-based corrosion protection systems with zinc flake pigments

technical data

base	epoxy-resin 2K-system	
colour	silver grey (dull)	
ratio of components	10:1 (primer:hardener)	
tap densitiy	1.52 g/cm³	
theoretical coverage	>70m²/l	
flash point	40° C	
zinc content [w%]	75 %	
drying time	0.5 h touch	2 h handling
thinner (recommended)	Xylene, acetone	

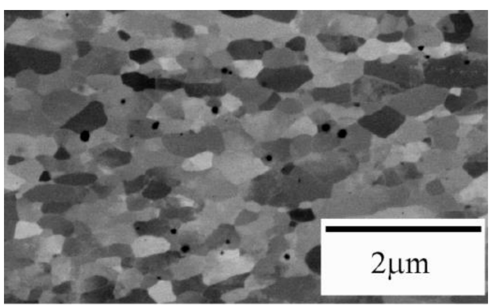


ODS/NFA

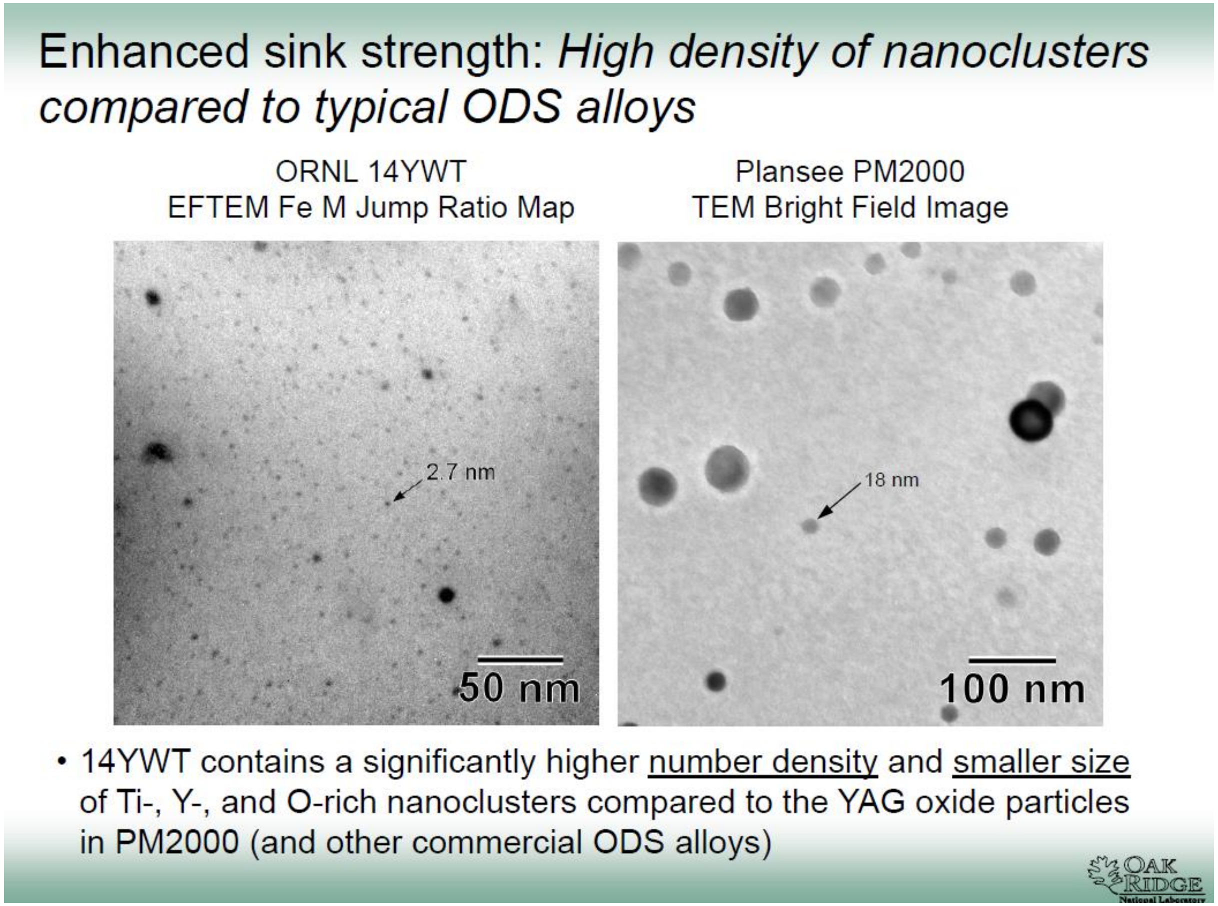
Nanostructured Ferritic Alloys
Oxide-Dispersion-Strengthened

- high temperature stability & strength (PM2000, partic. fine grain/HIP)
- resistance to irradiation damage (PM2018)
- available for additive manufacturing (PM2017)
- ➢ NFA // ODS oxide characteristics and location

brand	time	composition	name	origin
PM2000	2017-09	Fe-19Cr-5.5Al-0.5Ti-0.5Y2O3	19YAT	ODS-PM
PM2017	2017-12	Fe-20Cr-5.5Al-0.5Y2O3	20YAl	ODS-RR
PM2018	2018-??	Fe-14Cr-3W-0.4Ti-0.25Y2O3	14YWT	NFA-GE

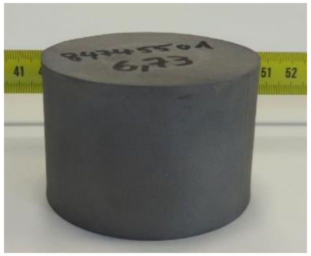


FAST METALLURGY



PM2000 – Porsche M-GT4

YAT, turbine Zoz-ARCI Center Hyderabad



V727-05c-2h-vac-SPS
2019-09-27
forging pr. 3 x 5 = 15mm
2s for ea. 5mm def.- step
heating temp. 1.100° C
air.

Karlsruhe Institute of Technology

D. T. Hoelzer, Oak Ridge National Laboratory: On the Development of Nanostructured Ferritic Alloys for Advanced Fuel Clad Applications in Nuclear Reactors, OZ-16, 9th International | 9th German-Japanese Symposium on Nanostructures (2016), Wenden, Germany, proceedings vol. 9 p-no. V02, S02

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F +49-2762-9756-7
E info@zoz.de

Zoz GmbH

PM2000 – ODS / SPS

SPS-consolidated, semi-finished and/or machined small parts

Application	Background & info
ODS-steels powder & bulk • high-temperature resistant • corrosion-resistant • (high strength) • components in gas turbines / aero- and combustion engines / combustors / incinerators • candidate for nuclear fusion reactors	• revitalization of Plansee PM2000 by Zoz • uniform distribution of dispersoids (nanoscale, 10-25nm) • PM-like process utilizing Simoloyer® for high kinetic processing (HKP) • ODS: Oxide Dispersion Strengthened steel • NFA: Nanostructured Ferritic Alloy • SPS: Spark Plasma Sintering • HIP: Hot Isostatic Pressing

Composition [w%]	Fe	Cr	Al	Ti	Y_2O_3
PM2000	bal.	19	5,5	0,5	0,5
PM2017ff (tbc)					

Dimensions – availability

SPS parts	dimensions	info
semi-finished	ø65 x H10-100mm	less ~ 1mm surface zone
semi-finished	ø105 x H10-100mm	
semi-finished	other dimensions upon inquiry	
machined	finished parts up to ø100x90mm	as per your requirement/dimensioning/drawing

Coming up next

brand	chem. composition (starting mat.)	ID	origin	t. b. on shelf
PM2000	Fe-19Cr-5.5Al-0.5Ti-0.5Y2O3	**19YAT**	ODS-PM	fine-grain/HIP only, ø40xL250mm
PM2017	Fe-20Cr-5.5Al-0.5Y2O3	**20YAl**	ODS-RR	powder only (AM, ALM, MIM)
PM2018	Fe-14Cr-3W-0.4Ti-0.25Y2O3	**14YWT**	NFA-GE	t. b. d.
PM3000	Ni-base ODS			

our Partners

Attention:
no regular cost before summer 2019, till that compensation agreement only

technical data subject to alterations

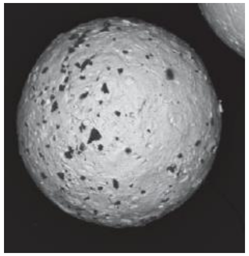
European Commission: Horizon 2020

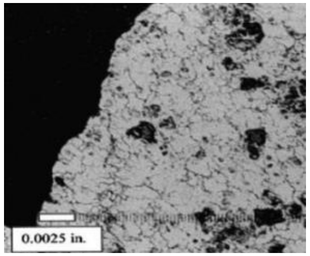
project no.: 685952 // 01.01.2016 // 3.5 years // total cost: 2.936.656,00 €

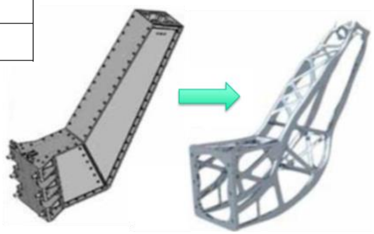
Development of the complete workflow for production and using novel nanomodified Ti-based alloy for additive manufacturing in special applications

Participant No *	Participant organisation name	Country
1 (Coord.)	ASOCIACION DE INVESTIGACION DE LAS INDUSTRIAS METALMECANICAS, AFINES Y CONEXAS	ES
2	LAURENTIA TECHNOLOGIES SLL	ES
3	CENTRO DE ESTUDIOS E INVESTIGACIONES TÉCNICAS	ES
4	UNIVERSIDAD POLITÉCNICA DE VALENCIA	ES
5	ZOZ GMBH	DE
6	TLS TECHNICK GMBH	DE
7	APR SRL	IT
8	VLAAM INTELLING VOOR TECHNOLOGISHCH ONDERZOEK NV	BE
9	THE WELDING INSTITUTE LTD.	UK

Ti-6Al-4V-0,5dps:
Y_2O_3, SiC & core-shell SiC@TiO_2







Yield Strength increase respect to the ASTM F2924 %)	Tensile Strength increase respect to the ASTM F2924 (%)	Elongation increase respect to the ASTM F2924 (%)
31%	28%	16%
32%	30%	36%
27%	28%	30%

The mechanical behaviour shown for three process parameters combination(1, 5 and 9) was better with respect to the ASTM F2924-14 reference.

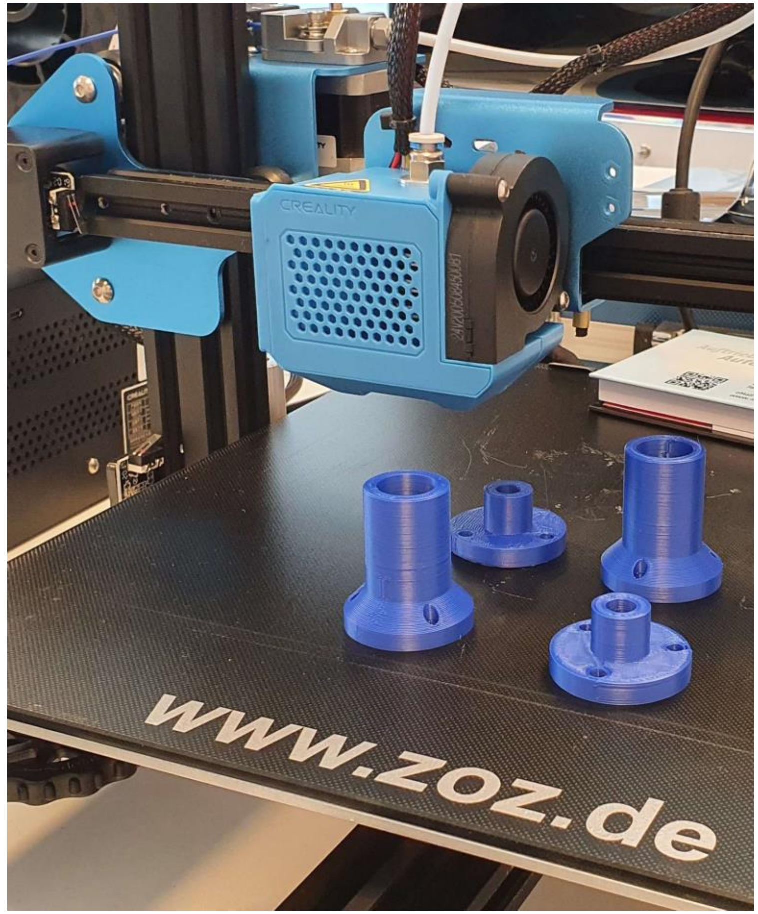
All processed material presented better behaviour than the standard AM Ti6Al4V, and additionally they were also better than a previous EU project (RepAir)

		Material	Building direction	Nº sample	Yield Strength (MPa)		Tensile Strength (MPa)		Elongation (%)	
	ASTM F2924-14 reference	Standard Ti6Al4V	XY		825		895		10	
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 1	Nanotun3d: Ti6Al4V+SiC	XY	1	1067	±18	1141	±19	12.5	±0.5
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 1	Nanotun3d: Ti6Al4V+SiC	XY	2	1057	±18	1138	±19	14.0	±0.5
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 1	Nanotun3d: Ti6Al4V+SiC	XY	3	1058	±18	1129	±19	15.0	±0.5
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 1	Nanotun3d: Ti6Al4V+SiC	XY	**Average**	**1061**	**±18**	**1136**	**±19**	**13.8**	**±0.5**
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 5	Nanotun3d: Ti6Al4V+SiC	XY	1	1060	±18	1146	±20	11.5	±0.5
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 5	Nanotun3d: Ti6Al4V+SiC	XY	2	1090	±19	1148	±20	11.5	±0.5
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 5	Nanotun3d: Ti6Al4V+SiC	XY	3	1084	±18	1150	±20	11.5	±0.5
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 5	Nanotun3d: Ti6Al4V+SiC	XY	**Average**	**1078**	**±18**	**1148**	**±20**	**12.0**	**±0.5**
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 9	Nanotun3d: Ti6Al4V+SiC	XY	1	1032	±18	1152	±20	6.5	±0.5
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 9	Nanotun3d: Ti6Al4V+SiC	XY	2	1086	±19	1136	±20	6.5	±0.5
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 9	Nanotun3d: Ti6Al4V+SiC	XY	3	1047	±18	1162	±20	14.0	±0.5
BUILD PLATE AND PROCESS PARAMETERS	EBM: STEP 3-PROCESS PARAMETERS 9	Nanotun3d: Ti6Al4V+SiC	XY	**Average**	**1055**	**±18**	**1150**	**±20**	**9.0**	**±0.5**

2020-10-02 ALM early stage in manufacturing

Spannbuchsen für Laser Zieleinrichtung,
Impulskanone IPM.
Erstes Serienbauteil in Additiver Fertigung bei Zoz

Clamping bushes for laser scope device,
Impulse-Collision-Twin-Gun IPM.
first series component in additive manufacturing at Zoz



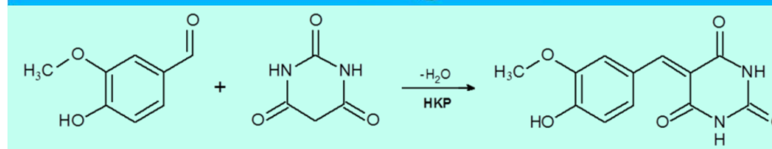
MechanoChemistry

interface between chemistry and chemical engineering
[RM to perform chemical syntheses]

mechanical alloying (MA)
⇨ $24\ Ti + Al_{11}Nb \rightarrow Ti_{24}Al_{11}Nb$

high energy milling (HEM)
⇨ **rapid flake formation**
⇨ **rapid particle size reduction**

reactive milling (RM)
⇨ $Ag_3Sn + 2\ Ag_2O \rightarrow 7\ Ag + SnO_2$



4-hydroxy-4-m ethoxy benzal dehyde
(vanillin)

2,4,6-trihydroxy pyrimidine
(barbituric acid)

5-(4-hydroxy-3m ethoxy-benzylidene)-barbituric acid
(5-vannillydene barbituric acid)

€ 203,00/kg + € 244,00/kg ⇨ € 488,00/g !?!

Knoevenagel condensation by HKP

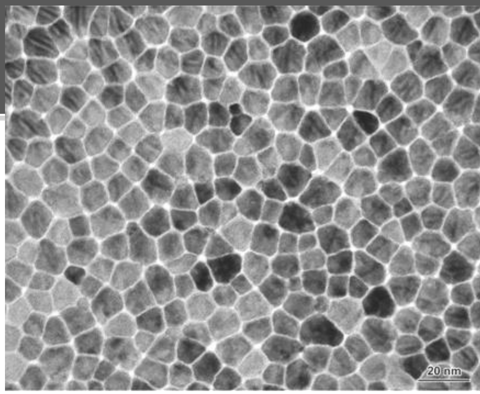
vanillin 99%
- bright yellow, sweet aroma
- M: 152.15 g·mol^{-1}
- mp: 81 - 83° C

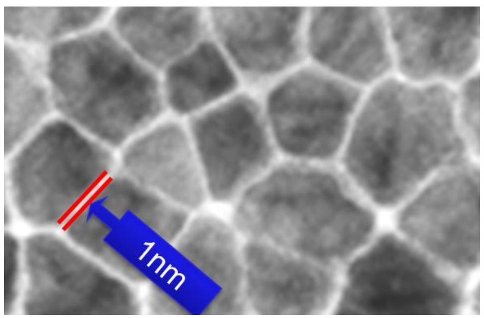
barbituric acid 99%
- colorless, odourless
- M: 128.09 g·mol^{-1}
- mp: 248-252 ° C

5-(4-Hydroxy-3-methoxy-benzyliden)-barbituric acid
- dark yellow, sweet aroma
- M: 262.22 g·mol^{-1}; mp: n. b.

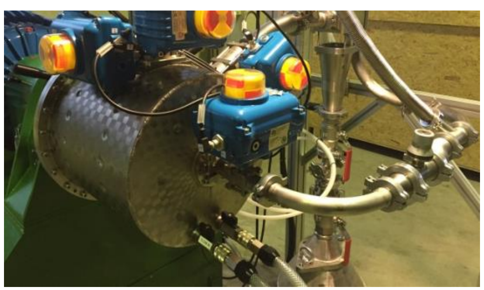
nanostructured target material

MDS/ODS – magnetic/optical data storage

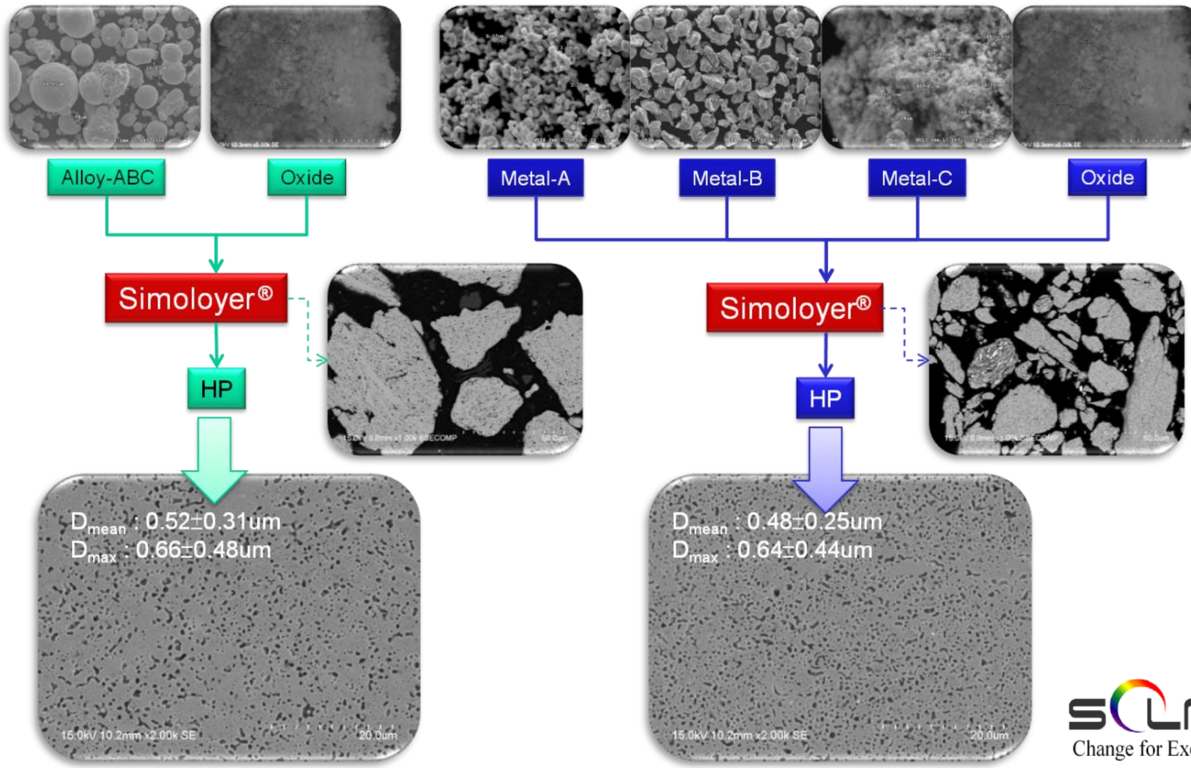




Pt-Oxide Thin Film, TEM



synthesis of metal & ceramic composite targets

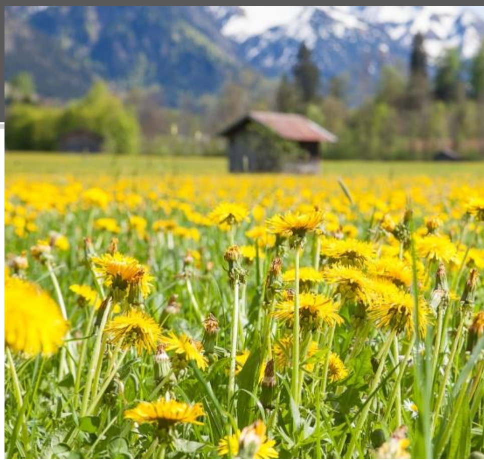


Change for Excellence!

S. J. Hou, Solartech, OZ-11, 4th German-Japanese Symposium on Nanostructures (2011), Kusatsu/Japan, proc. S03-V10

Taraxa Gum

from dandelion roots to high performance tires



"green" tires made by 100% natural raw materials

- rubber substitution by use of dandelion roots -

cooperative development Continental, Fraunhofer & Zoz

Fraunhofer

Zoz Group

Continental

Taraxa Gum

from dandelion roots to high performance tires

“green“ tires made by 100% natural raw materials

- rubber substitution by use of dandelion roots -

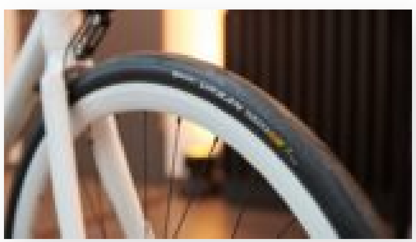
cooperative development Continental, Fraunhofer & Zoz

Fraunhofer

Zoz Group

Continental

参考記事



Continental launches bike tyre made from sustainable dandelion rubber - Cycling Weekly

Continental reveals its first ever bicycle tyre made from dandelion rubber and will make it available in time for the Tour de France

www.cyclingweekly.com

Alternative Natural Rubber

dandelion☼ successful, next comes banana☼☼

Zoz/Fraunhofer IME joint technology initiative

- sustainable biorefinery route for banana peels processing -

green^{+} rubber from dandelion, green^{++} from waste-peels

(a) Natural Rubber (NR) from Hevea Brasiliensis, background

NR is obtained from rubber trees (Hevea brasiliensis) providing latex, growing within the “green belt” of the planet
can technically not for 100% be replaced by synthetic rubber;

- market cost strongly fluctuating at increasing demand;
- from alternative resources known and challenging since WW-II.


Zoz-TRM at Anklam (left)

(b) Alternative NR (ANR) from dandelion roots

Russian dandelion, resource for Continental Taraxagum™
agrarian robust and undemanding, grows practically everywhere;
results in high quality natural rubber in one step;

- no latex coagulation required – environmentally friendly (green) rubber !
- FHG-IME increased the rubber yield crop massively, comparable to rubber tree.

2015 Fraunhofer IME Dandelion Rubber Extraction Facility was set up at the Zoz Technology Center (ZTC) at Olpe/Germany [4].
2017 Continental took over the dandelion unit at ZTC and
2018 opens the Taraxagum™ Lab at Anklam, Germany [5].
2018, Zoz designed a continuous processing unit in pilot scale for the above
⇨ In 5-10 years, Continental wants to be able to produce tires with ANR commercially. The goal is a more sustainable tyre production more independent from traditional NR sources.


Taraxagum™ tyre at OZ-16 + OZ-18

(c1) next step - continuous processing

Zoz designed, manufactured and in first years also operated the batch processing plant for rubber-extraction from dandelion roots in pre-industrial scale successfully. Converting such process into continuous operation for commercial industrial product volumes is the next step.

(c2) next resources - banana peels (BP)

- availability of (c1) can open a new world in green^{++} biorefinery offering a wide range of industrial utilization of quickly renewable natural resources;
- first flora candidate at high rubber content + available in large scale are banana peels;
- worldwide, about 135mio tons of bananas are cultivated, DE imports 1mio tons p.a.
- BP-waste at high volumes even in DE, as much as 30-40%wt (crop dry) of fresh fruit;
- BP degrades very slowly in composting, contains numerous pollutants from pesticides;
- including BP into product processing, prior or post transport, offers protection of the environment and value adding.

FuturBeton C.1

nanostructured cement/concrete

high strength ✦ CO2-low ✦ super durability

the world's first public bridge made of
Futur High Performance Cement/Concrete

project-no. 03X0068A, BMBF

Zoz Group | Dyckerhoff | Universität Siegen | Runkel | Straßen.NRW. | Olpe | Fuchs Lubritech

- 3-4x stronger (140 MPa)
- superior durability (95% GP)
- 20% CO_2-emission saving
- ➢ **all advantages for € 7,00 / ton**

FuturBeton can build more				
faster | sleeker | higher | cost-effective | durable | environmentally friendly				
100 % ready to market				
a	technologically	>!!	public bridge in Germany	
b	economically	>!!	+7 € / ton as of 43.000 tons p. a.	
c	ecologically	>!!	20 % CO2 savings	
			Automotive	**FuturBeton**
cost of additionally saved CO2			**678 €/ton-CO2**	**354 €/ton-CO2**

cost advantage FuturBeton vs. OPCC	cost relevance	CO2 savings relev.
higher strength > less material	🔥🔥🔥	🔥🔥
higher strength > replace steel	🔥🔥🔥🔥	
higher early strength > build faster	🔥🔥🔥	🔥
higher durability > less material	🔥🔥	🔥
higher durability > build less often	🔥🔥🔥🔥	🔥🔥🔥
better surface	🔥🔥	🔥
CO2-savings in manufacturing	🔥🔥	20 %
is FuturBeton more expensive ?	***€ 7,00/ton**	*2012-10, DE

		GER	World
CO2-savings-potential (by FuturZement/Beton)	[Mt]	**4.95**	**158.4**
CO2-savings-potential (ditto relative)	[-]	**0.6 %**	**0.5 %**

Zoz Group **D 57482 Wenden · Germany**

FuturZement|FuturBeton

environmental impact, new economic challenges

high strength ✦ CO2-low ✦ super durability

DesertSand + HKP and/or
DS + MicroPlastics + HKP

= advanced construction sand

- **40 bio.t/a** exploited, more than nature can deliver;
- **95%** of global sand not applicable for construction, river/beach sand yes, desert sand no !
- global trading volume for sand as construction material or for its minerals: **70 bio. USD/a**

⇨ HKP ⇨

world's largest exporter of sand

USA, Netherlands, Germany, 484–134 mio€ (2018)
cost from 6-60€/t (Natursand vs. Brechsand)

world's largest importer of sand

S'pore, from Indonesia, mid90`s 3€/t, 2000`s 190€/t

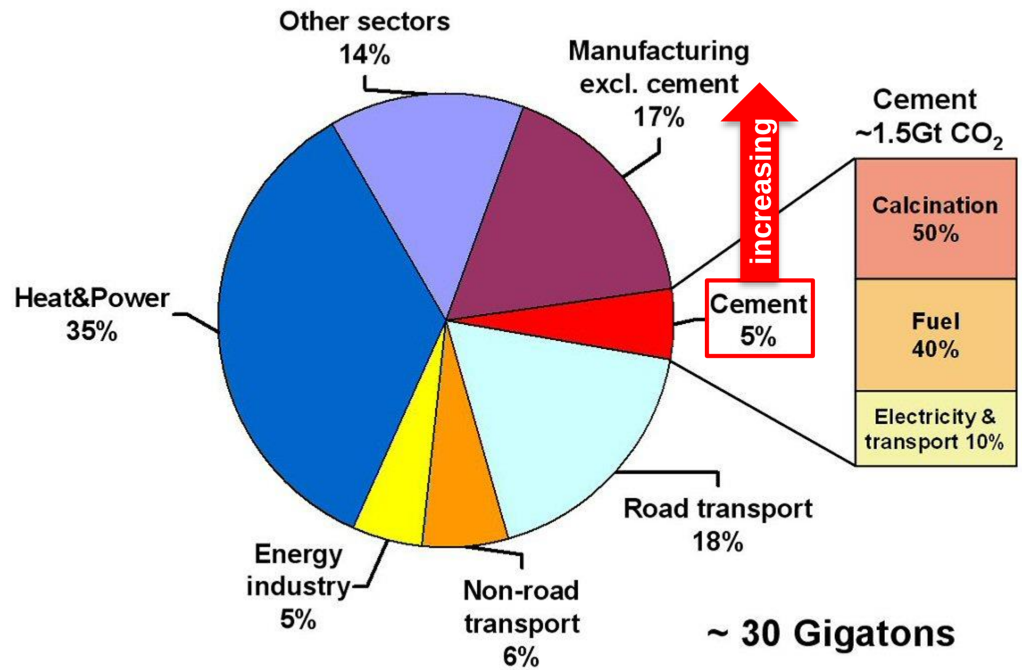
FuturBeton contains 32% sand
1x CM900, sand for 32kt/a FB
at 1:1 DesertSand + MicroPlastic
⇨ 10kt/a microplastic re-used

sources:
http://www.ploetzlichwissen.de/
http://www.welt.de

sand < 4mm
dry, φ = 1,3-1,4 kg/dm3

Where does CO_2 come from ?

What is the CO_2 saving potential regarding to cement industry ?

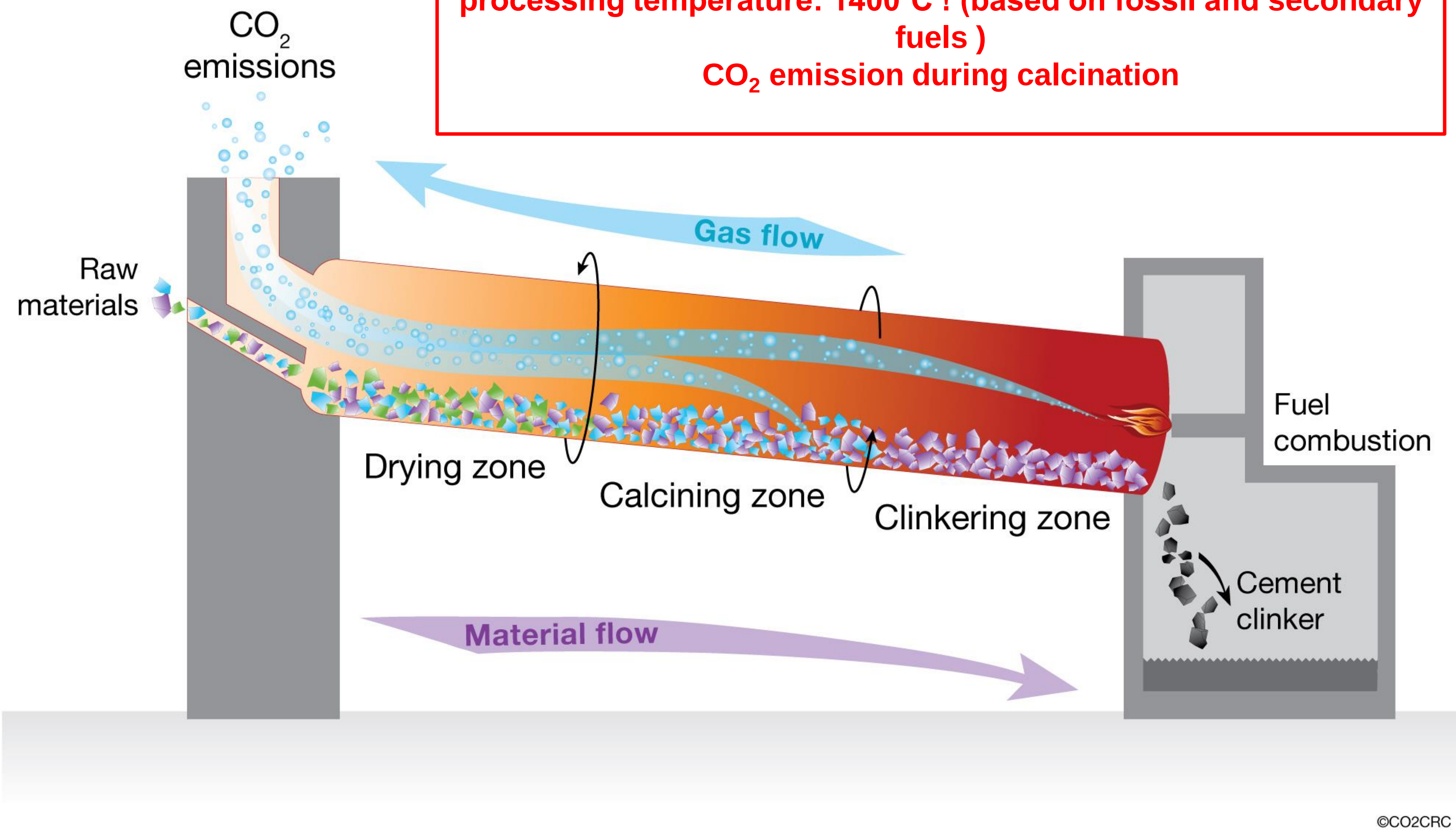


CO_2 – atmospheric lifetime: <u>50 – 200 years</u> !

<u>diagram:</u> global CO_2 production
[The Cement Sustainability Initiative Progress Report, 2005]

CO_2 emission during cement production ?

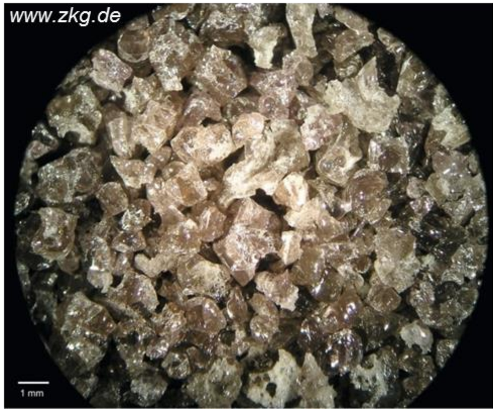
processing temperature: 1400˚C ! (based on fossil and secondary fuels)
CO_2 emission during calcination



nanostructured GGBS

- super-activation by High Kinetic Processing -

Ground granulated blastfurnace slag (GGBS) - high potential waste material



Influence of GGBS content on concrete properties

higher GGBS conctent

- ↓ slower hardening
- ↓ lower intial strength
- ↑ higher later hardening
- ↑ denser structure
- ↑ higher resistance against chemical attack

2013:
Production

⇨ 7.55 Mio t slag from steel manufacturing
⇨ 6.61 Mio t. GGBS

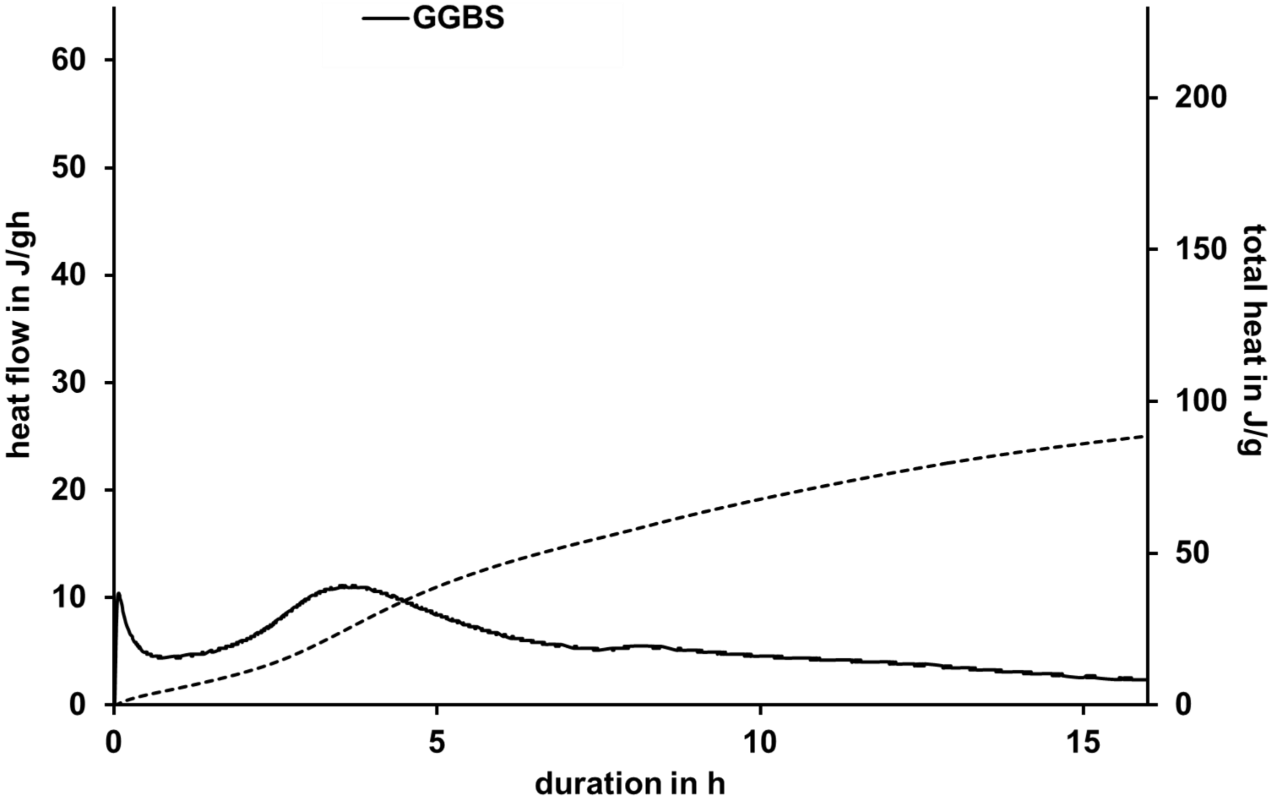
Application

⇨ 6.12 Mio. t GGBS for cement manufacture

source: www.fehs.de

shear and friction interaction in low kinetic processing

maximum relative velocity (MRV) < 5 m/s



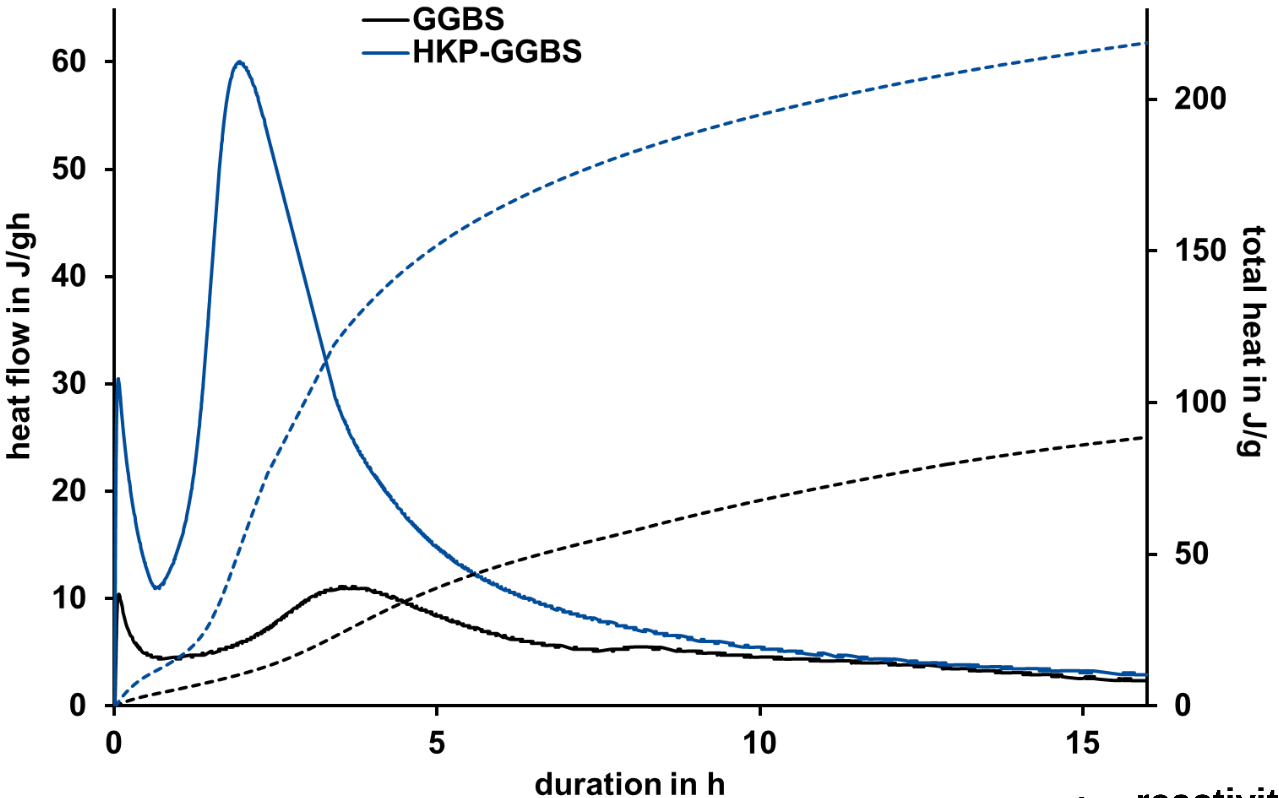
Low Kinetic Processing

- shear and friction -

Rollermill RM1 with transparent vessel RBG02

collision effects in high kinetic processing

maximum relative velocity (MRV) > 9 m/s



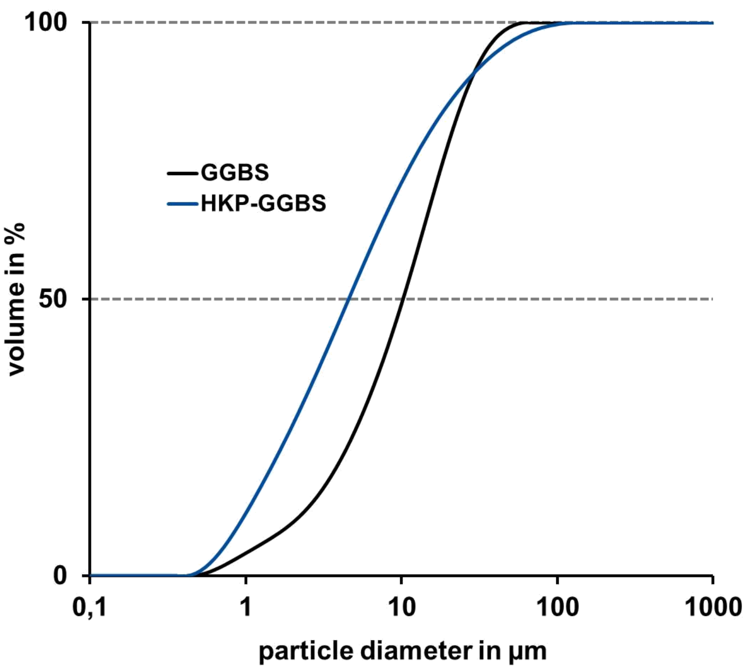
High Kinetic Processing

- collision -

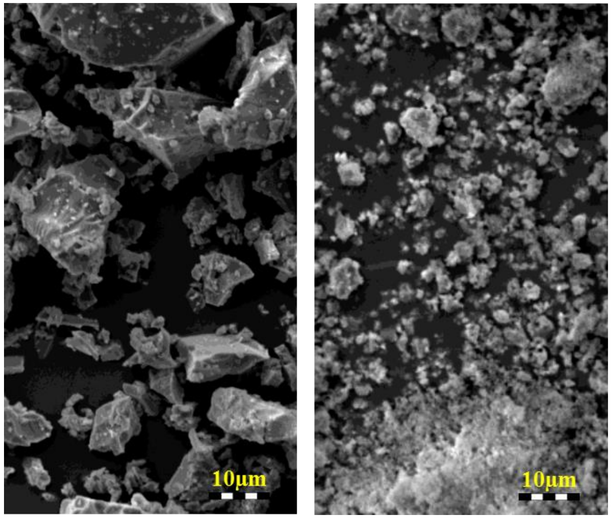
Simoloyer® CM01 with transparent vessel 01-2l

- **reactivity with water has been achieved**
  ⇨ no alkali activation necessary

GGBS - particle properties

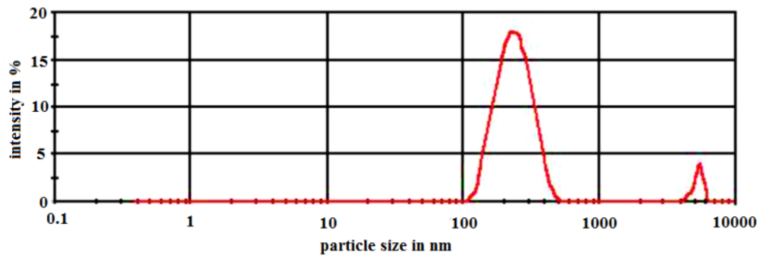


increase of fine particles



GGBS **HKP-GGBS**

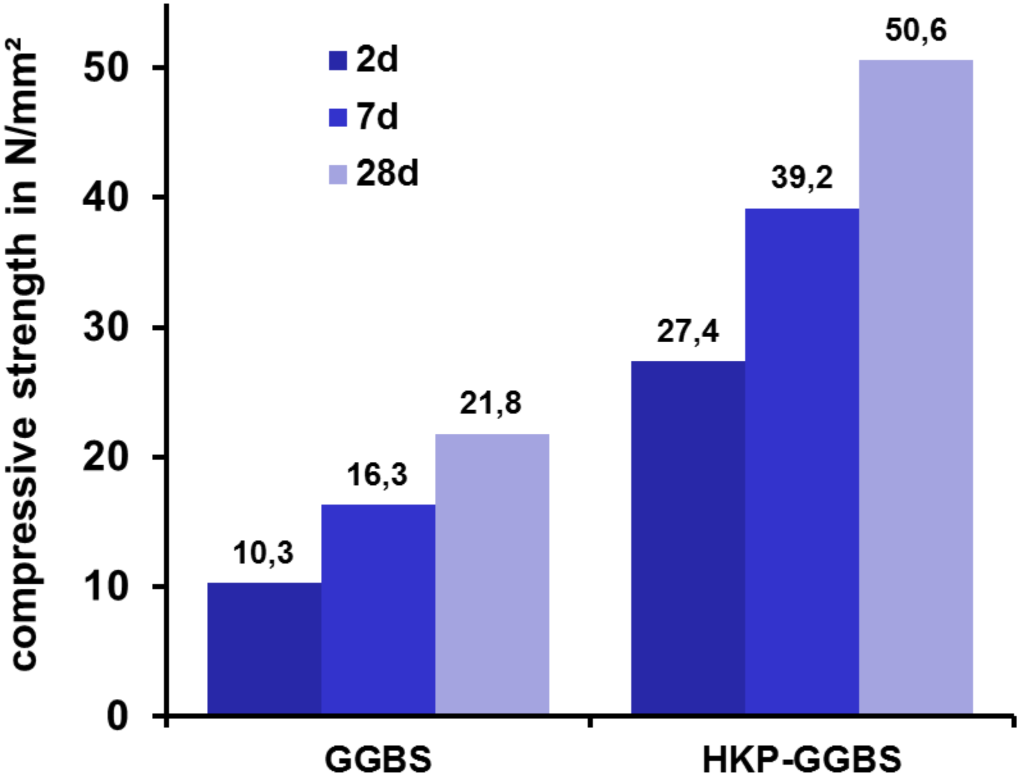
	particle diameter d_{50} (µm)	BET surface area (m^2/g)
GGBS	10,221	1,7
HKP-GGBS	4,572	2,7



HKP-GGBS: particles on nano scale

- **large specific surface area**
- **nano scale acitvation**

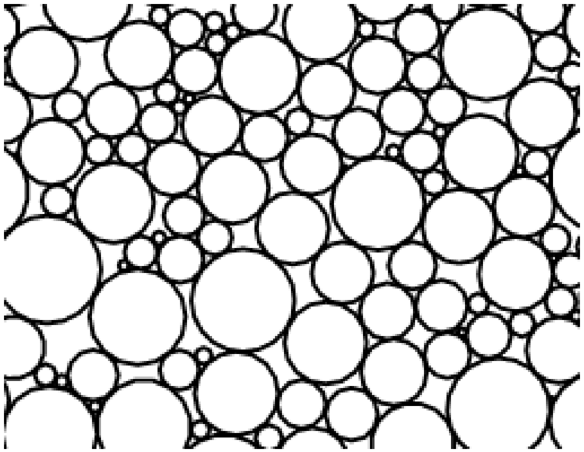
  ⇨ Increase of reactivity exponential to the increase of surface area



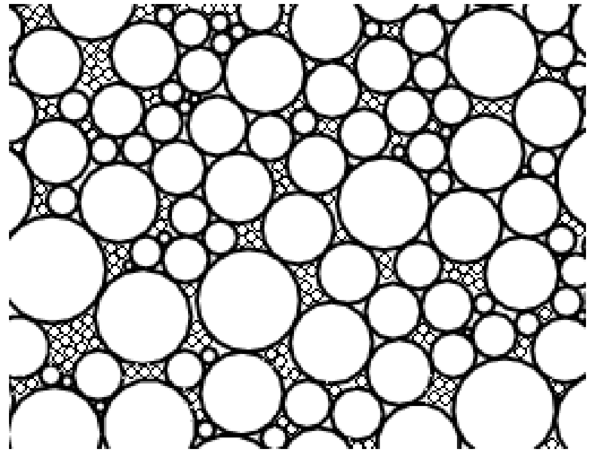
paste samples: GGBS + 2M NaOH, W/B=0,4

⇨ initial strength of HKP-GGBS higher than final strength of GGBS

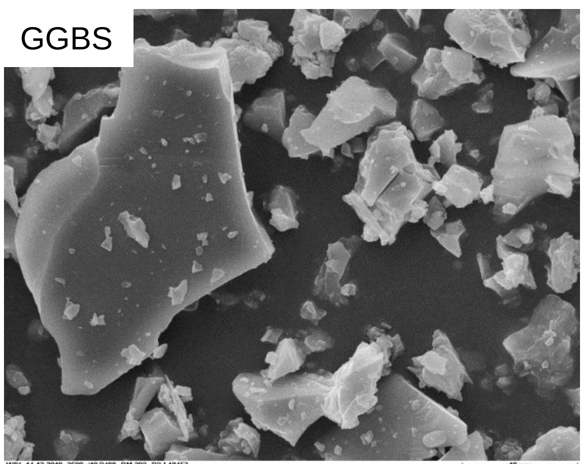
GGBS vs. HKP-GGBS

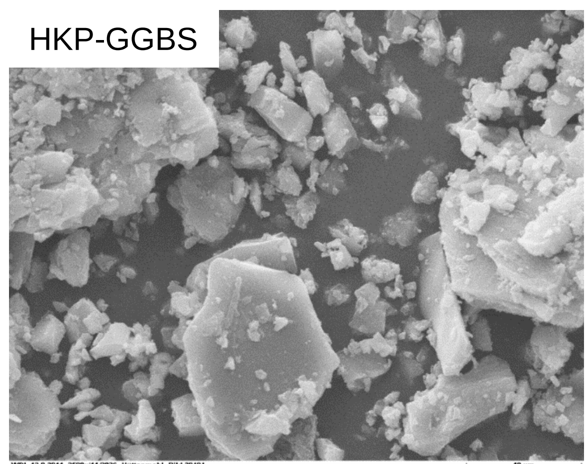


normal packing density



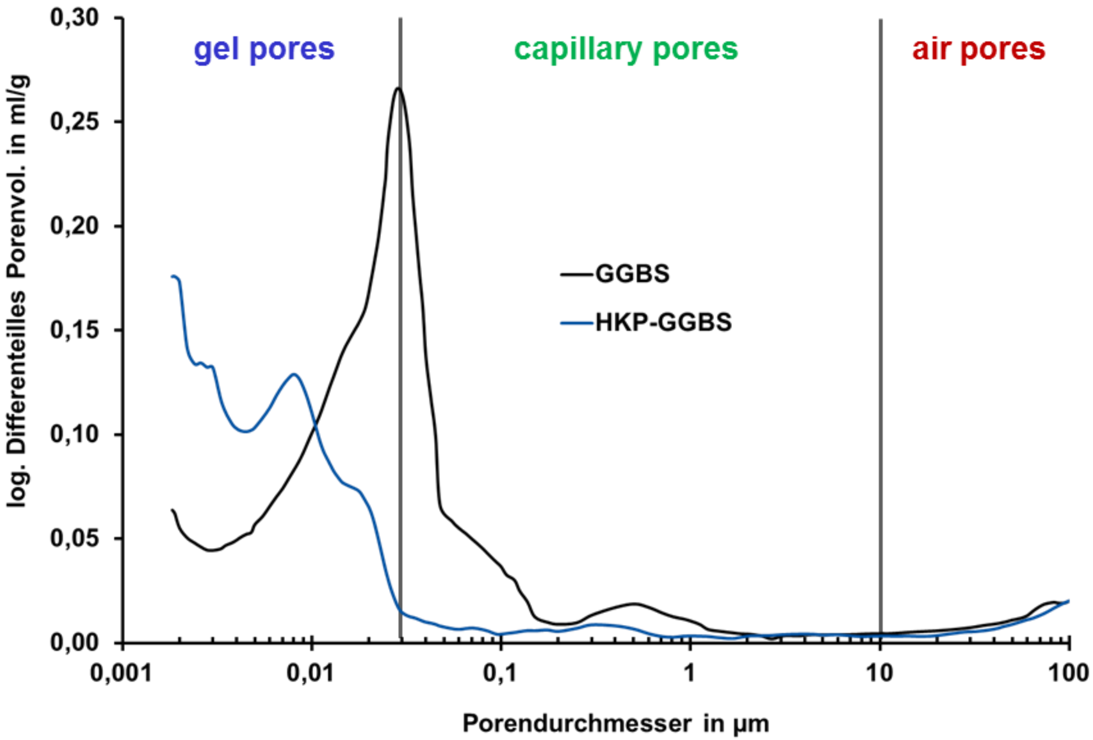
optimized packing density





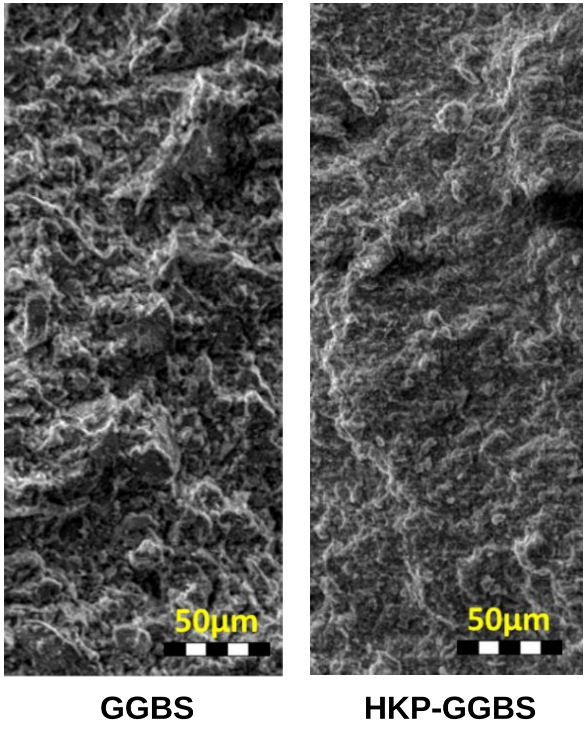
special PSD of HKP-GGBS generates a new binder system which is highly effective by providing an interface coupling in strictly two different dimensions.

particle size distribution GGBS vs. HKP-GGBS, model, SEM-micrograph



- **general porosity of HKP-GGBS paste samples lower than GGBS**
- **percentage of capillary pores and gel pores of HKP-GGBS significantly lower than GGBS**

increasing structure density



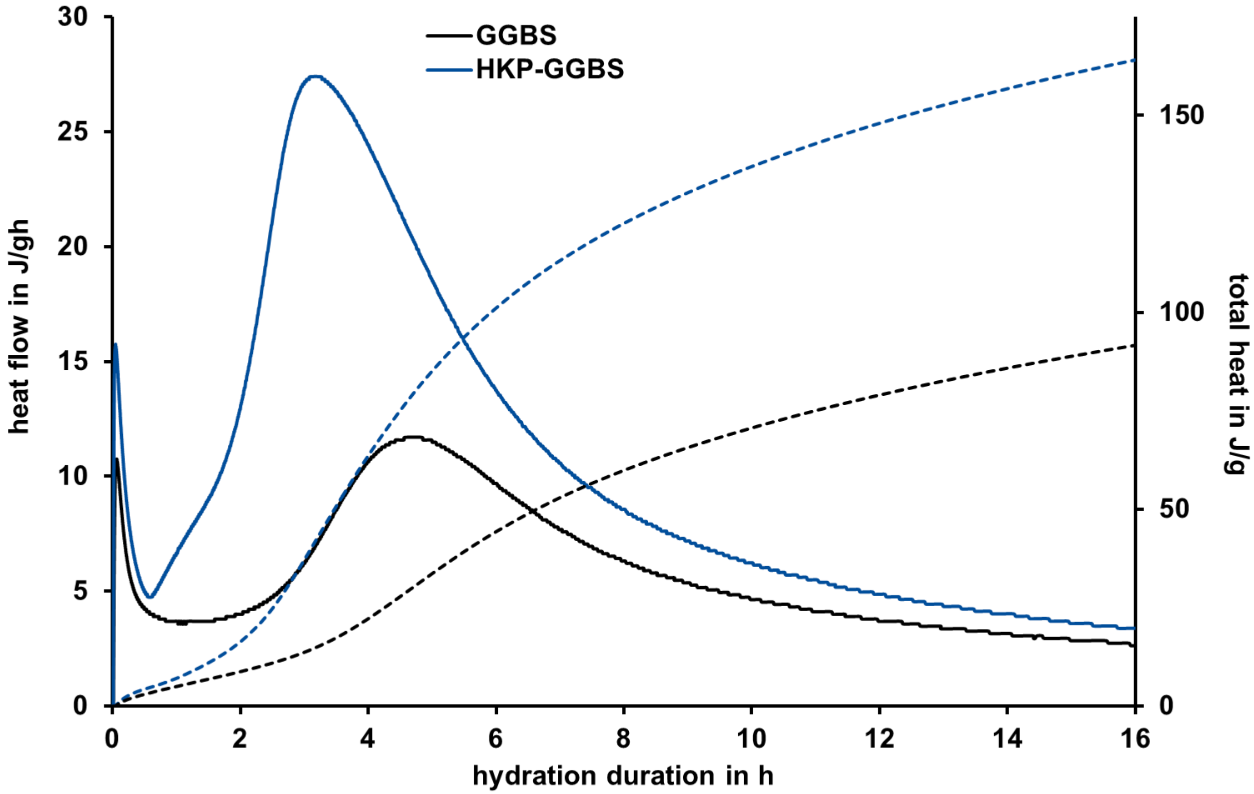
pore distinction according to Smolczyk		
gel pores	capillary pores	air pores
< 0,03 µm	10 - 0,03 µm	> 10 µm

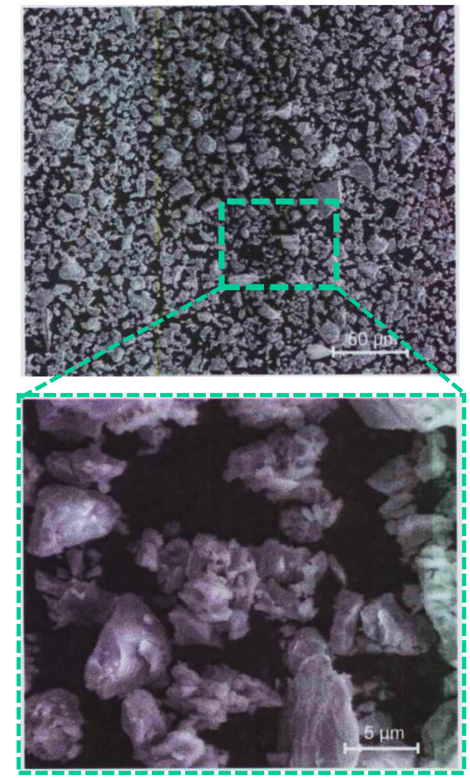
source: BMBF-Project: 03X0068A, final report, 2013

1) turbine Zoz SKZ300a
2) agitated powder container Zoz CS030a
3) screw-feeder Zoz SFV63-20-s1
4) HKP-device (Simoloyer® CM20)
5) cyclone Zoz ZK100-L
6) product container

material-flowchart: (2)-(3)-(4)-(5)-(6),
The turbine (1) supplies the closed carrier-gas circuit.

Manufacturing of nanostructured GGBS at ton-range by High Kinetic Processing plant Simoloyer® CM20-20lm-s1 (Zoz builds such plants up to 45x larger) with continuous material handling system for cement. It is precisely this "laboratory" system that has been used to process the material for the bridge Rosenthal within a 2-weeks / 2-shift operation and with this also the GGBS for the demonstrator "front-balustrade Villa Marie" has been produced.





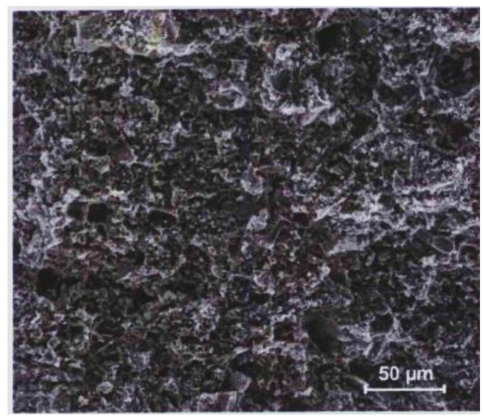
GGBS	HKP-GGBS conti
10,2 µm	7,4 µm

FuturZement - cement properties

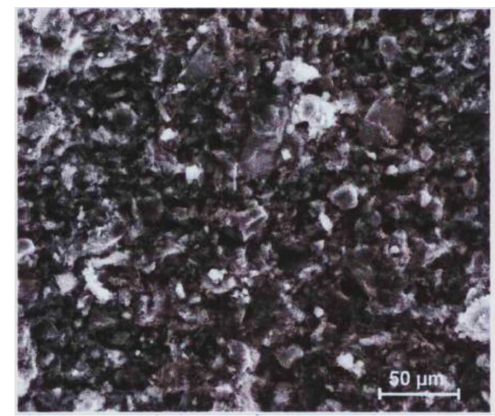
	FuturZement	Portland slag cement
density [g/cm³]	3.03	3.09
Blaine surface [cm²/g]	5,670	5,160
specific surface area [m²/g]	2.1	1.5
average particle diameter d_{50} [µm]	7.3	8.9

high surface quality and good casting accuracy

FuturZement



Portland slag cement

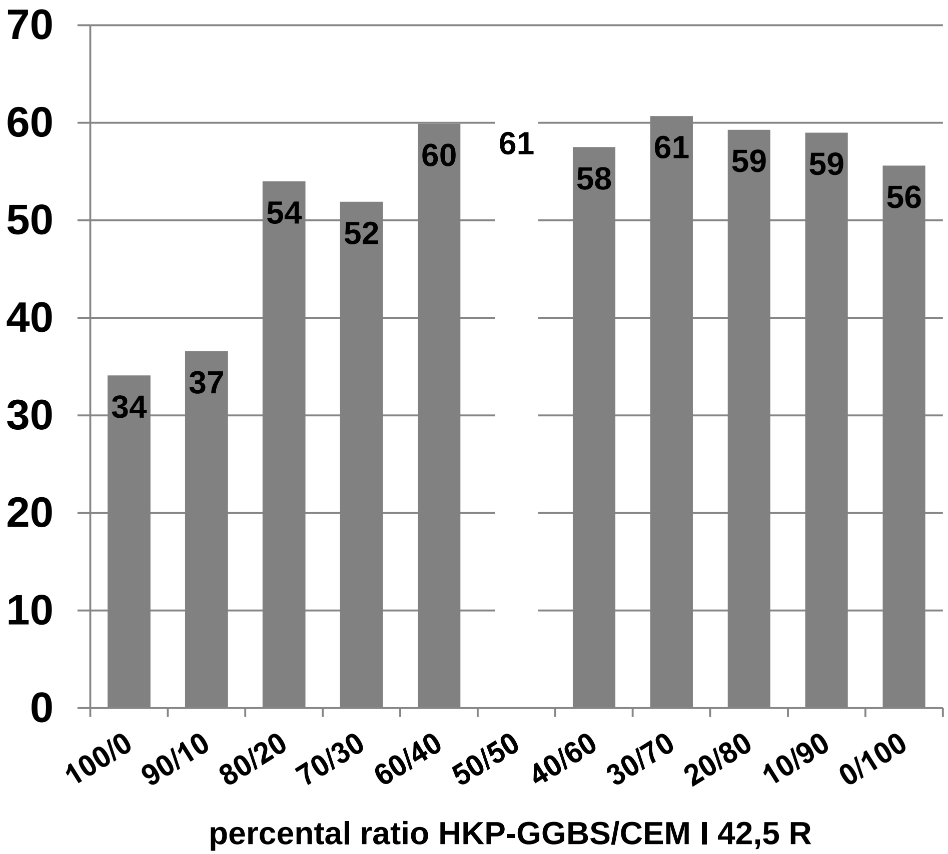


- **considerably denser structure of hardened paste system of FuturZement (w/b=0.4) after 28 d**
- **FuturZement provides very high compressive strength within *mortars***

⇨ $\beta_D > 40 \frac{N}{mm^2}$ after 2 d, $\beta_D > 70 \frac{N}{mm^2}$ after 28 d

⇨ strength class 52,5 R

compressive strength according to standard DIN EN 196 and DIN EN 15137-1



standard prisms 40x40x160 mm³

Results show that HKP-GGBS in a ratio of 50/50 improves CEM I 42,5 R up to the values of a CEM III 52,5 R (blastfurnace cement)

Cements in Germany (main cement types):

- CEM I : Portland cement
- CEM II: Portland composite cement
- CEM III: Blastfurnace cement
- CEM IV: Pozzolan cement
- CEM V: Composite cement

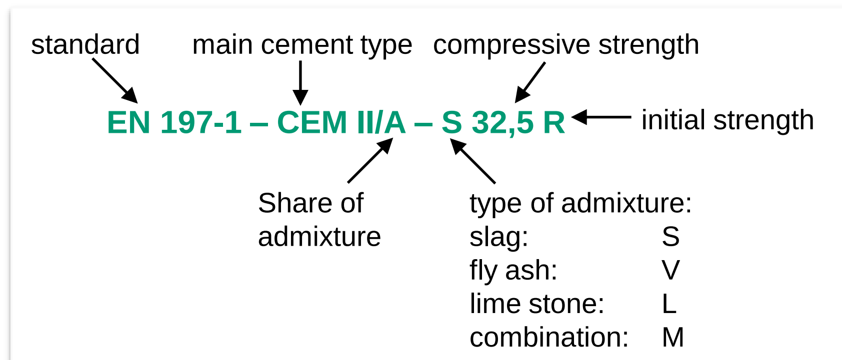
Labeling cements by DIN EN 197-1:

- main cement type and standard label
- abbreviation of the cement type
- strength class 32.5, 42.5, 52.5 and
- initial strength: N (standard), R (high, rapid), L (low, just for CEM III cements)

Standard cements with low hydration heat are also labelled with LH, cements with high sulphate resistance SR. With respect to CEM I with high sulphate resistance the amount of C_3A has to be named

Strength class and initial strength:

Strength class	Compressive strength [MPa]			
	Initial strength		Final strength	
	2 days	7 days	28 days	
32,5 L	-	≥12,0	≥32,5	≤ 52,5
32,5 N	-	≥16,0		
32,5 R	≥10,0	-		
45,5 L	-	≥16,0	≥42,5	≤ 62,5
45,5 N	≥10,0	-		
45,5 R	≥20,0	-		
52,5 L	≥10,0	-	≥52,5	-
52,5 N	≥20,0	-		
52,5 R	≥30,0	-		



Cements für high performance concrete and ultra high performance concretes are recommended to be fast hardened and high strength, e.g. 52.5 R cements

FuturZement | FuturBeton

- innovation and performance -

- FuturZement C.1 | FuturBeton C.1 -

nanostructured cement/concrete

super reactive and more than twice as strong as ordinary concrete at superior durability and substantial CO2-emission saving

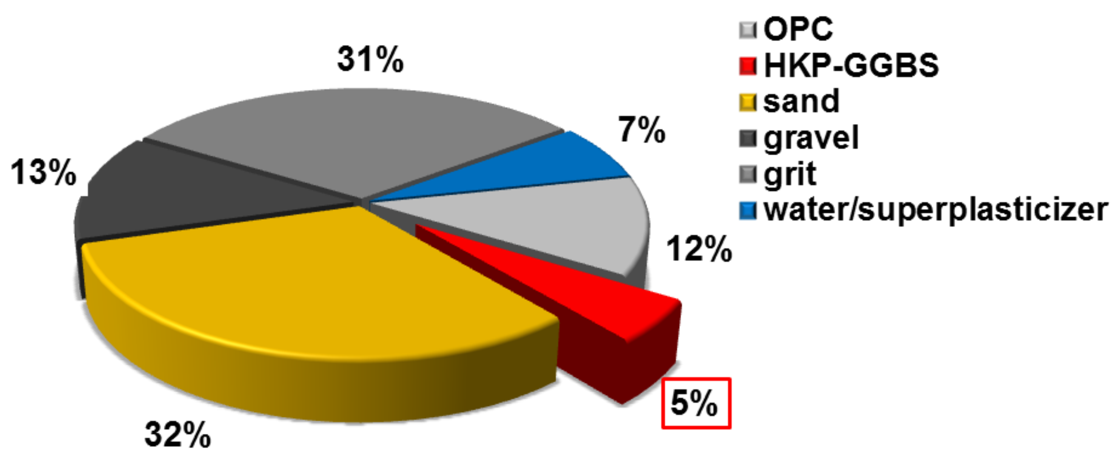
advantages at a glance:

nanoscale activation of ground granulated blast furnace slag (GGBS) is generating new binder systems which highly improve properties and reduce clinker content in cements

high strength ✦ CO2-low ✦ super durability

- → **higher strength** means less material
- → **less weight** and insofar one can build lighter and e. g. also **higher**
- → **dense packing & pore refinement** results into a substantially improved **durability**
- → **faster setting times** for acceleration of construction project
- → **adjustable handling times** for controllability
- → **fine fraction particle size distribution** also suitable for fiber-reinforcements
- → GGBS is a **steel mill waste** which is produced during blast furnace processes
- → **CO2-saving** is enormous and next to the care for our environment can be converted into cash !

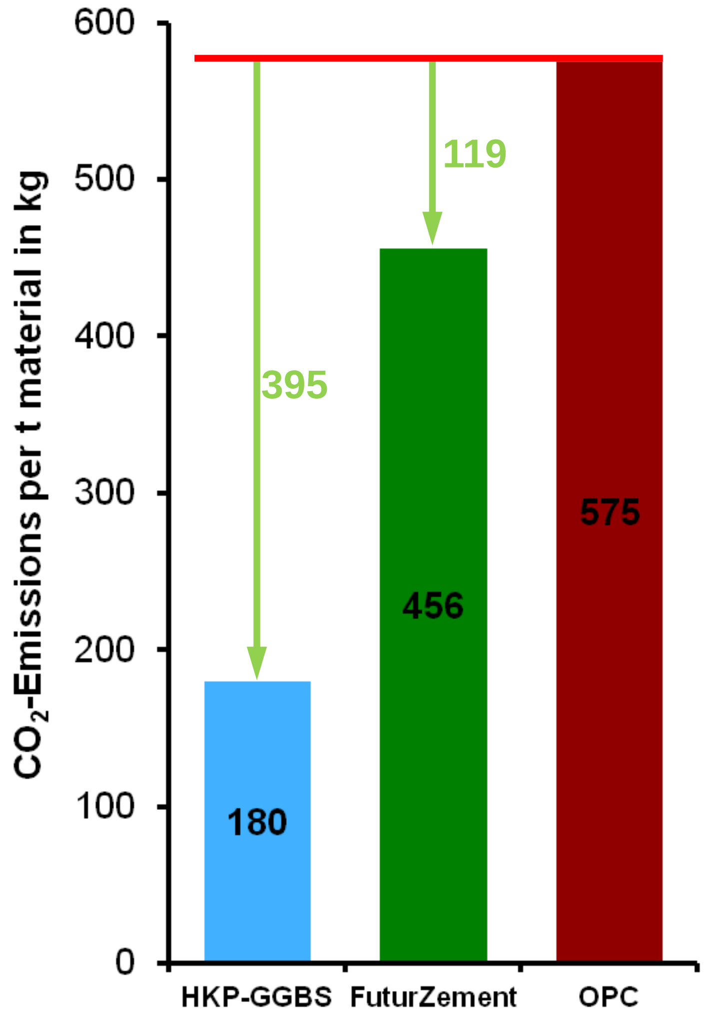
FutuBeton - enormous CO_2 saving potential by Simoloyer® technology



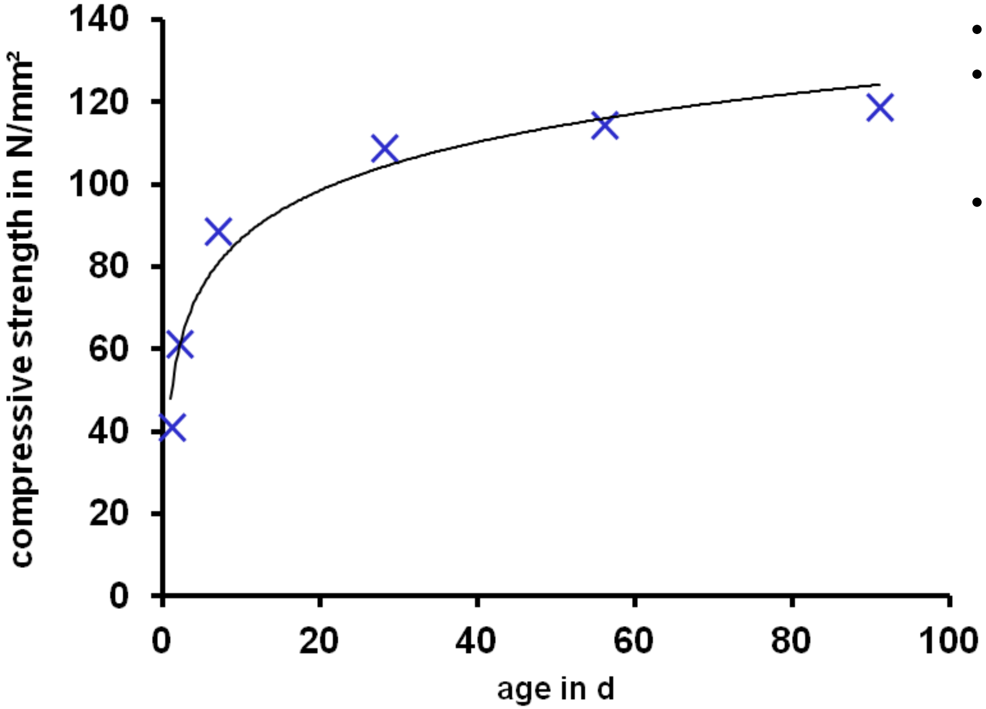
	OPC	HKP-GGBS
CO2 emission by manufacturing per ton	575 kg	179.7* kg
	CO2 saving potential	
total CO2 per ton HP slag cement	456.4 kg	
CO2 saving per ton slag cement	118.6 kg (- 20.6%)	
CO2 saving per ton HKP-GGBS	395.3 kg (- 68.7%)	

* =

Energy consumption of processing GGBS	347 kWh/ton
CO2 emission per MWh energy generated	518 kg (Germany, 2002)
CO2 emission per ton GGBS processed	179.7 kg



concrete prefabrication at factory (Runkel) on 05.11.2012 and set-up of the bridge Rosenthal, 14.11.2012, Olpe/Germany



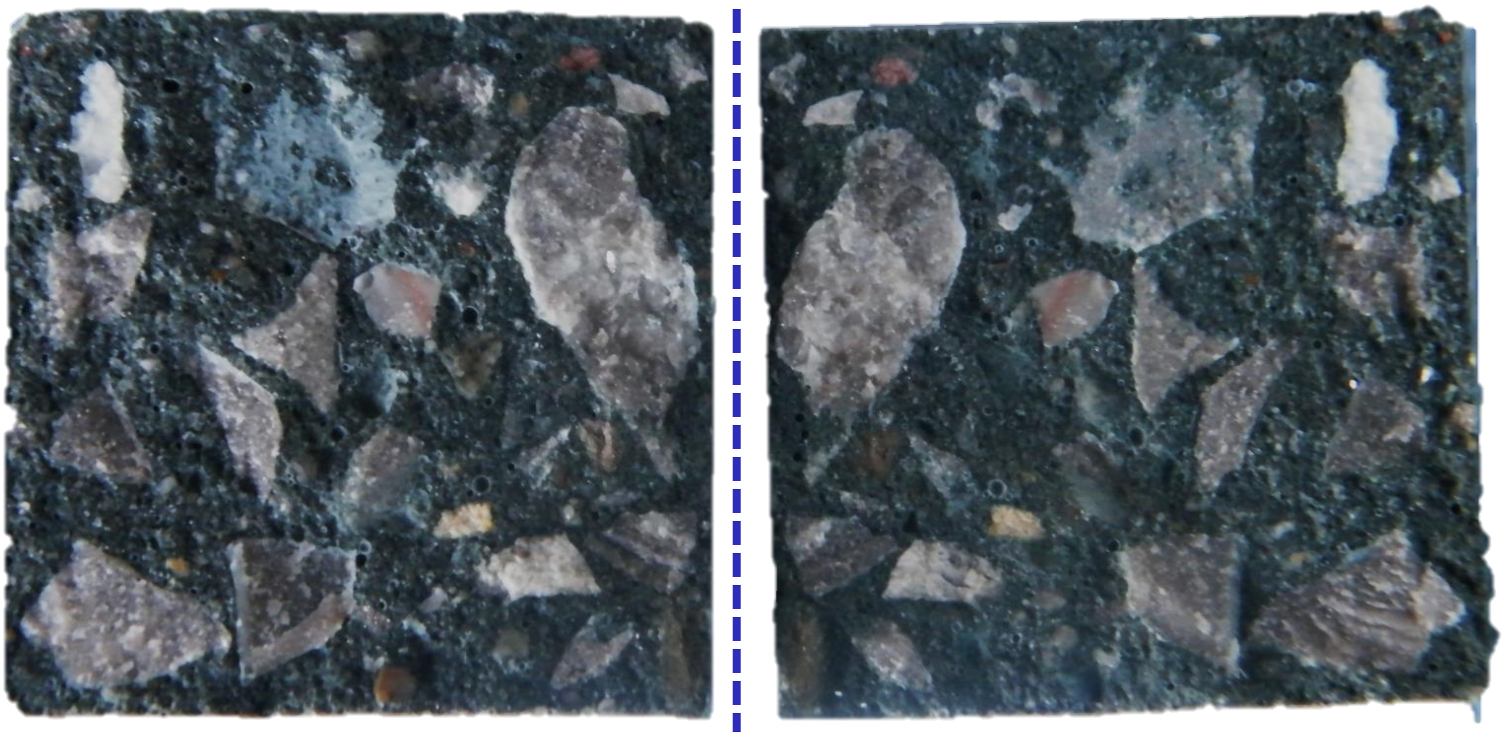
- **final strength of FuturBeton reached after ~20d**
- **high initial strength of concrete**
  - ⇨ fast hardening time
  - ⇨ range of High Performance Concrete (HPC)
- **lower porosity**

comparison: concrete C 45/55

compressive strength	45/55 N/mm²
bending tensile strength	7,6 N/mm²
tensile strength	~3,8 N/mm²

source: Beton der Druckfestigkeitsklasse C 45/55
InformationsZentrum Beton GmbH

- **bridge construction part casting: 5.11.2012**
- **standardized samples cast additionally to the bridge construction part**
  - ⇨ bendig tensile strength tests after 1 1/3 year: aggregates are broken instead of cement matrix
  - ⇨ blue colour due to metal sulfides, typical in slag cements hydrated in absence of air, oxidation to colourless sulfates and sulfites under atmospherical conditions

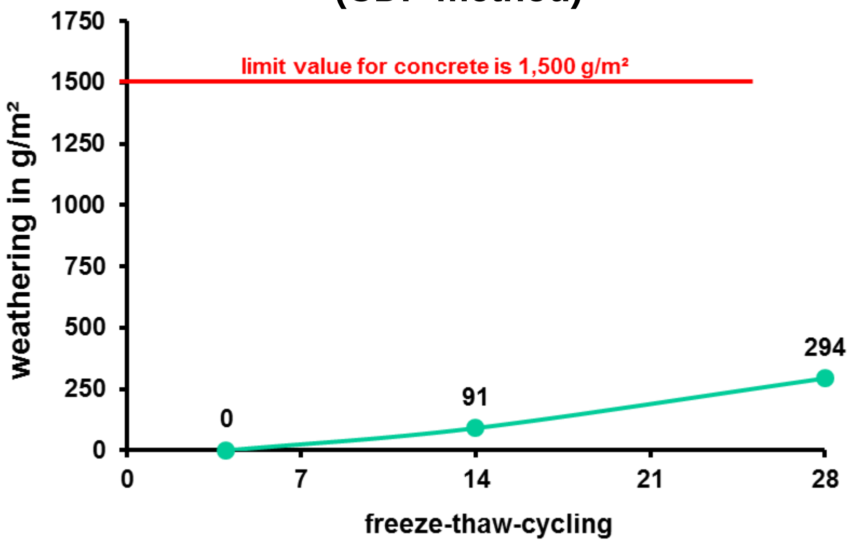


chloride migration coefficient (CMC-method)

	FuturBeton
CMC, 35 d [m²/s]	$1.3 \cdot 10^{-12}$
CMC, 97 d [m²/s]	$1.4 \cdot 10^{-12}$

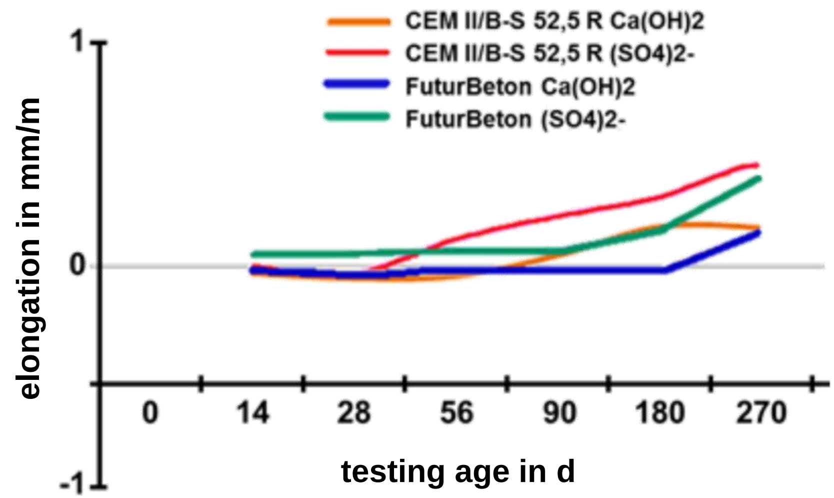
marginal chloride diffusion

resistance against freezing and thawing (CDF-method)



Low weathering after 28 cycles

resistance against sulphate attack



less elongation in different testing solutions than reference (testing temperature 20 ° C)

FuturBeton: higher durability

- ⇨ low chloride migration
- ⇨ higher resistance against freezing and thawing
- ⇨ high resistance against sulphate attack

standstill is forbidden

-we cannot do tomorrow, what we already are doing today-

12th May 2016
-Ljubljana-

15th - 17th May 2016
-Changzhou-

Prof. Zoz & President Prof. Unger

CMEA V-President Xie, Changzhou Mayor Shi, Construction Minister Song, Prof. Zoz, Jiangsu Technology Authority Chairman Ruan, A. Zoz & GIC-CEO Dr. Zhou

Prof. Zoz, PCG-Chairman Zhang, Prof. Shen, A. Zoz, Wei Peng

Zoz-GIC Center Changzhou

中国市政工程网 China Municipal Engineering Network

OZ-Workshop 2016 at GIC, Changzhou

盘固集团 PANGU GROUP

PANGU CEMENT
12 Mt p. a.

OZ-Workshop 2016
at GIC, Changzhou
May 17-18, 2016, China

中国市政工程网
China Municipal Engineering Network

Zoz-GIC Center
Changzhou

center opening
17.05.2016

FuturBeton ASTM-sample processing # 15.05.2016

44-49 MPa after 20 hours !! # 16.05.2016

Final strength DE+C 140-145 MPa !!! # 16.05.2016

- FuturZement C.1 | FuturBeton C.1 -

nanostructured cement/concrete

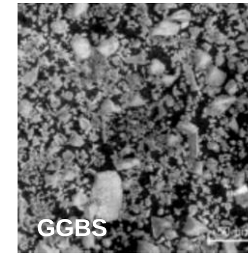
how to make

processing step by step

FuturBeton C.1 – from slag to high performance concrete

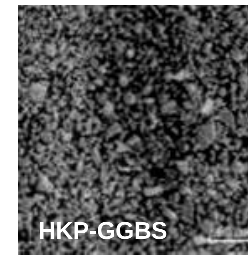
01 drying & pre-milling of slag to Ground Granulated Blastfurnace Slag (GGBS)

- drying of slag by conventional drying techniques (oven etc.), remaining humidity should be < 1%
- pre-milling in a common drum ball mill (e. g. Zoz), processing time about 4 h (low-cost process)



02 super-activation of GGBS to HKP-GGBS

- High Kinetic Processing (HKP) utilizing a continuously operating Simoloyer® (Zoz, -s1 series + cement appl.)
- closed carrier-gas circuit (air) at zero emission with automatic charging & discharging

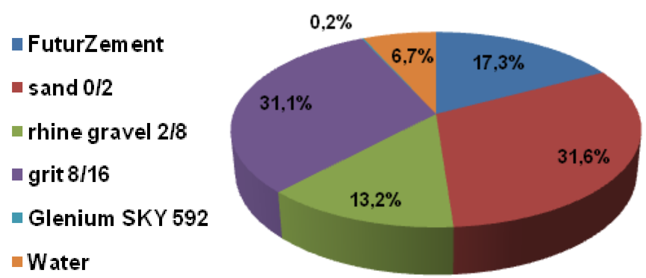


03 mixing FuturZement from OPC and HKP-GGBS

- mixing HKP-GGBS with Ordinary Portland Cement CEM I 52.5 R in a 30:70 ratio
- mixing approx. 3-5 min utilizing a ploughshare-mixer (e. g. Loedige)

04 composition of FuturBeton

- FuturZement, grit, gravel, sand, water and super-plasticizer (Glenium® SKY, PCE-based, BASF Co.)
- water should preferably not contain accelerating ions, common concrete reinforcement possible



FuturBeton C.1 – from slag to high performance concrete

05 mixing FuturBeton
in a common plate concrete mixer:

- add aggregates (grit, gravel, sand) and FuturZement, mix dry until the mixture is homogeneous (5-10 min)
- add water and mix shortly to disperse (ca. 5-10 min)
- add super-plasticizer and mix until slurry is homogeneous and smooth (5- 10 min)

06 casting of FuturBeton

- form prepared with mould talcum powder, preferably at ambient temperature, casting by buckets or other
- densification & mould-degassing on a vibratory plate or inject mobile vibrating unit into slurry (5-10 min)

07 encasing of FuturBeton

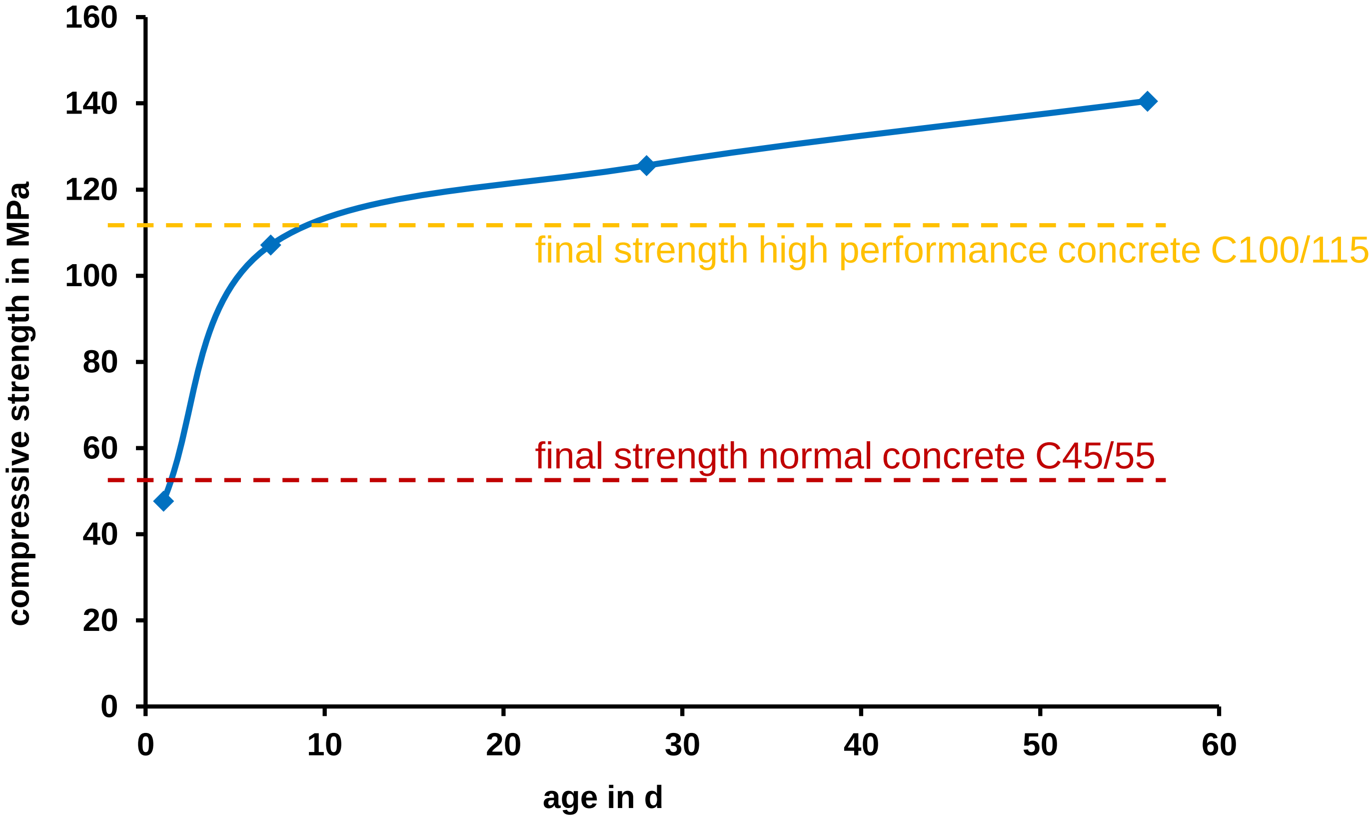
- at a curing time of < 15 h, encasing can be done after 16 h at the high early strength of > 25 MPa !
- post-processing of the virtually shiny surface and transportation after 1 day !

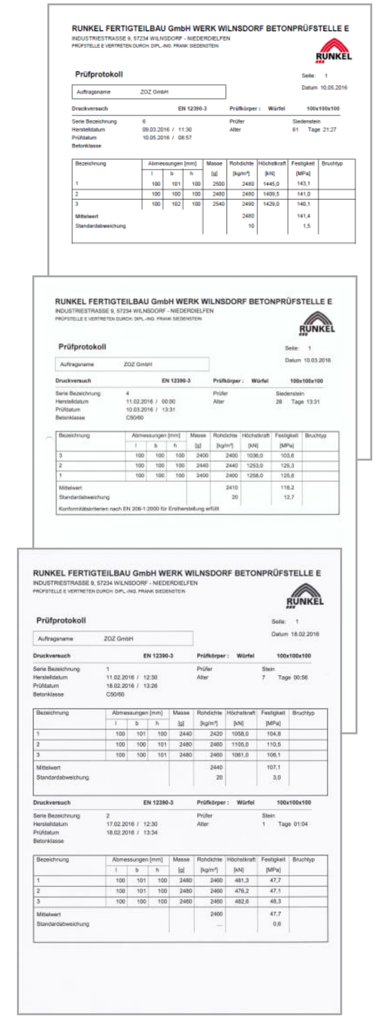
08 the product FuturBeton

- after setting, the concrete binder matrix becomes stronger than the aggregates !
- light blue colored matrix due to GGBS will turn grayish-white at air

recent tests of the compressive strength 1/7/28/61 days

18.02.-10.05.2016





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INDUSTRIESTRASSE 9, 57234 WILNSDORF - NIEDERDIELFEN
PRÜFSTELLE E VERTRETEN DURCH: DIPL.-ING. FRANK SIEDENSTEIN

RUNKEL

Prüfprotokoll

Seite: 1
Datum 10.05.2016

Auftragsname ZOZ GmbH

Druckversuch EN 12390-3 **Prüfkörper : Würfel 100x100x100**

Serie Bezeichnung 6 — Prüfer Siedenstein
Herstelldatum 09.03.2016 / 11:30 — Alter 61 Tage 21:27
Prüfdatum 10.05.2016 / 08:57
Betonklasse

Bezeichnung	Abmessungen [mm] l	b	h	Masse [g]	Rohdichte [kg/m³]	Höchstkraft [kN]	Festigkeit [MPa]	Bruchtyp
1	100	101	100	2500	2480	1445,0	143,1	
2	100	100	100	2480	2480	1409,5	141,0	
3	100	102	100	2540	2490	1429,0	140,1	
Mittelwert					2480		141,4	
Standardabweichung					10		1,5	

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INDUSTRIESTRASSE 9, 57234 WILNSDORF - NIEDERDIELFEN
PRÜFSTELLE E VERTRETEN DURCH: DIPL.-ING. FRANK SIEDENSTEIN

RUNKEL

Prüfprotokoll

Seite: 1
Datum 10.03.2016

Auftragsname ZOZ GmbH

Druckversuch EN 12390-3 **Prüfkörper : Würfel 100x100x100**

Serie Bezeichnung 4 — Prüfer Siedenstein
Herstelldatum 11.02.2016 / 00:00 — Alter 28 Tage 13:31
Prüfdatum 10.03.2016 / 13:31
Betonklasse C50/60

Bezeichnung	Abmessungen [mm] l	b	h	Masse [g]	Rohdichte [kg/m³]	Höchstkraft [kN]	Festigkeit [MPa]	Bruchtyp
3	100	100	100	2400	2400	1036,0	103,6	
2	100	100	100	2440	2440	1253,0	125,3	
1	100	100	100	2400	2400	1258,0	125,8	
Mittelwert					2410		118,2	
Standardabweichung					20		12,7	

Konformitätskriterien nach EN 206-1:2000 für Erstherstellung erfüllt

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INDUSTRIESTRASSE 9, 57234 WILNSDORF - NIEDERDIELFEN
PRÜFSTELLE E VERTRETEN DURCH: DIPL.-ING. FRANK SIEDENSTEIN

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Prüfprotokoll

Seite: 1
Datum 18.02.2016

Auftragsname ZOZ GmbH

Druckversuch EN 12390-3 **Prüfkörper : Würfel 100x100x100**

Serie Bezeichnung 1 — Prüfer Stein
Herstelldatum 11.02.2016 / 12:30 — Alter 7 Tage 00:56
Prüfdatum 18.02.2016 / 13:26
Betonklasse C50/60

Bezeichnung	Abmessungen [mm] l	b	h	Masse [g]	Rohdichte [kg/m³]	Höchstkraft [kN]	Festigkeit [MPa]	Bruchtyp
1	100	101	100	2440	2420	1058,0	104,8	
2	100	100	101	2480	2460	1105,0	110,5	
3	100	100	101	2480	2460	1061,0	106,1	
Mittelwert					2440		107,1	
Standardabweichung					20		3,0	

Druckversuch EN 12390-3 **Prüfkörper : Würfel 100x100x100**

Serie Bezeichnung 2 — Prüfer Stein
Herstelldatum 17.02.2016 / 12:30 — Alter 1 Tage 01:04
Prüfdatum 18.02.2016 / 13:34
Betonklasse

Bezeichnung	Abmessungen [mm] l	b	h	Masse [g]	Rohdichte [kg/m³]	Höchstkraft [kN]	Festigkeit [MPa]	Bruchtyp
1	100	101	100	2480	2460	481,3	47,7	
2	100	101	100	2480	2460	476,2	47,1	
3	100	100	100	2460	2460	482,6	48,3	
Mittelwert					2460		47,7	
Standardabweichung					---		0,6	

FuturZement | FuturBeton

- costs/benefits -

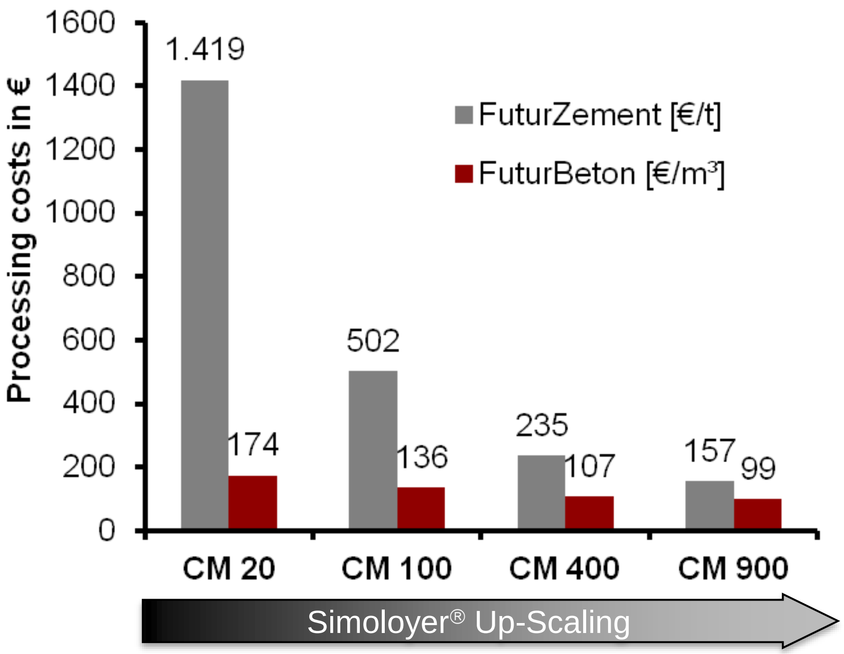
hard facts

Simoloyer® unit-size		CM20	CM100	CM400	CM900
production performance	[kg/h]	8	40	160	360
capability daily (20h)	[t]	0.16	0.8	3.2	7.2
capability annual (300 D)	[t]	48	240	960	2,160
capability total (20 Y)	[t]	960	4,800	19,200	43,200
energy per ton	[kWh/t]	n. a.	347	320	300
CO2-saving	[t]	380	**1,900**	**7,590**	**17,080**
processing cost (GGBS)	[€/t]	n. d.	**432**	**200**	**140**
process additional cost FuturZement (GB30:70)	[€/t]	n. d.	130	60	**42**
process additional cost FuturBeton (FZ1:6)	[€/t]	n. d.	22	10	**7***

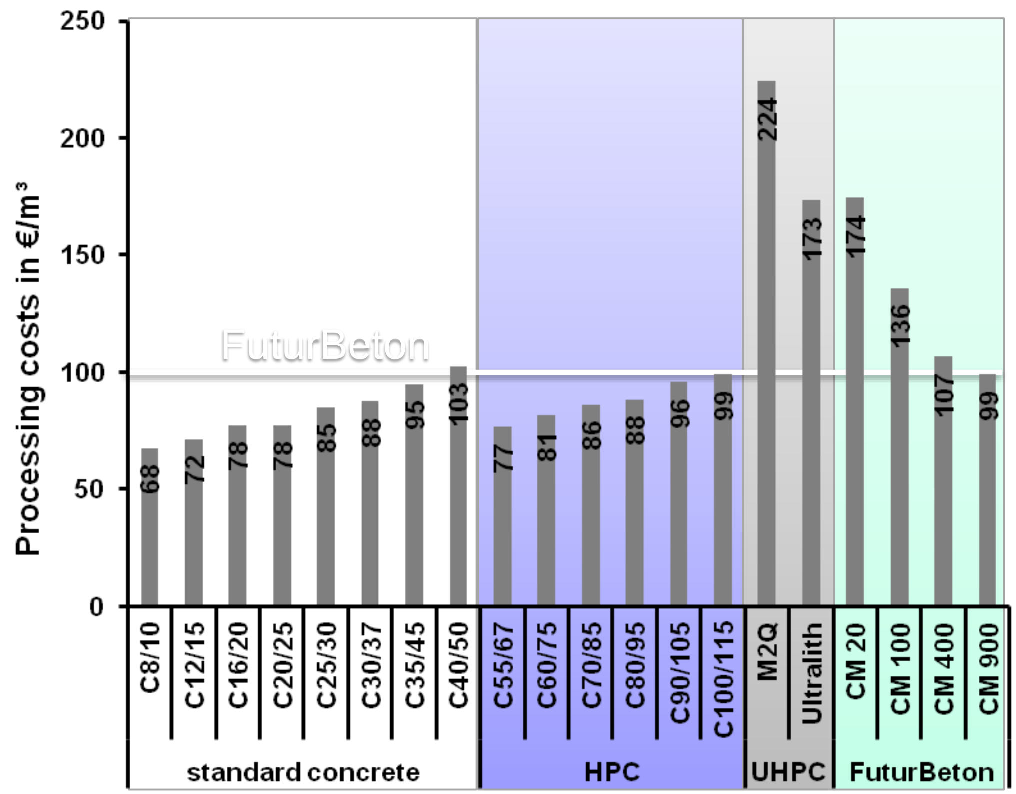
HKP-GGBS, processing cost and CO2-saving including investment, maintenance, labor cost, energy and water as per October 2012 in Germany (in this case energy costs 0,10 €/kWh), resulting additional cost for FuturZement and FuturBeton.

*Ordinary Concrete cost DE: € 40-45/t;
*CO2-Emission Certificate cost: € 6/t

Up-Scaling of production process: FuturZement at comparable costs like CEM I 52.5 R, and FuturBeton like standard concrete



processing cost including investment, maintenance, labor cost, energy and water as per 2015 in Germany (0,15 €/kWh)



costs calculated by data of internet recherche

CO2-savings in figures

and non-cash benefits

The processing costs of about 140.00 €/t HKP-GGBS also pays for an emission saving of about 395 kg CO2 per each ton of replaced OPC-fraction in FuturZement C.1.

Under complete ignorance of product and product benefit, CO2-saving virtually costs 354,00 €/t.

CO_2 emission saving cost automobile vs. total processing cost HKP-GGBS

primary target CO_2-emission saving, additional cost [7]		Auto	CM900		total processing cost HKP-GGBS, CO_2-saving as a side-effect
CO_2-emission today	[g/km]	136	140	[€/t]	total processing cost
CO_2-emission base (target 2015)		130			
CO_2-fleet-goal		95	395	[kg/t]	CO_2-saving per replaced ton OPC-fraction in FuturZement
CO_2 saving (-CE-)		35			
CE at 12.500 km p. a. / 12 years	[t/vhc]	5,3	0 !!	[€/t]	product value share of FuturZement
additional cost / vehicle (-vhc-)	[€]	3.600			
additional cost for CO_2-saving	**[€/t]**	**678**	**354**	**[€/t]**	**total cost for CO_2-saving**

14.03.2013

- total value share of FuturZement simply ignored (side effect) !
- automotive from million-fold production compared to a single Simoloyer® CM900 from individual manufacturing !
- additional indirect CO_2 savings due to less material (higher strength and durability of FuturBeton) also ignored !

Since any society can only invest a certain share of their capability in this case for CO_2 emission savings, in the very logic conclusion we should for now better waive any further CO_2 savings in the automotive sector and should first replace the OPC in this world by FuturZement C.1. Economic compensation could be done e. g. via emission trading!

[7] Communication with Dr. Ulrich Eichhorn, Managing Director VDA (Association of the German Automotive Industry, Berlin [05-2013]

volumes and potentials, Germany and globally p. a.		GER	World	share GER
CO2-emission total [9]-DE, [10]-World	[Mt]	850	30,000	2.9 %
concrete consumption		250	8,000	3.1 %
		absolute	relative	
FuturZement, CO2-saving / ton of cement	[kg]	118.6	20 %	
FuturBeton, CO2-saving / ton of concrete		19.8		
		GER	World	
CO2-savings-potential (by FuturZement/Beton)	[Mt]	**4.95**	**158.4**	
CO2-savings-potential (ditto relative)	[-]	**0.6 %**	**0.5 %**	

-very much simplified calculation indicates approximate values at a presumed further simplifying autonomous concrete production in Germany-

Reminder:

the CO2-emission-savings-potential would be further potentiated by enormous savings in material e. g. also resulting into energy savings (currently up to 50% !!) - and the additional costs FuturBeton are only about 7 € per ton !

Nanostructures – achieving more with less !

[9] publication Federal Environment Agency of Germany (UBA) [26.02.2013]

[10] The Cement Sustainability Initiative Progress Report, 2005]

market & ready to market

- FuturZement C.1 | FuturBeton C.1 -
nanostructured cement/concrete

FuturZement/Beton is 100 % **ready to market**:

- technologically, otherwise the public bridge could not have been built as the BMBF demonstrator.
- economically, already the laboratory scale (a CM900 system does represent such small scale for the conditions of the construction industry) demonstrates economy and
- ecologically there is probably no better way to save such huge numbers of CO2-emission economically.

Potential customers for the new building materials / for the innovation are:

a) cement manufacturers for the technological change

b) concrete manufacturers that at a) procure FuturZement as a modern binder system

c) the construction industry, that with FuturBeton can build eminently faster, sleeker, higher, more cost-effective, more durable and also significantly environmentally friendlier.

history and outlook

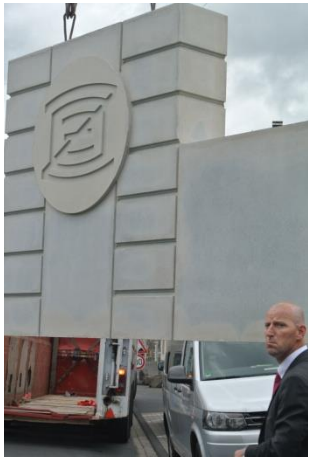
in the very Center of Siegen City…
Zoz Group is building on approx. 3,000 square meters…

2010

1900 & 2015

missing balcony ● & Balustrade ●

2nd demonstrator, 6 x 6 m roof balustrade at "Villa ZCS", very center of Siegen, set-up 21.06.2013



roof balustrade at "Villa ZCS": 6 x 6 meter, 12 tons FuturBeton

Zoz Center Siegen, # 23.06.2015

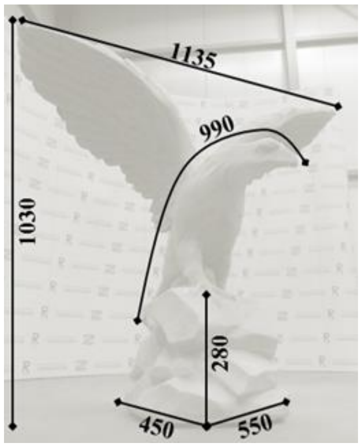
Zoz-FuturBeton-Eagle

green nanotechnology for foyer/garden/park and/or your building

high strength ☼ CO2-low ☼ super durability ☼ super surface

FuturBeton golden color

FuturBeton natural



dimensions

152 kg of "nanostructure"

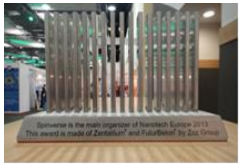
Sales and Options	
FuturBeton golden color	EUR 999,00 + VAT
FuturBeton natural	EUR 649,00 + VAT
sales and distribution via Frank Lessmann Co.	

Technical Data, Dimensions	
L x B x H	990 x 1135 x 1030 mm
net weight	152 kg
material	FuturBeton C.1 (> 100 MPa)
curing time	< 15 h
CO_2-saving*	3 kg(*compared to OPCC)

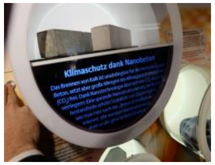
After the set-up of the public bridge Rosenthal and the establishment of the balustrade, the Zoz-Eagle represents the first on-shelf available product and clearly demonstrates the possibilities of FuturBeton in complex structures at high requirements on surface quality.

the bridge "Rosenthal" at Olpe / Germany established on 14.11.2012

12 ton balustrade, Villa ZCS at Siegen / Germany established on June 21, 2013



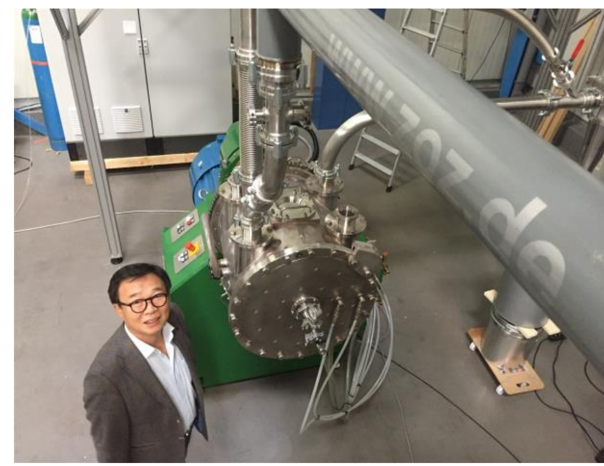
EuroNano Award 2013, Zentallium® & FuturBeton



FuturBeton in the BMBF nanoTruck (2014)

continuous operation mode of CM100-s1 for manufacturing of nanoscale activated GGBS

CM20-s1 (front) & CM100-s1 (back)



near Siegen, Germany

at Vlora, Albania

ohne Kinder – keine Zukunft !
without children – no future !

[OZ-22]

13th German - International
Symposium on Nanostructures

March 6-8, 2022
Olpe, Germany

FuturZement|FuturBeton in Zacatecas/Mexico

Zoz Nanostructure for Christian monumental buildings in Mexico

Mexican delegation already 2018 (OZ-18) at Wenden townhall, construction starts 2021/22.
Breakthrough for Zoz FuturZement|FuturBeton.
10 years "after" the Rosenthal Bridge !