Presentations

Business Lunch Talk about Future Topics

8th October 2009 in Brussels

Imprint

This proceeding was compiled by Projektträger Jülich as one of the organiser of the Business Lunch Talk. It provides the presentations and other information given at this meeting.

For further information about the FP6 Foresight Support Action **"SMART"** and its outcome **MaterialsEuroRoads**, please refer to http://www.materialseuroroads.net or send an email to ptj-smart-ssa@fz-juelich.de

If you wish to get more information or to be invited to the next Business Lunch Talk, please contact Dr. Gerd Schumacher, email: g.schumacher@fz-juelich.de

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November 2009

Table of Content

Introduction

On the 8th October 2009 about 20 people from France, United Kingdom and Germany gathered together in order to discuss future topics in Nanotechnology and Materials and Production Technologies.
The collected presentations outline the challenges in Nanomaterials as well as in inorganic and functional materials and new production systems and technologies. The importance of the automotive industry as one of Europe's key industrial sectors was stated by two additional presentations with aspects lying in the greening and the changeability in the car production. The head of unit in DG RTD G3 Materials Renzo Tomellini shared his view point about the role of Research Roadmaps to define future topics.

The Business Lunch Talk is an outcome of the FP6 Specific Support Action "SMART", a foresight activity in materials technology. Since the European strategic materials actions were felt to be fragmented, a networking platform "MaterialsEuroRoads" was set up to coordinate and accelerate efforts in this area. An annual meeting should facilitate the dialogue between materials foresight activities / researchers and funding bodies in the Member States and in Europe.

After two meetings, named as Annual Meeting of MaterialsEuroRoads (March 2007 in Paris and May 2008 in London) with fruitful discussion about the way forward in materials technology, we improved the format of this meeting. A more condensed version was choosen regarding time frame and auditorium, but the themes were enlarged in considering Nanotechnology and Production technologies too. This was the beginning of Business Lunch Talk, which took place first in July 2008 and this year in October 2009, both in Brussels.

This proceeding collects the five presentations given at the Business Lunch Talk at 8th October 2009.

We wish you a suggestive reading.

The National Contact Points in NMP of France, Germany and the United Kingdom

Business Lunch Talk

about Future Topics, 8th October 2009

Venue:	Helmholtz Office, Rue du Trône 98, 1050 Brussels, Phone: +32 02 5000970
Organization:	Technology Strategy Board, TSB (A. Hooper) Forschungszentrum Jülich, PtJ, Phone: +49 (0) 2461-61-3545 (G. Schumacher)
Moderation:	Vladimir Maly, Helmholtz Office Brussels

12.00	Arrival of the participants, **lunch and coffee**
12.45	**Opening** Susan Kentner (Helmholtz Association – Brussels Office) and Heike Bauer (BMBF – Federal Ministry of Education and Research)
12.55	Renzo Tomellini (Unit RTD G 3) *Importance of Roadmaps and European Technology Platforms*
13.05	Robin Young (Materials KTN) *Materials for Green Cars*
13.25	Ulrich Bast (Siemens AG) *Inorganic Functional Materials: Trends and Challenges,*
13.45	Christian Inglis (Technology Strategy Board) *UK Nanomaterials Strategy*
14.05	Peter Weber (BMW Group) *Changeability in Automobile Production*
14:25	Discussion • *What are the answers of nanotechnology and materials and production technologies to the future challenges in society?* • *How can topics be implemented in future NMP WPs?* • *How will the Public-Private-Partnerships influence the future NMP WPs?*
15:00	End of the event; Coffee and possibility for informal discussions

Research RoadMaps in Materials

past

present

future

Renzo Tomellini
European Commission
Head of Unit "Value-added Materials"
renzo.tomellini@ec.europa.eu

FP7: http://cordis.europa.eu/fp7/home_en.html
FP7 calls: http://cordis.europa.eu/fp7/dc/index.cfm
Find documents: http://cordis.europa.eu/fp7/find-doc_en.html
FP7 Helpdesk: http://ec.europa.eu/research/enquiries

SEVENTH FRAMEWORK PROGRAMME

Materials and materials science and engineering are KEY for successful innovation

**increased global competition,
shorter life cycles of products,
accelerated industrial innovation,
demand for sustainability,
demand for reliability,
search for costumers' pleasure …**

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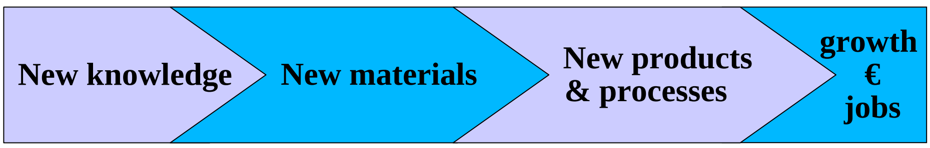
Materials enable industrial and commercial success

For existing products and processes: They introduce new *functionalities* and/or improved *properties*, and thus adding value to products/services. New and improved materials represent an *invisible revolution* that changes products and process in large extent.

For not-yet existing products and processes: The engineered realization of *materials by design* will allow re-designing or re-conceiving products and/or processes under a really sustainable systemic approach: energy and primary raw materials consumption, added value, safety (REACH, …), less components, less production steps, …

Materials are KNOWLEDGEmediaries (intermediaries of knowledge)

Materials embed and «transfer» the new knowledge into new products and processes, therefore we hear talking of «active» or «intelligent» materials, materials that «do a work»



From the Lund Declaration, 7-8 July 2009

States together should, based on a broad consultation process, agree on the most appropriate and efficient division of labour when designing future programmes.

- Meeting the Grand Challenges also requires the following:
  - **Taking a global lead in the development of enabling technologies such as … materials**

but WHICH MATERIALS ?

past

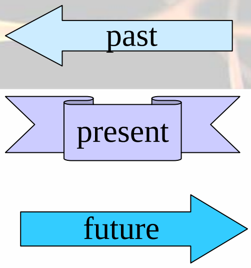
present

future

Research Roadmaps (RRMs)

A technology roadmap is a plan that matches short-term and long-term goals with specific technology solutions to help meet those goals

http://en.wikipedia.org/wiki/Technology_roadmap



Research Roadmaps (RRMs)

involve

- Carrying out socio-economic, market and S&T surveys

allow

- Steering activities and investments
- Planning research (and funding perspectives)
- Coordinating technological development
- Educating young researchers
- Driving industrial contacts with industry
- Advicing public authorities

There is normally a continuum

- From visions
- To strategies
- Via e.g. FP7 themes
- To specific topics
- And workflows

… but focus and emphasis vary

In the literature: two complementary types of RRMs

The RRMs of Governments and National Research Institutes
usually focusing on « Grand Challenges »

The RRMs of researchers (NoEs, IPs, ETPs …)
usually focusing on future S&T

Some examples in « Materials »

- Germany: BMBF, Max-Planck, Fraunhofer
- France: CEA, CNRS, Ministère de la recherche
- UK: Technology Strategy board, Materials EuroRoad
- Japan: NIMS
- US: DoE, National Research Council
- Spain: National Research Council, CSIC
- Italy: CNR
- Denmark: Research 2015, inano uni Aarhus
- India: Ministry of Science and Technology

- FPs dedicated studies : SMART, NanoRoadMap, …
- FPs Networks of Excellence
- FPs Integrated Projects or other projects

Some example initiated by the EC

SMART
Specific support action

nanoRoad sme
Materials
Nanocomposites
Metals & Alloys
Biological nanomaterials
Nano-polymers
Nano-glasses
Nano-ceramics

μ-Sapient
www.microsapient.org
Micro and Nano Manufacturing

ETPs
EuMaT
SusChem
European Technology Platform For SUSTAINABLE CHEMISTRY
nanomedicine
niac
MANUFUTURE-EU

NRM
nanoroadmap project
Materials
Health & Medical Systems
Energy

MINAM
Establishing a..
Strategic research agenda (SRA)
European Technology Platform on Micro and Nanofacturing

EVA 1
Technologies
R&D and Science
Strategies
Applications/Industries

4M
Micro-Manufacturing for "multi" materials

Working Group NanoManufacturing
NanoManufacturing
Particles
Composites
Surfaces

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European Technology Platforms (ETPs)

Contribute to defining visions, Strategic Research Agenda, roadmaps, in particular in research areas of special industrial relevance.

Universities played crucial role in defining the SRAs and

(around 1/5 of stakeholders are from Universities).

36 ETPs have been launched, covering a wide range of technological challenges and are reaching the implementation stage.

http://cordis.europa.eu/technology-platforms/individual_en.html

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The objectives of RRMs vary, hence content and methodology too

Analysis of roadmaps from various origins:

- Inputs highly inhomogeneous, both in production date and period of time spanned
- Inputs inhomogeneous as themes are different: nanomaterials, advanced materials…
- Producers with divergent interests: academia, industry, large agencies, governements
- Set of data is not always exhaustive

A set of RRMs provides a «meta–survey» of the field of materials

A distinction can be echoed in the strategies

For closed strategies an end result is defined and **retro engineering** is performed to define means, milestones, funding (*roadmaps*) ←

Open strategies start from the state of the art and do **extrapolation** in time, often with linear models (*foresighting*) →

For instance :

- RRM on instruments with timelines: e.g. US DoE
- RRM based on market development: e.g. UK technology strategic board
- RRM based on people's needs (energy, environment, health…): e.g. Fraunhofer, Danish Ministry of Science
- RRM based on projection of present activity: e.g. most of large research institutions

- Quite often: a combination of the above

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Comments we register…

Closed roadmaps based on objectives: markets, products, needs…

- are robust constructions, highly predictive
- are adapted to markets and socio-economic needs
- Have to be reviewed subject to changes in the environment: e.g. automotive industry in case of economic stagnation

Open roadmaps extrapolating previous activities:

- are fragile constructions, lowly predictive
- are suitable to blue-sky type research
- are more adaptable to environment changes, allowing easily reallocation of resources

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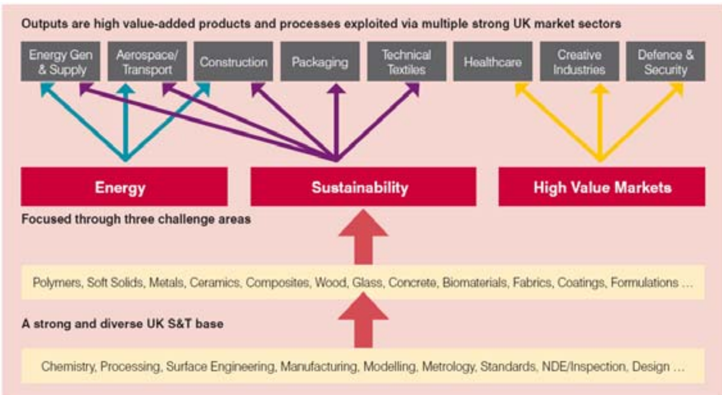
Example 1



Example 2

- Front lines themes: Tomorrow's opportunities, Fraunhofer

Health, Environment, Energy, Security, Communication, Mobility

↓

Grid locks identification

↓

Roadmaps construction

↓

Research plans

Example 3

- CSIC Action Plan 2006-2009

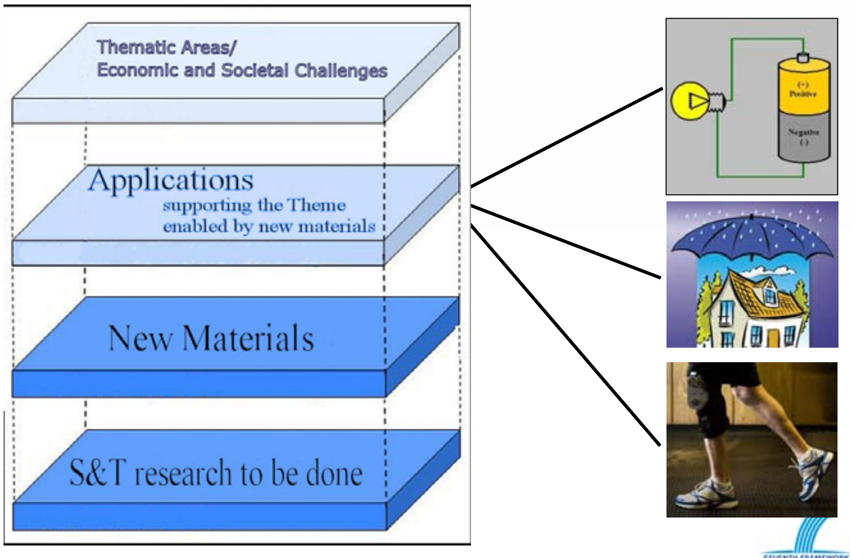
SWOT analysis of capabilities
(Strengths Weaknesses Opportunities Threats)
⬇
Strategy: research-knowledge-training-culture-int'al quality
⬇
Resources needed & objectives
⬇

The EC has organized a dedicated workshop in December 2008 (organizer: Dr. Anne de Baas)

4 main layers and 11 supporting chapters have been identified for a « closed » RRM

1. **Layer:** "Theme" / "Economic and Societal Challenge" / "Grand Challenge" addressed
2. **Layer:** Application / System supporting the challenge and enabled by Material S&T results
3. **Layer:** Materials enabling the user-application
4. **Layer:** S&T Research Topics for the future (horizontal and / or vertical)

Major chapters of RRMs



RRM First Layer

FP7 Themes supported by NMP

- **Food, Agriculture and Fisheries, Bio-technology**
- **Health**
- **Information and Communication Technologies**
- Nano-sciences &-technologies, Materials and new Production Technologies (NMP)
- **Energy**
- **Environment**
- **Transport**
- **Socio-economic Sciences and Humanities**
- **Space**
- **Security**

RRM Second Layer

Systems/applications by users* / followers in the value chain

- supporting the Theme/Challenge
- enabled by new materials

* such systems are often developed by the actors in the value chain that follows the material developer

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RRM Third Layer

New Materials (to be) developed

- «Functional» materials targeted to use
- Biomaterials
- Organic materials
- Hybrid materials
- ...

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Fourth layer

Research in Materials S&T

- Design and modelling
- Synthesis and production
- Characterisation
- ...

Supporting chapters

providing justification for investment

- Potential application domains / lead market sector of new material S&T results
- Context, including current bottlenecks
- Motivation
- Key performance figures (targets)
- Activity in- and dynamics of- the field, including the patent landscape
- References
- Time-line (for R&D and applications)
- Dependencies/ conditions to be addressed (regulations, standardisation)
- Prioritisation for different (regional, national, European) funding schemes
- Technology transfer possibilities and necessary education
- Conclusions and recommendations

Example short RRM
Metamaterials (VI-Metamorphose)

Layer 1 FP7 Themes addressed

Energy
ICT
Health
Environment
Transport
Security

Example short RRM
Metamaterials (VI-Metamorphose)

Layer 2 Application created by users*

Energy:
- Low-loss electronic and optical components,
- advanced solar cells,
- intelligent control of power consumption and generation,...

ICT:
- sub-wavelength optical information processing systems, low-cost magnetically and electrically controllable components,...

Health:
- sensors including biosensors,
- on-body communication systems,
- in-body drug delivery and control devices, ...

....

**the users are the next actors in the development chain*

Example short RRM
Metamaterials (VI-Metamorphose)

The Layer 3 Materials to be created

- Materials with superior and unusual electromagnetic properties, including
- Negative-valued permittivity and permeability
- Near-zero values of permittivity and/or permeability
- Extreme anisotropy (permittivity along one direction is close to zero but permittivity in the orthogonal direction is very high)
- Strong and anisotropic spatial dispersion (material parameters strongly depend on the wave vector)
- Extremely strong chirality and other bi-anisotropy coefficients
- Externally tunable parameters
- Designed-for-purpose nonlinearity
- Develop application-targeted synthesis and design of electromagnetic materials
- Develop new technologies to manufacture these materials

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Example short RRM
Metamaterials (VI-Metamorphose)

Fourth layer Materials S&T

- Design and modelling
- Synthesis
- Production
- 3D Charaterisation
- ...

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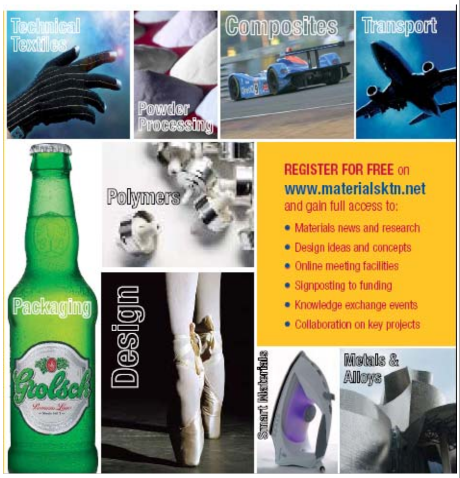
Materials for Green Cars

Case Studies



Dr Robin Young
Materials KTN

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Content

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- **Who we are**
- **Themes in the Green Car**
- **Materials: Sustainable stuctures**
- **Materials: Lightweighting**
- **Functional materials: projects and case studies**
- **Materials and design for end of life**

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MATERIALS KTN

- An overarching Materials Network to bring together business, design, research and technology organisations. finance , academia in the value network across the materials community
- Exchange of Knowledge and the stimulation of business
- Access to the latest news, developments and reports on materials technology from around the world

MATERIALS KTN

- An instrument to help formulate policy for research and also help business to respond to pressures and opportunities
- Delivery tool for FP7 in the UK – a portal for UK participation

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The Materials KTN

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The Green Car – what is important

- Optimise for reduced total emissions – reduce weight, improved power train
- Commercially credible and acceptable to market
- Legislative angle
- Functional as well as structural materials
- End of Life
- Design for Environment

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Fuel Consumption vs Vehicle Weight

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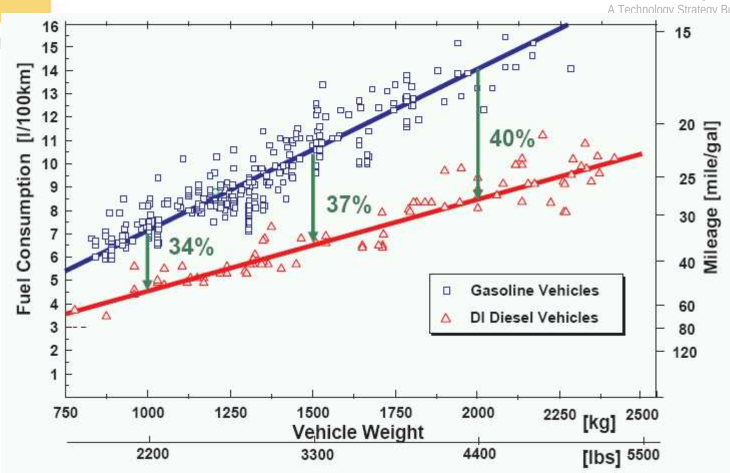

Stefan Pischinger, President and CEO, FEV Group, SAE Centennial 2005

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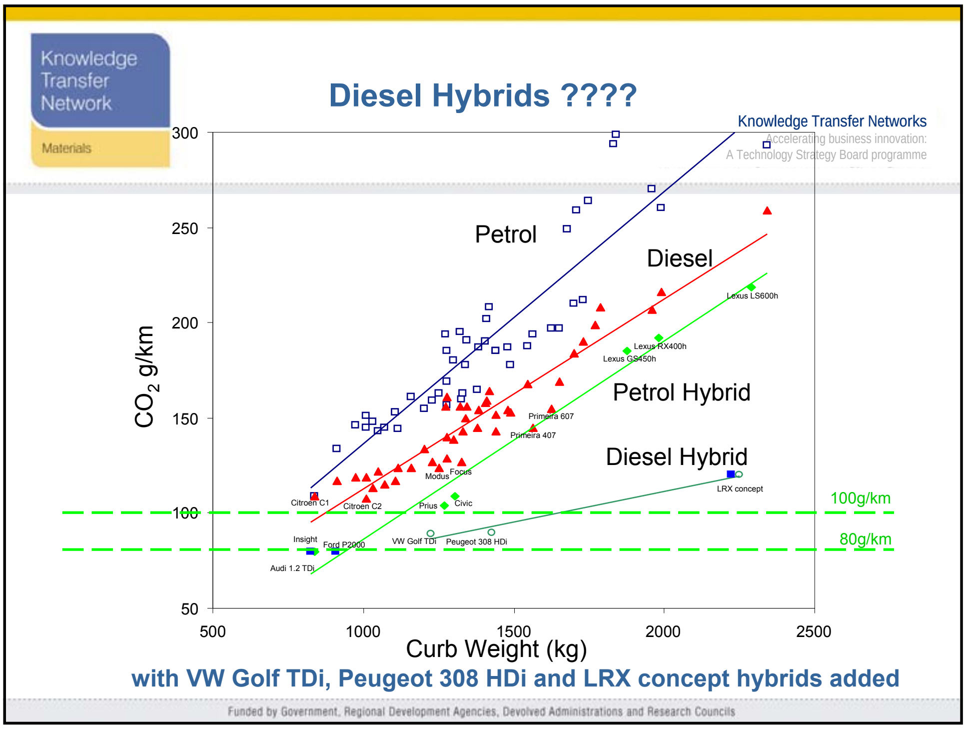
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Diesel Hybrids ????
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Petrol
Diesel
Petrol Hybrid
Diesel Hybrid
Lexus LS600h
Lexus RX400h
Lexus GS450h
Primera 607
Primera 407
Modus
Focus
Prius
Civic
Citroen C1
Citroen C2
Insight
Ford P2000
VW Golf TDI
Peugeot 308 HDi
Audi 1.2 TDi
LRX concept
100g/km
80g/km
CO_2 g/km
300
250
200
150
100
50
500
1000
1500
2000
2500
Curb Weight (kg)
with VW Golf TDi, Peugeot 308 HDi and LRX concept hybrids added
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Diesel Hybrid Vehicles
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Peugeot 308 (2010) 90g/km
LRX Concept Vehicle 120g/km
VW Golf TDI Hybrid (2009) 89g/km
Mercedes E300 Bluetec (2010) 46 mpg
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Myths

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- Aluminium is difficult to spot weld reliably and consistently
- Bonding of aluminium requires high modulus adhesives and aerospace quality pretreatment systems
- Aluminium sheet requires surface texturing to enhance formability
- Aluminium sheet requires a stabilisation treatment
- Aluminium intensive vehicles require purpose built finishing lines
- Aluminium automotive sheet is too expensive for the production of affordable volume production vehicles
- There is not enough aluminium

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- **JEC Show: Biomaterials Forum**
- **March 26th 2009, Paris**

Eco-Elise: a manufacturing study

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Advantages of natural fibre reinforcement

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- **Benefits**
  - Renewable source of raw material
  - Biodegradable
  - Sustainable
  - Excellent specific strength and high modulus
    - High flexural and tensile modulus -up to 5×base resin, high notched impact strength -up to 2×base resin
  - Reduced density of products
  - Lower cost
  - Reduced tool wear
  - Safe manufacturing processes
    - No airborne glass particles, relief from occupational hazards.
    - Reduced dermal and respiratory irritation and no emission of toxic fumes when subjected to heat and incineration

Source: Development of Composites Based on Natural Fibers, M.T. Ton-That & J. Denault, Industrial Materials Institute, The Institute of Textile Science, Ottawa, ON, April 13, 2007

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Eco-Elise technology

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- **Fibre**
  - Hemp
  - Hemp and Glass
- **Matrix**
  - Epoxy
  - Polyester
  - Acrylic resin
- **Process**
  - Hand Lay-up
  - Vacuum bagging
  - Resin Transfer Moulding
- **Panels**
  - Front clam (partly)
  - Access covers
  - Hard top
  - Seats
  - Roll hoop cover

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Next steps

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- **Opportunities and potential**
  - Performance through light weight design using sustainable materials
- **Challenges to the supply chain**
  - Resolving the microbial and moisture issues
  - Building structured textiles
  - Understanding the agricultural factors that control fibre length, strength and variability
- **Bio-Composites**
  - Develop flax / hemp fibre reinforced composites with bio-based resin systems
  - Investigate
    - Processing routes
    - Properties (mechanical and humidity)
    - Recyclability
    - Economics

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Recyclable Ultra Light Mixed material Automotive Platform (RULMAP)

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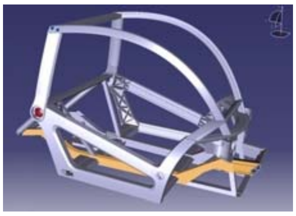
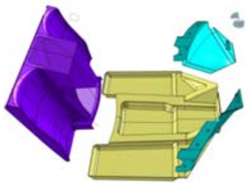


geoff.scamans@innoval.co.uk

Spray formed and extuded advanced aluminium alloy

Thermoplastic body panels with novel attachment

TSB funded



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Presentation Summary

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Fibrecore™
Lightweight Strength

- Fibre Core – structural sheet with low density steel fibre core
- Improved Specific Properties
- NVH benefits

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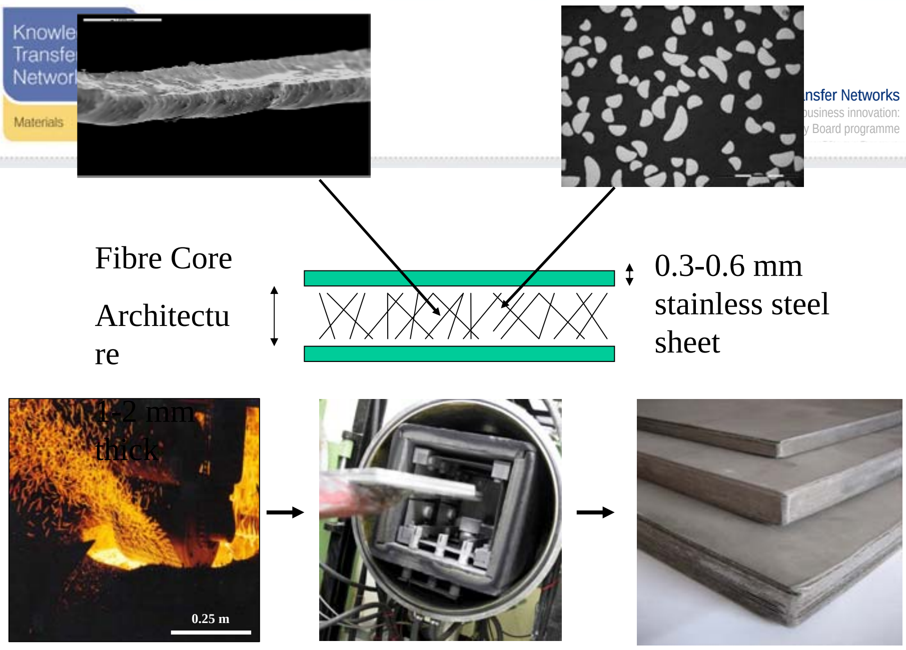

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What is Fibrecore™

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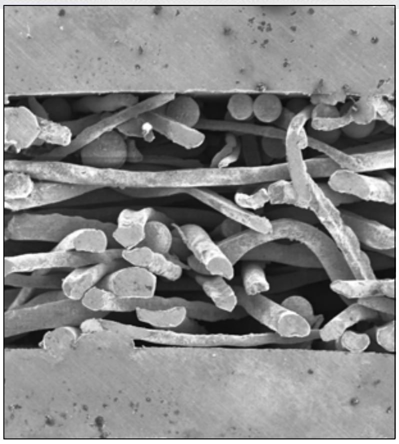

- **All Stainless Steel**
- **Diffusion Bonded**
- **All Metal Composite**
- **High Stiffness**
- **Low Density**
- **Random Planar Fibre Distribution**

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Non structural materials for Green Cars

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- Carbon Brakes
- Magnetics - efficiency – recycling
- Power Electronics; reliability; novel die attach and thermal management
- Batteries and energy storage technologies
- Materials for supercapacitors
- Catalysts
- Tyres

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Huntercombe Carbon-Carbon Brakes

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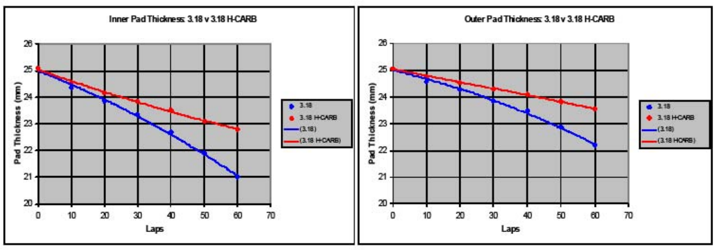
H-CARB vs Standard C-C Brake Disc : Pad Wear (3.18)



8

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Magnetics for Green Cars

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INCREASING RELIANCE ON MAGNETS for ELECTRIC TRACTION

- HYPROMS bob.blake@materialsktn.net .
- The UK is dependent on imported rare earth sintered magnets and rare earth materials (China). The materials are increasingly scarce and expensive. HyProMS aims to demonstrate to the UK market that rare earth magnets can be recycled using a non-melt process. Significantly increased efficiency opportunities of replacing standard magnets and electrically-generated magnetic fields with high energy rare earth magnets in motors and actuators, is envisaged

Lux, 2008

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Lux, 2008

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Advanced Electric Machines through Materials

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- TSB supported project for more efficient power systems, particularly for the aerospace and automotive industries, with the aim of reducing CO_2 emissions. Involving sixteen partners from the UK Magnetics Industry supply chain, it investigated improved magnetic materials, processing technologies, measurement facilities and computer modelling capability for electric machines.
- operational conditions of electric machines.

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Materials

High temperature Electronics for Green Cars

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Accelerating business innovation:
A Technology Strategy Board programme

Durable High Temperature Electronic Packaging

colin.johnston@materials.ox.ac.uk

- TSB supported project for developing and assessing novel substrate and interconnect technologies for durable high temperature systems.
- This develops an understanding of degradation processes, physics of failure and reliability
- Demonstrated in context of down-well applications the underlying study is also relevant to harsh environments encountered in automotive projects
- Sondex, GEM, MCE, Thermastrate, Oxford U.

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Modelling Reliability

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A Technology Strategy Board programme

Modelling Reliability of Power Electronic Modules

robin.young@materials.ox.ac.uk

- TSB funded project to incorporate physics of failure models for structures into design tool software to predict reliability in Power Electronics Modules.
- Uses FEM to build Reduced Order Models for Monte Carlo simulations of impacts of design choices on reliability
- Statistical approach allows effects of variability to be quantified
- Dynex, Semelab, Roll-Royce, Goodrich; model development by University of Greenwich.

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Association for European NanoElectronics ActivitieS

International Conference on
High Temperature Electronics Network (HiTEN)
September 13-16, 2009, St. Catherine's College Oxford
Oxford, United Kingdom

High Temperature Nanoelectronics for Electrical and Hybrid Vehicles

SINTEF
Infineon
CENTRO RICERCHE FIAT
austriamicrosystems

Ovidiu Vermesan SINTEF, Norway
Reiner John Infineon Technologies AG, Germany
Marco Ottella Centro Ricerche FIAT S.C.p.A, Italy
Harald Gall austriamicrosystems AG, Austria
Reinhold Bayerer Infineon Technologies AG, Germany

eniac

Confidential

Aeneas

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Oxonica
Leaders in Nanotechnology

develop innovative commercial solutions for international markets using expertise in the design and application of nanomaterials

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Envirox™ - Delivering Fuel Savings

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Accelerating business innovation:
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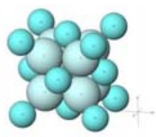
Drivers

- **Reductions in recoverable oil**
- **High fuel prices**
- **Environmental pressures**



Oxonica's solution:

- **ENVIROX™**
  - Fuel combustion catalyst based on nano-particulate cerium oxide
  - Liquid additive for diesel fuel
  - Improves fuel economy by 4-10%
  - Reduces harmful emissions up to 18%
  - Easy to use –dosing units
  - Available now

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Proven product – saving fuel

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- **City Bus Hong Kong 2002/3 field trial, 80 vehicles**
  - 9 -11 % fuel consumption improvement
- **Stagecoach UK 2003/4 field trial, over 1000 vehicles**
  - 5 –7 % fuel consumption improvement
- **Stagecoach UK 2007 field trial, over 500 vehicles**
  - 4.3 % fuel consumption improvement
- **NiederzierGermany 2007, municipal fleet**
  - 6% fuel consumption reported

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Hong Kong Trial – Cummins L10

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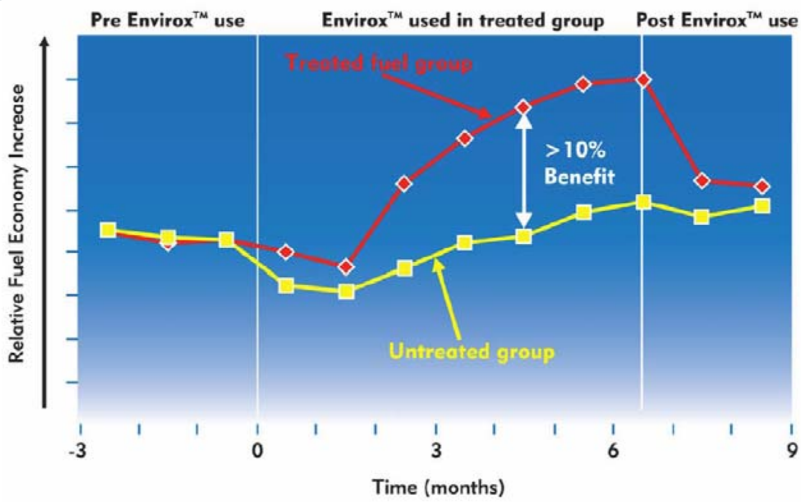

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Lowers emissions

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CO2
- Directly linked to fuel consumption, every tonne of fuel saved reduces CO2 by approximately 3 tonnes

Minimal energy used to produce Envirox™
- Calculated net CO2saving for Stagecoach = 24,500 tonnes (annual)

Particulates
- Up to 18% reductions observed

Hydrocarbons
- Up to 13% reductions observed

CO
- Up to 6% reductions observed

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The benefits

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Financial benefit
- UK Fleet Scenario
- 5% fuel saved
- Fuel price = 108 pence/litre (excl VAT)
- Additive cost = 15% of saving
- Fleet consumes 1 million litres/year

Net Cost Saving = £45,900

Environmental benefit
- UK Fleet Scenario
- 5% fuel saved
- Negligible energy consumed in Envirox™ manufacture and supply
- Fleet consumes 1 million litres/year

Net CO2 Reduction = 132 tonnes

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Johnson Matthey

a speciality chemicals company focused on its core skills in catalysis, precious metals, fine chemicals and process technology

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Autocatalysts

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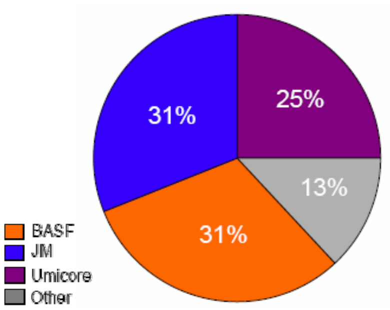

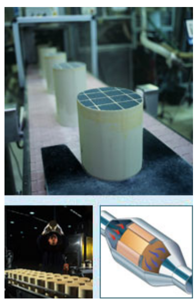

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Exhaust Catalysts

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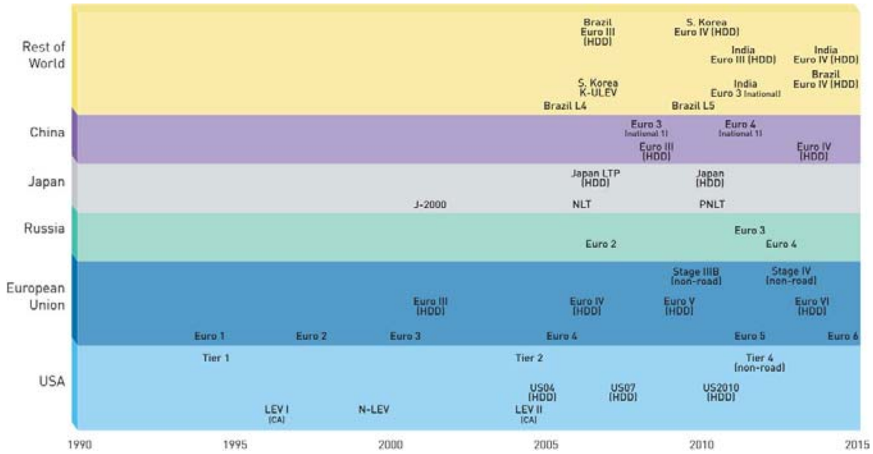
Legislation Timeline



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Traditional products

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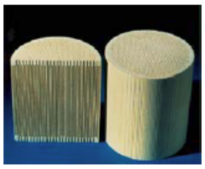
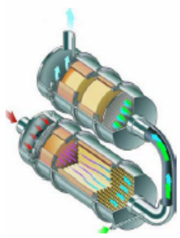


- Flow through components
  - three way catalyst (TWC)
  - diesel oxidation catalyst (DOC)
  - selective catalytic reduction (SCR)
  - NOx absorber catalyst (NAC)

Particulate filters

also known as diesel particulate filters (DPF) and catalysed soot filters (CSF)



- Systems of catalyst components
  - continuous regenerating trap (CRT®)
  - catalysed CRT® (CCRT®)
  - SCRT®(SCR + CRT)
  - EGRT® (EGR + CRT)

Johnson Matthey

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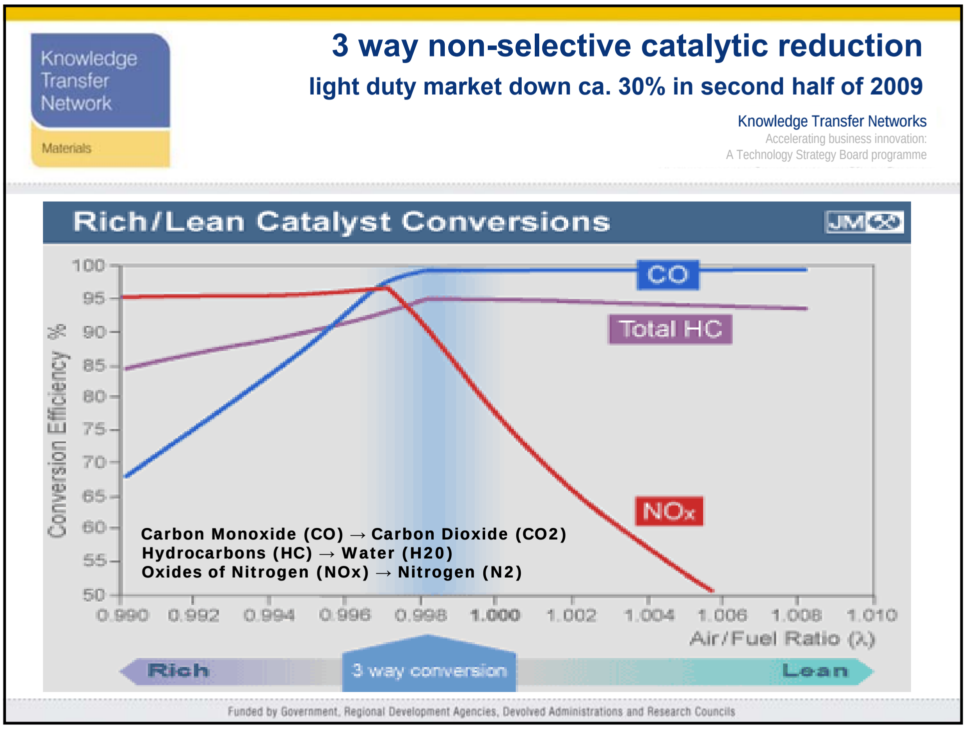
Knowledge Transfer Network
Materials
3 way non-selective catalytic reduction
light duty market down ca. 30% in second half of 2009
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Rich/Lean Catalyst Conversions
JM
Conversion Efficiency %
100
95
90
85
80
75
70
65
60
55
50
CO
Total HC
NOx
Carbon Monoxide (CO) → Carbon Dioxide (CO2)
Hydrocarbons (HC) → Water (H20)
Oxides of Nitrogen (NOx) → Nitrogen (N2)
0.990 0.992 0.994 0.996 0.998 1.000 1.002 1.004 1.006 1.008 1.010
Air/Fuel Ratio (λ)
Rich
3 way conversion
Lean
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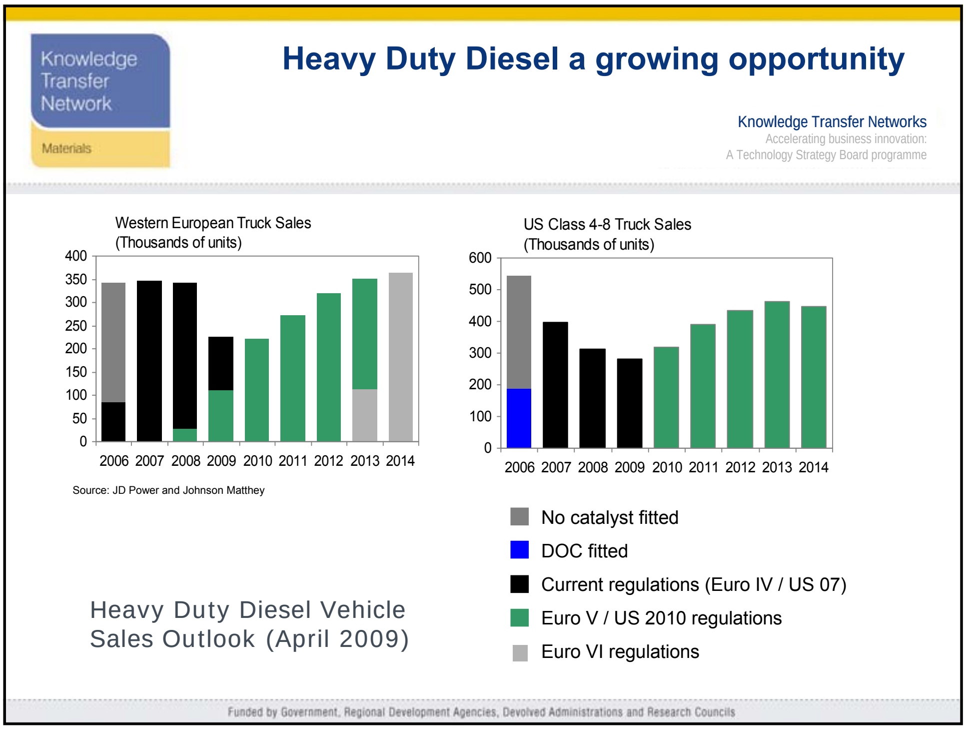
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Heavy Duty Diesel a growing opportunity
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Western European Truck Sales
(Thousands of units)
400
350
300
250
200
150
100
50
0
2006 2007 2008 2009 2010 2011 2012 2013 2014
Source: JD Power and Johnson Matthey
US Class 4-8 Truck Sales
(Thousands of units)
600
500
400
300
200
100
0
2006 2007 2008 2009 2010 2011 2012 2013 2014
No catalyst fitted
DOC fitted
Current regulations (Euro IV / US 07)
Euro V / US 2010 regulations
Euro VI regulations
Heavy Duty Diesel Vehicle
Sales Outlook (April 2009)
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SEC future growth

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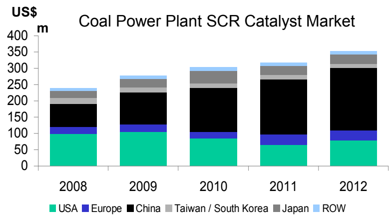
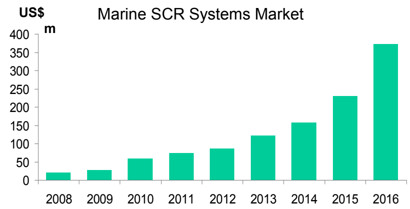
- NOx control for SEC applications should grow significantly over next decade
- Currently the market is worth approximately US $500m sales (ex pms)
- By end of 2016 expect total SEC markets to grow to around US $1.2bn
- JM is well positioned
  - Only supplier of coated, extruded and plate type SCR catalyst technology



Source: Boston Consulting Group



Source: Maritime equipment supplier

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Carbon Black

A 3,500 year old nanotechnology

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Facts and Figures

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- **Virtually pure colloidal carbon**
  - Derived from incomplete combustion or thermal decomposition of gaseous or liquid hydrocarbons
- **8.1 million metric tons produced annually**
  - Top 50 bulk chemicals
  - 90% of carbon black is used in rubber applications
  - 9% as a pigment
  - remaining 1% as an essential ingredient in hundreds of diverse applications

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Tyres

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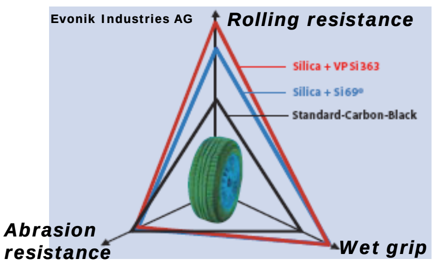
- **Competing requirements**
  - Grip
  - Reduced rolling friction
- **Other properties**
  - Abrasion resistance
  - Tear resistance
  - Slip proof
- **Cost vs Complexity**



Dunlop RunOnFlat tyre

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Tyre running surface – comparison of individual component size

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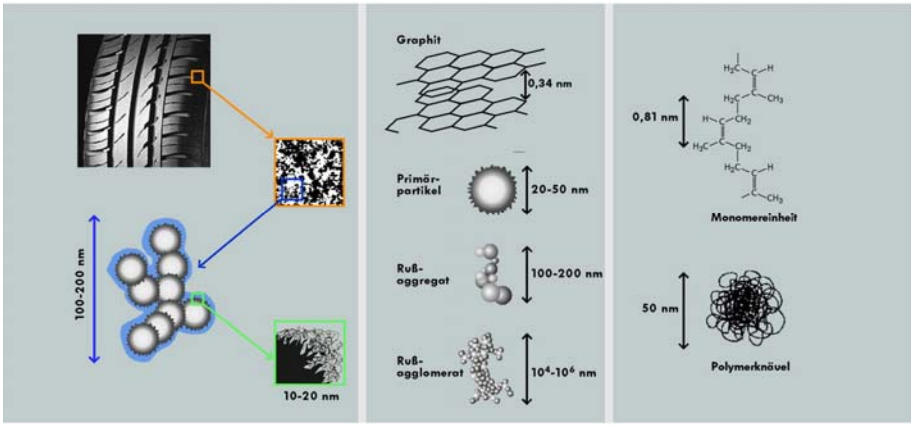

Volkswagen AG

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END of LIFE

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- **DRIVENET: EPSRC funded network on sustainability and end of life issues for automotive industry to help respond to EU legislative initiatives**

- **Sustainable Vehicle Engineering Centre (SVEC)**

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Sustainability Projects

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The Sustainable Vehicle Engineering Centre

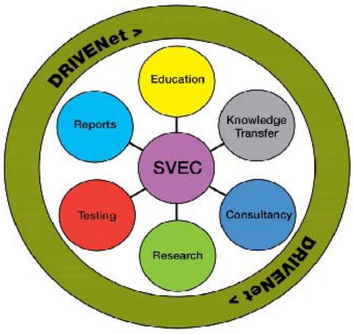
SVEC will deal with

current

and

future

challenges facing the whole life of the vehicle



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DRIVENET

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...mme

DRIVENet: Network for the design for dismantling, reuse and recycling in road vehicles (2004 –)

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End of Life Issues (SVEC, Brookes U)

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Global statistics

	1930	1960	2000	2030 (forecast)
Global population	2 billion	3 billion	6 billion	8.5 billion
Total number of vehicles on the road	36 million	136 million	767 million	1450 million
Total distance travelled (km)		2 trillion	13 trillion	23 trillion
Total fuel used (l)		280 billion	920 billion	2000 billion
Number of vehicles scrapped		5 million	36 million	116 million

From 2000 to 2030, 2,900 million vehicles will be produced and 2,200 million will be scrapped

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DRIVENET

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Materials recovery – debond-on-demand adhesives

Better joining and separation techniques

Repair and ELV

3.65 billion tonnes of materials by 2030

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This is an important materials resource!

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DRIVENET

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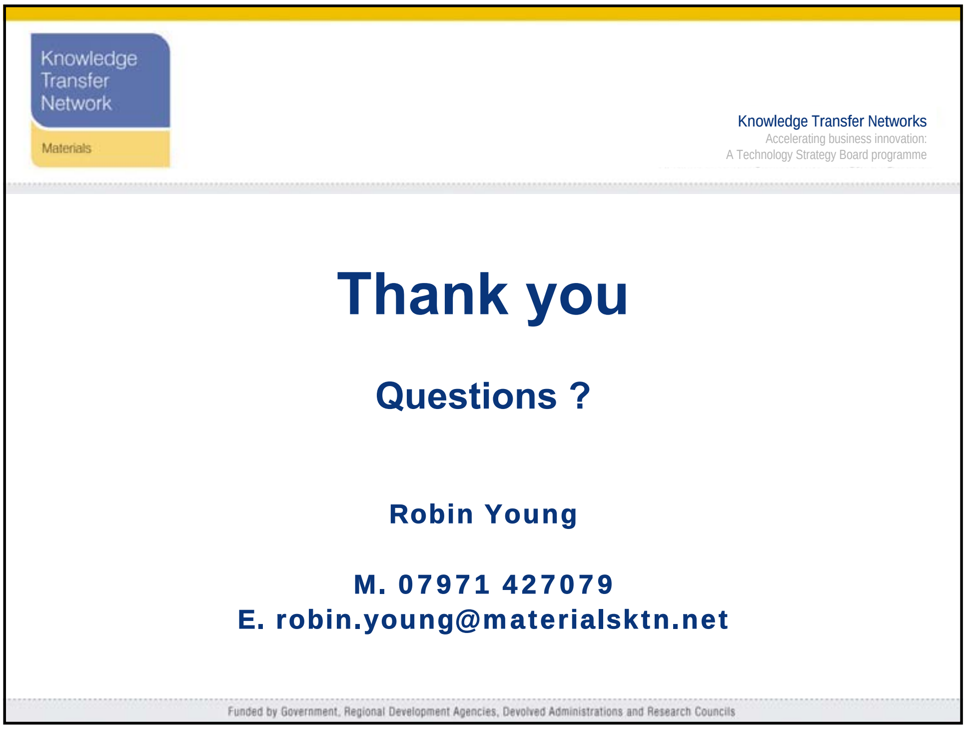
Waste streams

Material	1960-2006		2007-2030	
	Aftermarket Tonnes (Millions)	ELV Tonnes (Millions)	Aftermarket Tonnes (Millions)	ELV Tonnes (Millions)
Iron	438.62	1,447.75	560.09	1,610.89
Non-ferrous	66.46	110.20	84.86	262.51
Plastics	22.15	123.06	28.29	279.86
Glass	8.86	54.06	11.32	73.98
Rubber	221.53	85.17	282.88	119.62
Others	15.73	91.61	200.84	139.23
Total	914.91	1,911.84	1,168.28	2,486.08

- Metal content 70% can be recovered but parts for reuse not removed
- Recycling of rubber, plastics, glass
- Need for better assembly, dismantling, and disassembly
- More development of pre/post shredder techniques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Thank you
Questions ?
Robin Young
M. 07971 427079
E. robin.young@materialsktn.net
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SIEMENS

Corporate Technology

Inorganic Functional Materials: Trends and Challenges

Business Lunch Talk
Brussels, Oct 8, 2009

Ulrich Bast
Siemens Corporate Technology

Based on a Presention of Wolfgang Rossner CT MM 2

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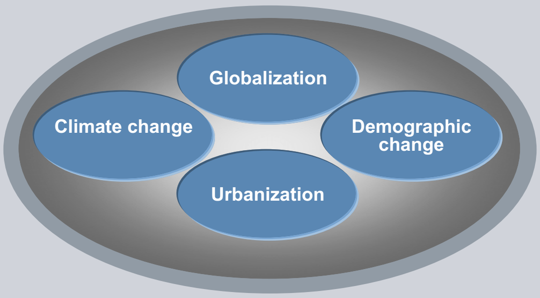
Megatrends Define Future Challenges



Energy demand vs. **environmental protection**
Quality of healthcare vs. **affordability**
Urbanization vs. **quality of life**
Globalization vs. **local /regional competitiveness**

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Trendsetting Technologies Required

Industry	Energy	Healthcare

Innovative and comprehensive solutions are required in all Siemens Sectors, Industry, Energy, and Healthcare

Material technology is a key enabler of system innovation in these fields

SIEMENS

Functional Materials
The Key to System Innovations

Osram LED-Lighting

OSTAR® - Product Family

- Osram's **most powerful** cold-white LED
- **Brightness of 1,000 lumen** at 20 W (= 50W halogen lamp)
- **Flat**, **compact** and **integratable**

Energy saving and **longest life time**

Epitactic semiconductor deposition
Improved surface structure
Convertion material on surface

Siemens Gas Turbine – Unmatched Efficiency

Gas Turbine SGT5-8000H

- **Fast** start-up capability & **operational flexibility**
- **High** reliability and availability
- In combined cycle duty **efficiency** of **over 60%**

Lowest life cycle costs and **reduced** investment costs/kW

High temp. alloys
Ceramic thermal insulation

World's first dual source Computed Tomography

Somatom Definition:

- **Faster** than **every beating heart**
- Full cardiac detail at **half the dose** (**50% lower** radiation exposure)
- **One-stop shop** scanning in acute care

Scan **every heart at any heart rate** without **beta-blockers**

Ultrafast ceramic scintillator material

From Powder to Complex Systems - Functional Materials as Key Enablers

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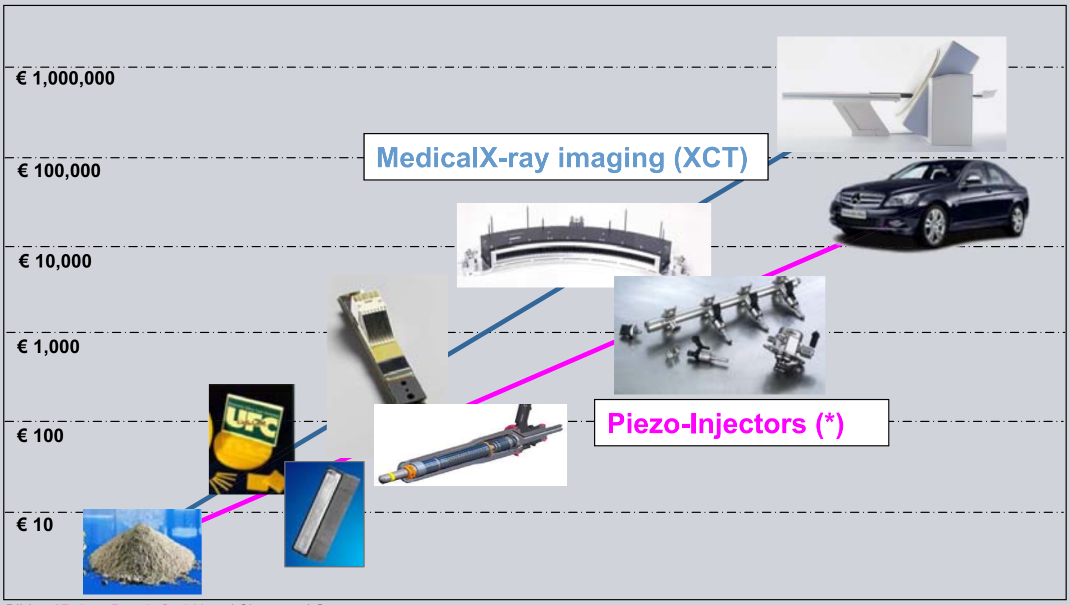

Bilder: *Robert Bosch GmbH und Siemens AG

⇨ Added value level

Seite 5 Oct 2009 Bast CT MM 2

From Material to System Innovation

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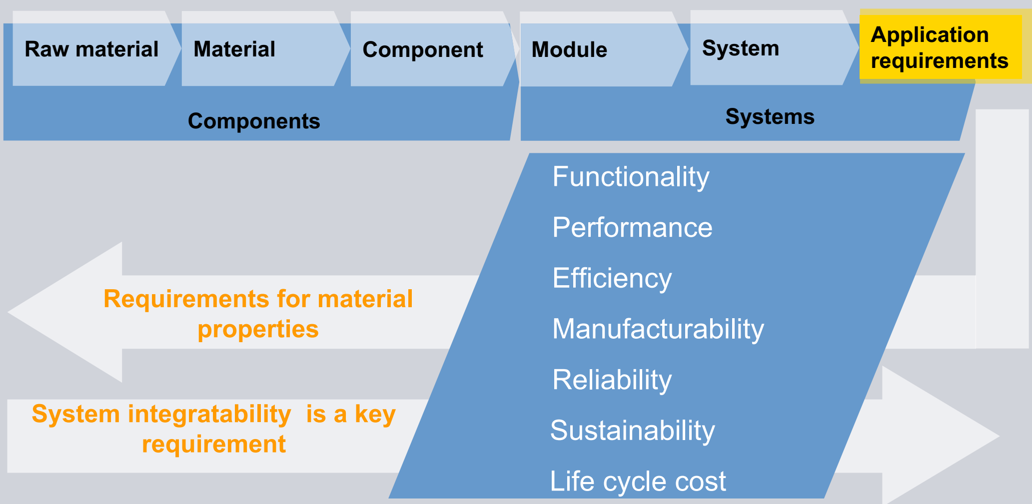

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Challenges for Functional Materials

New functionalities and applications

- Self healing
- Adaptive
- Multi-functionality
- Energy harvesting

Performance beyond today´s limits

- Operation in harsh environments
- Ultra-low heat conductivity
- High temperature capability
- Extremely low electrical resistance

Sustainability

- Recycling
- Safety, Health, Environment
- Risk management
- Material substitution

Cost efficiency

- Raw materials
- Availability
- Processing

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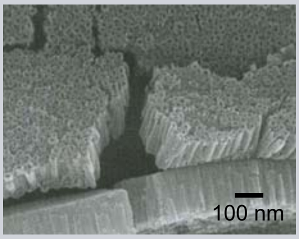
R&D Needs for Functional Materials

- Materials with complex architectures (multi layer, composites)
- Engineering of structures from nano to macro
- Simulation and modelling tools (multi scale)
- Improvement and functionalization of surfaces (e.g. for sensors
- Understand degradation and failure mechanisms in harsh conditions
- Substitutional materials to replace rare, scarce, toxic or costly materials
- Production technologies for highest quality

Example:
Structural Engineering on all Length Scales

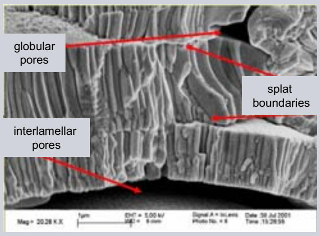
Structure engineering leads to tailored properties:



TiO_2 Nano-Tubes for photokatalytic water splitting

Source: C. Grimes, PennStateUniversity publiziertin ACERS Bulletin, March 2007

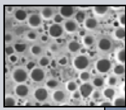
> nano <



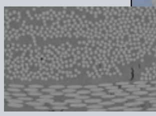
Thermal Barrier Coating

Source: Forschungszentrum Jülich

> micro - meso <



Substrat: dehungstolerante und rissunempfindliche Oxid-Oxid-Komposit (CMC)



Ceramic Matrix Composite

> macro <

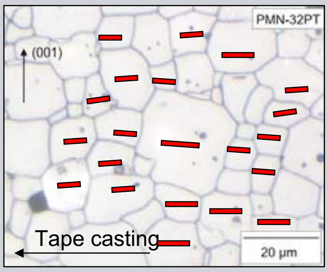
High catalytic efficiency

Strain tolerance
Thermal insulation

Damage tolerance
Thermal insulation

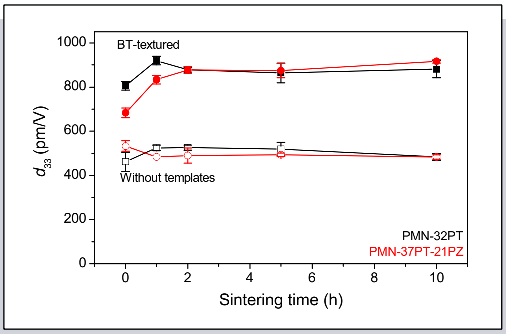
Example:
Textured Material Architectures for Improved Performance

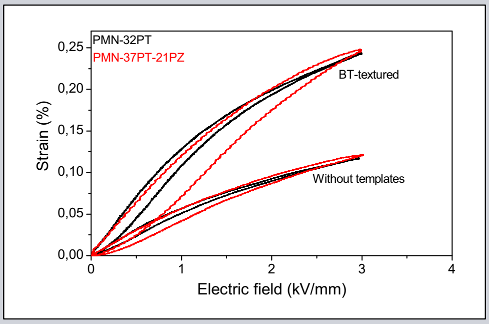
Textured Piezo ceramic material



Textured PMN-PT ceramic
with 5 vol-% BT-seeds

Substantially improved piezo properties





Example: New Semiconducting Materials for Medical X-Ray Imaging

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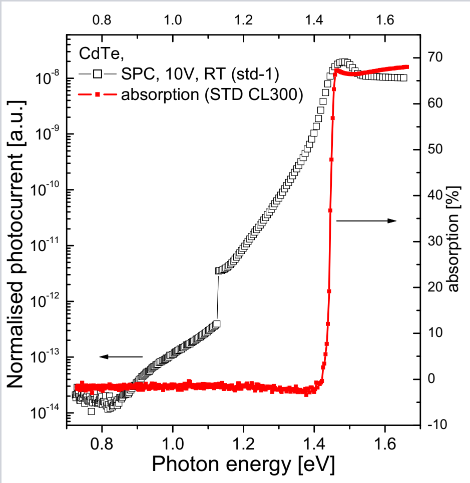
Understanding of influencing factors down to the atomic scale



- Typificationof relevant point defects
- quantitative charcterization of point defects
- interaction load carrier - defect
- New production technologies for semiconductors
- Novel detector designs
- Cost-efficient packaging
- …

Example: Functionalized Surfaces on a Layered Architecture

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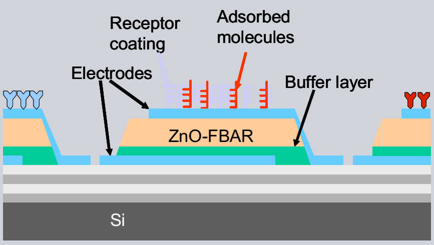
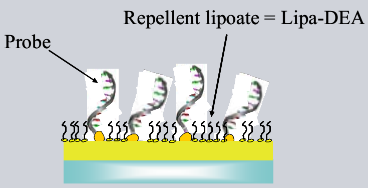
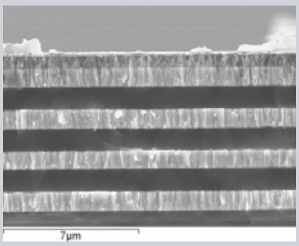




FBAR with functionalisation for DNA detection



Thin Film Bulk Acoustic Resonators (**FBAR**) consist of a zinc oxide layer sandwiched between two electrodes, mounted on a quarter-wavelength mirror. The resonators for operation in liquids operate at around 800MHz in shear-mode. Shear coupling coefficients up to Keff=19.2% and quality factor up to Qs=130 in water have been achieved.

EU FP6 Project Biognosis

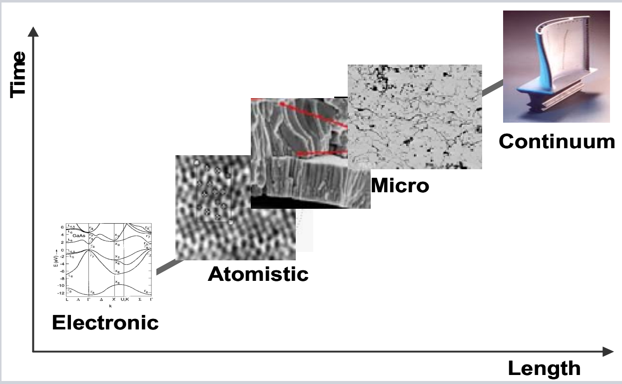
Example:
Advanced Functional Materials through Modeling

SIEMENS

Multiscale Material Modeling helps to
- Understand mechanisms (-> targeted development)
- Replace experiments (-> accelerated development)

➢Thermal Barrier Coatings w/ extremely low thermal conductivity
➢Thermoelectric materials with improved efficiency
➢Piezo actuators with increased strainand domain switching

Ongoing public funded programs



Continuum Scale:
Finite Element, Finite Difference, Boundary Element, Finite Volume

Microstructure Scale:
lattice gas, cellular automata, coarse grained MD, kinetic MC

Atomistic Scale:
atomistic MC, MD (<10^9 Atoms)

Electronic Scale:
Q-MC, Tight-Binding, DFT (< 400 Atoms)

Conclusion:
Future R&D Topics for Inorganic Functional Materials

SIEMENS

➢**Strong focus on application oriented R&D**
➢**More interdisciplinary work**
➢**Crosslinking of science & engineering**
➢**Increasing modeling and simulation**
➢**Address the entire technology chain**

- **Complex chemical compositions and structural architectures**
- **Higher functionality**
- **Increased reliability and life time (Zero- Failure)**
- **Cost and resources efficient production**

Technology Strategy Board

Driving Innovation

Enabling a better world – Our strategy for nanoscale technologies

Christian Inglis – Technologist, Advanced Materials and Nanotechnology

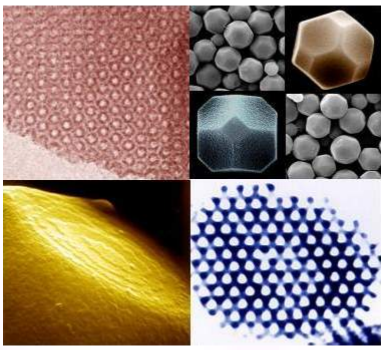
Trilateral business lunch - 08/10/2009

Technology Strategy Board

Driving Innovation

Purpose

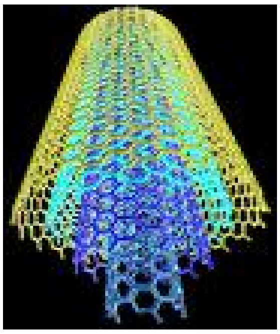
- Inform UK companies about our approach, over 2009 -2012 and beyond, and the opportunities it creates
- Guide the Technology Strategy Board internally in its work on both nanotechnology and other topics e.g. Materials, Healthcare, Electronics, Energy
- Advise other areas of Government about our approach and areas of mutual interest



Technology Strategy Board
Driving Innovation

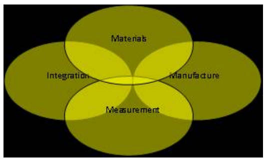
Content

- What is nanotechnology?
- Where are we now?
- Where do we want to be?
- UK aspirations
- Technology Strategy Board potential investment



Technology Strategy Board
Driving Innovation

What is it ? – Four Areas



- Nanoscale **materials** (~1nm to 100nm) with one or more specific properties of:
  - High surface area and hence high surface activity, enabling self-assembly
  - Quantum effects becoming dominant
  - Changes in optical, magnetic, or electrical properties
- **Fabrication** techniques; the ability to produce and engineer nanoscale materials and structures via new approaches
- New **measurement** techniques to understand properties of materials and quality control in production
- **Integration** into a final product

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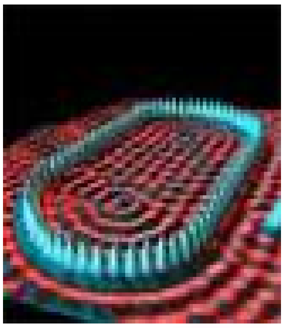
Driving Innovation

Highly Pervasive

- Nanoscale technologies are highly pervasive over a range of market sectors,
- Usually embedded into components and systems, which are not on the nanoscale e.g. sensors
- Considered as a set of enabling technologies, rather than end products in their own right



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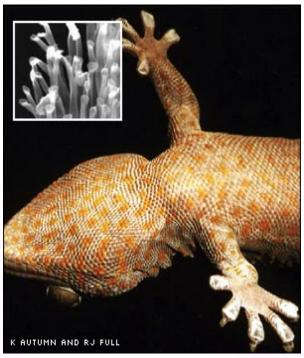
Nanoscale technologies have many links to nature:

- Bone – a nanostructured organic/inorganic composite giving excellent toughness properties
- Gecko feet - nanoscale fibres giving "sticky" feet due to Van der Waals' forces and the concentration of fibres in a small area
- Lotus leaf - nanostructured topography giving control of surface tension
- Cell biology – e.g. molecular motors



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Nanoscale technologies are not entirely new

Examples from history

- The Lycurgus cup, dichroic glass containing small amounts of colloidal gold and silver..made in 4th century AD
- Catalysts providing a high surface area for a number of applications
- Colloidal chemistry

Images courtesy of the British Museum

They are also not.....

The “Nano” satellite

The Ipod “Nano”

Tata Motors “Nano” car

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Driving Innovation

Current Understanding & Application

- Our understanding of properties at the nanoscale has improved and has resulted in a desire to engineer and exploit the potential added functionality of these properties
- Current engineered products incorporating nanoscale technologies are generally evolutionary improvements to existing products:
    - Metal oxide nanoscale particles in sunscreens
    - Nanoscale filler materials in e.g. car bumpers
    - Nanoparticle drug delivery
    - Nanostructured materials and surfaces in batteries
    - Antibacterial coatings

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Driving Innovation

Where are we now (Globally)?

- Public and private investment into nanotechnologies is large ($10bn worldwide in 2007)
- Products currently manufactured use between $2.3billion to $10billion of nanomaterials globally across a wide range of markets
  - a subject of significant debate
  - The consensus is that markets will grow in the coming years
- Revenue generation comes in the main from coatings, particles, nanoporous structures, and composites
- Leaders in the field are USA, Japan, Germany, UK and South Korea with many other countries improving their standing significantly

Technology Strategy Board
Driving Innovation

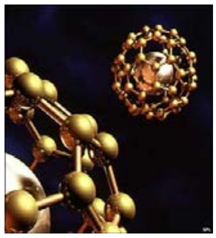
Where are we now (UK)?

- Investment into infrastructure and R&D inclusive of the regions, and industry through the Micro and Nano Manufacturing initiative
  - Split approximately 50:50 between micro and nano
  - Challenge led investment resulting in projects utilising nanoscale technologies, e.g. Materials for Energy competition, Autumn 2007
- UK considered to be excellent in the research base through coordinated activity across the Research Councils
- UK currently leading in EHS and public engagement issues across government
- Significant knowledge transfer activity

Technology Strategy Board
Driving Innovation

Where are we now (UK)?

- UK well placed in nanoscale technologies at various stages of Technology Readiness Levels:
  - Coatings and surfaces
  - Structural and functional materials
  - Modelling, design and scale-up
  - Controlled release, diagnostics, therapeutics
  - Displays, memory, sensors
  - Instrumentation for measurement



- Technological barriers in scale up of manufacture, measurement, life cycle analysis and integration into systems and new products
- Other issues include perception of EHS, coordination of the public debate, appropriate regulation and cross discipline skills development within academia and industry

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Driving Innovation

UK Aspirations

- **Obtaining more than our fair share of the potential global market for nanoscale materials predicted at ~$81billion by 2015**
- UK should focus efforts in creating wealth and a better quality of life by addressing priority challenge areas:
  - Living with environmental change (energy, sustainability, and environmental monitoring)
  - Living with an ageing and growing population (healthcare, and inclusive of food packaging)
  - Living in an intelligent connected modern world (creative industries, entertainment, safety and security, intelligent transport)

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Driving Innovation

UK Aspirations

- Innovation should be based on collaboration across market sectors (e.g. healthcare, textiles, electronics), throughout the supply chain (e.g. materials suppliers, integrators, end users), and working closely with Research Councils/Universities
- Innovation should be responsible through dialogue between industry and government via available coordinated networks, and discussion and removal (where appropriate) of potential safety concerns

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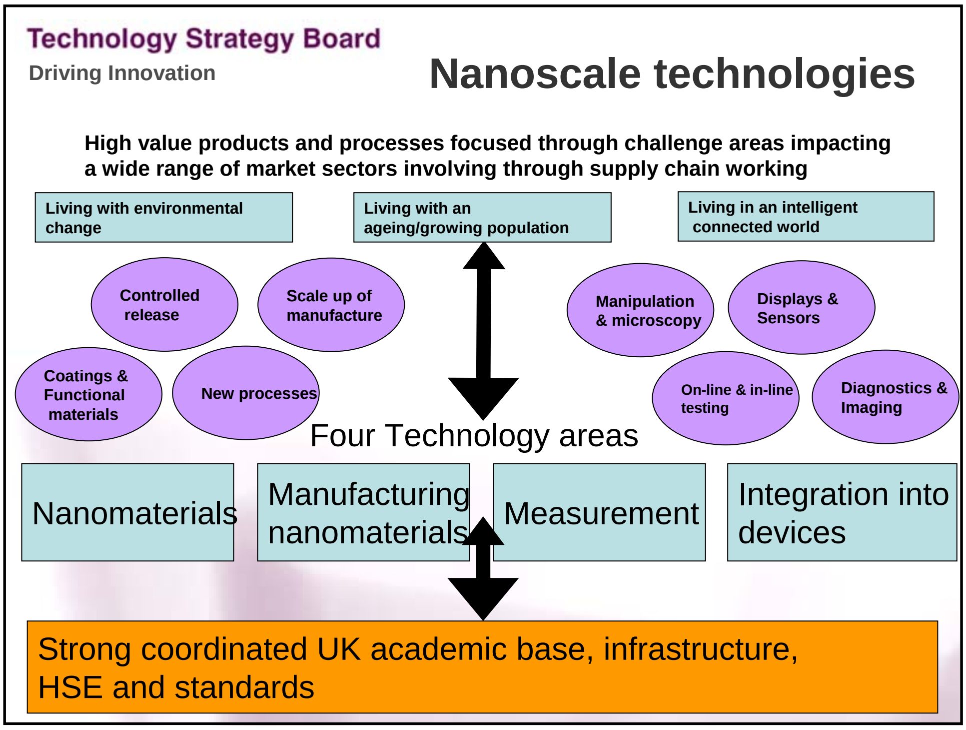
to catalyse UK aspirations we will:

- Invest in cross market sector collaborations by enabling supply chains to compete in **Collaborative R&D** competitions having a challenge-led focus, where the UK has strength.
- Partner closely with **Research Councils**, RDAs/DAs, and Government departments where appropriate to connect activities (e.g. nano grand challenges, national KTP scheme, SBRI, UK coordinated strategy) to pull ideas through the supply chain to commercialisation
- Ensure that the **UK facilities network** is appropriately coordinated, communicated and focused on developing exciting new technologies
- Engage appropriately within **Europe** and globally to enhance programmes for the benefit of UK industry (through Framework 7 and 8 activity, OECD working parties)
- Continuing to provide mechanisms for coordinated **knowledge transfer** and responsible development



Technology Strategy Board

Driving Innovation

Nanoscale technologies strategy

- Essence of strategy
  - Linking together how nanoscale technologies can help to impact key societal challenges (balancing technology push with market pull)
- Strategy to be launched on October 13th, London, UK


Technology Strategy Board
Driving Innovation
www.innovateuk.org

Short Extract

Business Lunch Talk about Future Topics.

Changeability in Automobile Production.

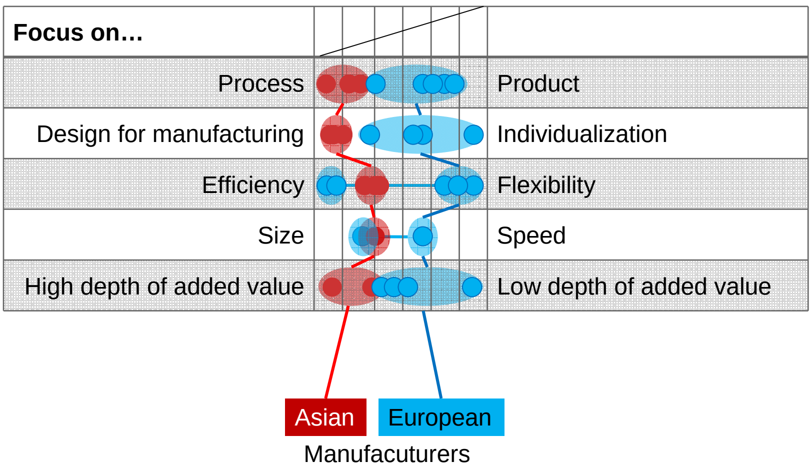
Dr. Peter Weber
October 8, 2009

BMW Group

Short Extract

The Premium Car Producers Production Networks.

Different production systems.



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Page 3

Short Extract

Hypothesis.
It is AND. Not OR.

Focus on…		
Process		Product
Design for manufacturing		Individualization
Efficiency		Flexibility
Size		Speed
High depth of added value		Low depth of added value

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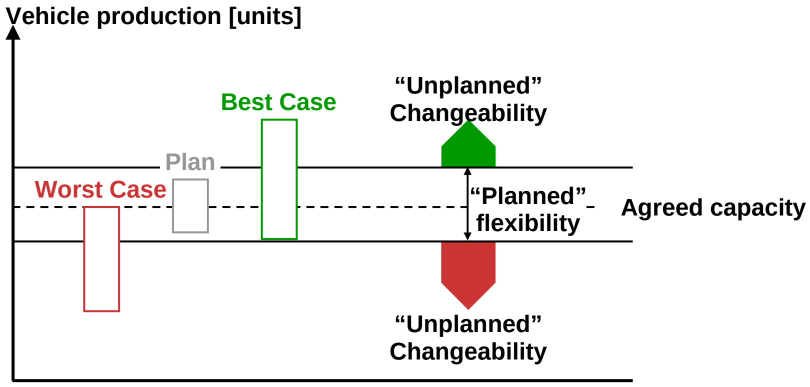
Page 4

Short Extract

Hypothesis.
Changeability – More than Flexibility.

Changeability *

Capability to structurally change an established system
in a fast and sustainable way



* **Source:** Prof. Dieter Spath, Fraunhofer Institute for Industrial Engineering IAO

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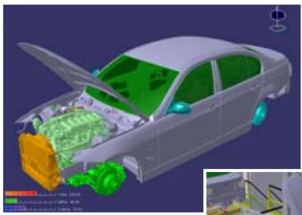
Page 5

Enablers for a Changeable Production System.
Fusion of virtual and real Factory.

Short Extract



Integration of product development and process planning to cope with the complex interactions between product and process

Cope with the integration of individual products into existing structures

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Page 6

Conclusion.

Short Extract

We have to define the future "European way" of Automobile Production.

Changeability…

… is a key factor of success in times of discontinuity.
… requires an interdisciplinary approach to scientific research and education.

But many questions remain:

- How can we achieve holistic changeability in terms of technique and organization and human resources?
- How can we identify the necessary elements for changeability?
- How can we combine and apply these elements for a specific situation in a "lean way"?

Business Lunch Talk about Future Topics, 8th October 2009

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