EurORoads

Agenda for Business Lunch Talk about Future Topics, 26th of January 2016

Venue: **Helmholtz Office, Rue du Trône 98, 1050 Brussels**

Organisation: Joint Activity of the British, French and German Delegation of the PC NMP

Forschungszentrum Jülich, PtJ,
Phone: +49 (0) 175-2238018
+49 (0) 2461-61-3545 (G. Schumacher)

12:00 Arrival of the participants, lunch and coffee

12:25 Opening by Rosita Cottone (German Ministry of Education and Research)

12:30 EU KOM (statement by Achilleas Stalios about future of NMBP)

12:50 Presentation by Didier VanDen Abeele (CEA) about "KIC - added value manufacturing"

13:20 Presentation by Klaus-Michael Weltring about "Emerging and Strategic Technologies for Healthcare"
Presentation by Ehrenfried Zschech (FhG) about "New Materials Concepts for Nonvolatile Data Storage"

13:50 Presentation by Pufinji Obene (PVI), about "A Business Perspective: On the use of Nano-Materials for Printed Circuit Board Fabrication"

14:10 Discussion

- Which is the expected impact in NMBP?
- Do they have the potential to provide effective solutions?
- Which are the appropriate funding instruments?
- How can topics be implemented in future work programmes in Horizon 2020?

15:00 End of the event, coffee and possibility for informal discussions

Business Lunch Talk about Future Topics, 26th of January 2016

Introduction

The current Business Lunch Talk was held in Brussels on the 26th of January 2016. About 16 participants from EU Commission, national Ministries, enterprises and National Contact Points attended the meeting in order to discuss future topics in the NMBP part of Horizon 2020 with focus on materials and production aspects.

Mrs. Rosita Cottone, the new National Delegate from Germany and host of the event welcomed the participants and gave a short introduction on EU-funded CSA SMART and the history of the former business lunch talks.

Achilleas Stalios, Research Programme Officer for Materials for Transport and Machines Tools in the Research & Innovation Directorate-General, introduced the state-of-the art of the NMBP activities and the current planning of the related work programme for the last three years of Horizon 2020. He pointed out the necessity to receive thematic input from the stakeholders especially regarding the industrial needs and the market demand. He stressed that EU Commission is in close contact with the related Technology Platforms and PPP associations. In this context he highlighted the materials roadmap and the SPIRE implementation plan.

The importance of frugal technologies has been pointed to by René Martins, Research Programme Manager in the Research & Innovation Directorate-General. He encouraged the participants to consider this aspect where appropriate.

Didier van den Abeele, Deputy Director for European Affairs at CEA List introduced the KIC Added Value Manufacturing. He described the role of KICs in the innovation chain, explained the vision and gave details on the call. He discussed the functions and roles of Co-locations Centres – CLCs and Regional Innovation Centres and their roles and functions within the KIC.

The following three presentations of representatives of organizations from Germany and United Kingdom gave an overview of the specific demand in NMBP related funding activities on European level, with emphasis on applications in live sciences and ICT.

Klaus-Michael Weltring, representative of Bioanalytik Münster e.V. and chairman of the German platform biomedicine and member of the ETP Nanomedicine, discussed the need of strategic and technical innovations in medicine with an emphasis on nanomaterials. He presented the strategic roadmap of the ETP and put a special focus on the transition needs to foster the current challenges in the fields of healthcare and medical technologies. He introduced ESTHER, an initiative of EU Commission and the healthcare industry, that will become one of the next so called IDI = Industry Driven Initiatives.

Suggesting that new materials concepts for nonvolatile data storage are of high importance for the European IT industry, Ehrenfried Zschech, representative of Fraunhofer Institute IKTS Dresden, welcomed the opportunity to present his vision to the attendees. He illustrated that the competitiveness of the EU ICT sector depends strongly on the ability to develop and integrate new materials that fulfil the demands on functionality, performance and reliability.

Finally Dr. Pufinji Maclean Obene, operations director of Precision Varionic International presented his vison of Nano-Materials for printed circuit board fabrication. He pointed out the challenges on sustainability, compatibility and processability of nano-matrials and put a special focus on the economic aspects. By comparing the innovative printing technology with the state-of-the-art, he described the estimated market share and described in detail the intended production process. Pufinji illustrated the importance of European funding in order to overcome the valley-of-death in this specific technological field and described the potential of the envisaged technology in the sensor market that is currently dominated by Asian products.

The Business Lunch Talk is a direct 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 after the SMART project to coordinate and accelerate efforts in this area. An annual meeting was also initiated to facilitate the dialogue between materials foresight activities / researchers and funding bodies in the Member States and in Europe as a whole.

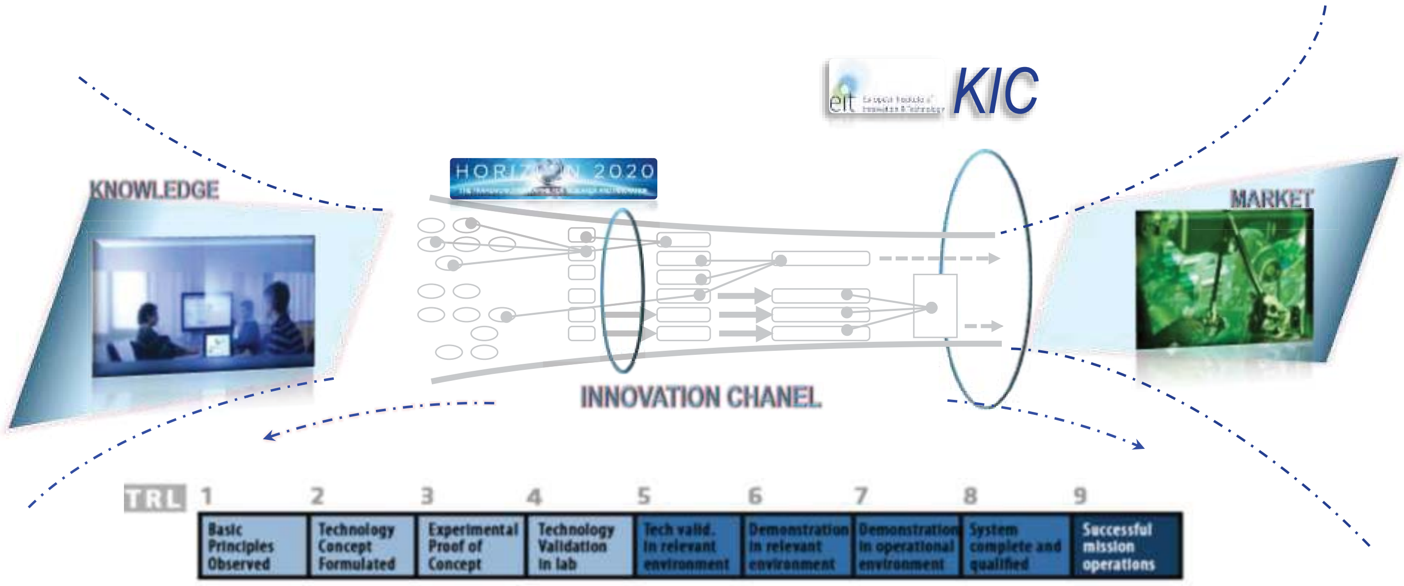
After two meetings, the Annual Meeting of MaterialsEuroRoads (March 2007 in Paris and May 2008 in London) with fruitful discussion about the way forward in materials technology, the format of this meeting was improved by creating a more condensed version with respect to time frames and audience. This was the beginning of the "Business Lunch Talk", which first took place in Brussels in July 2008 and was followed by meetings in Brussels, in October 2009, February 2011 and December 2012.

These proceedings collect the four presentations and a speech given at the Business Lunch Talk on 26th January 2016. We would like to take this opportunity to thank the speakers for their stimulating presentations and also to Lee Vousden for his skilful moderation of the event. We also express our gratitude to the attendees for their contributions in the closing discussion.

We hope you find the presentations interesting and informative.

The National Delegates / National Contact Points for NMP of France, Germany and the United Kingdom

KIC, WHAT about the innovation chanel?



EIT KICs do NOT fund R&D but TECHNOLOGICAL TRANSFER

Create a common technological interest for European market

KIC ADDED VALUE MANUFACTURING

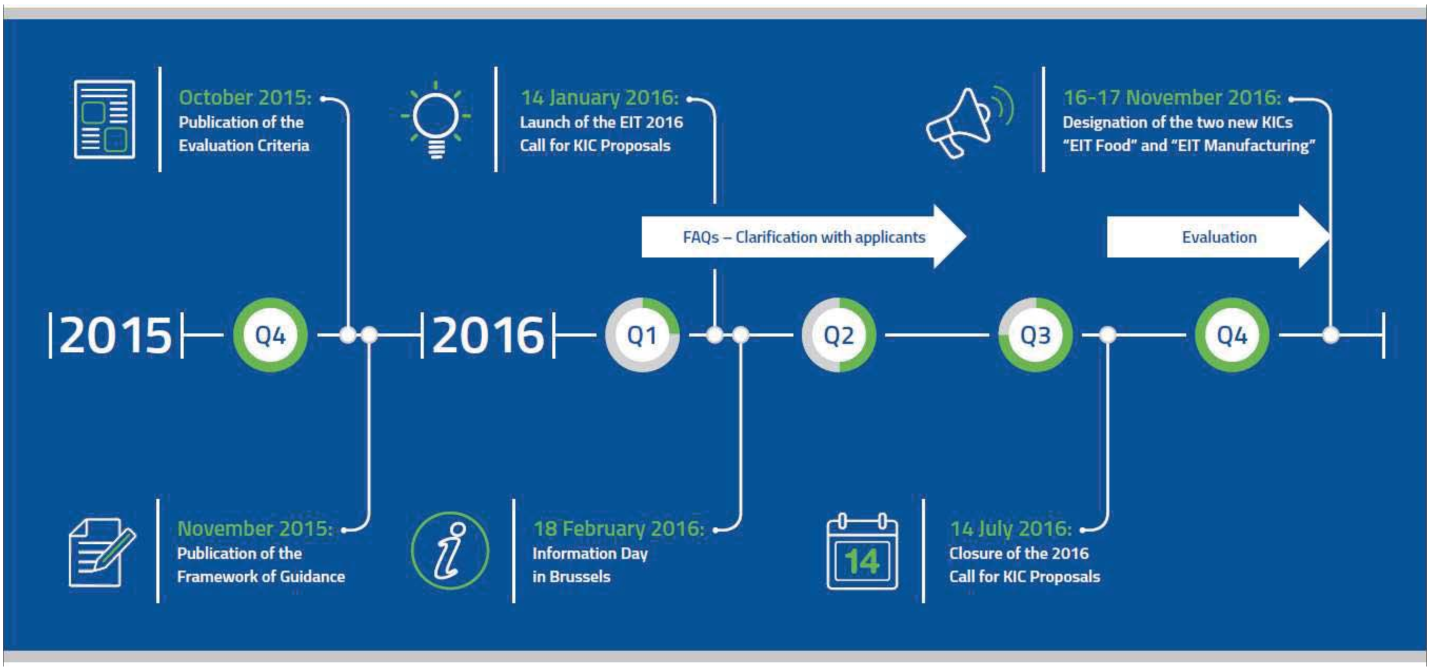
AVM KIC – Vision

Vision

For EU to become highly competitive in manufacturing and overcome societal challenges

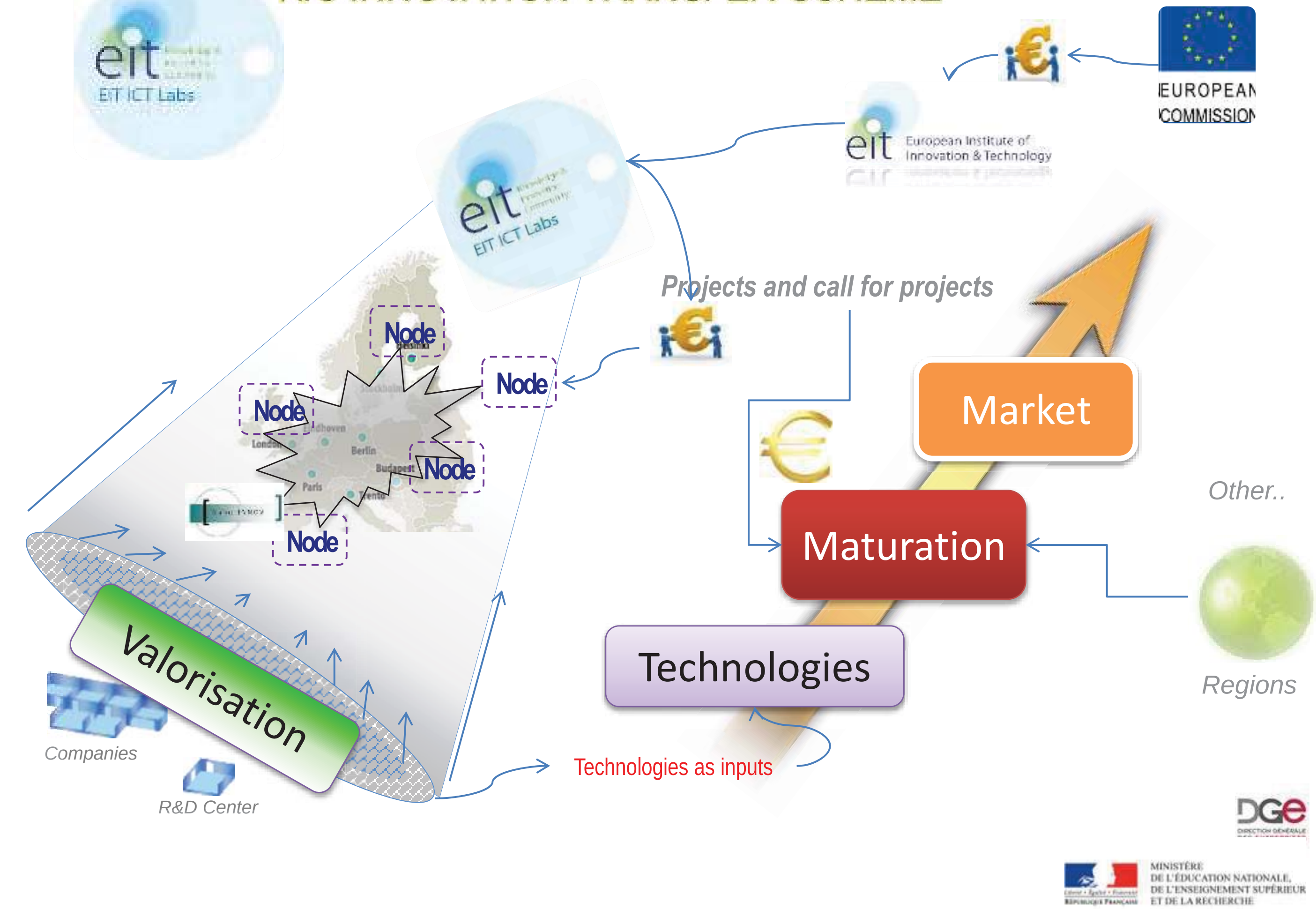
Added Value Manufacturing

Planning of the Call



KIC Added Value Manufacturing

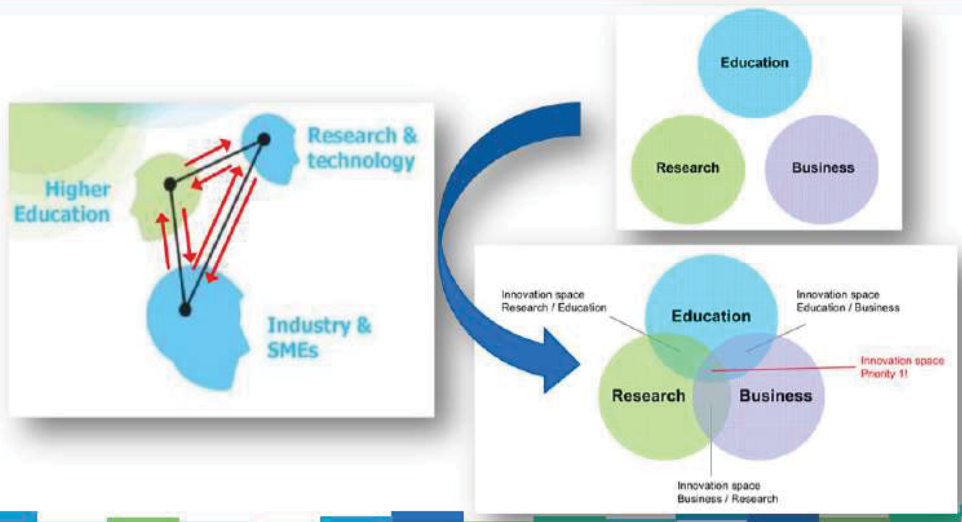
KIC INNOVATION TRANSFER SCHEME



AVM KIC – Mission

Mission

AVM KIC is the catalyst to develop, improve, strengthen, champion and endorse capabilities and key actors needed to be highly competitive in added value manufacturing



Topics/Challenges (preliminary, to be modified)

- Human-centred & Customer-focused manufacturing
- Advanced manufacturing processes
- Digital, virtual & resource efficient factories
- Adaptive & smart manufacturing systems
- Collaborative & mobile enterprises
- Industrial automation and robotics.
- Lean Manufacturing, ergonomy, workplace organization and logistics.
- Sensors and micro-nano devices.
- Economically, Environmentally and Socially Sustainable Manufacturing
- Mass Personalisation & Mass Customization
- …

!! Thematic are for example – Under review

Key Issues (preliminary, to be modified)

Efficiency | **Evolution** | **Sustainability**

- Innovation Leadership / Innovation for the Future
- Added value in Supply Chain
- Versatile Value Creation Systems and Solutions
- Future value creation
- Digitising Manufacturing
- Supporting SMEs in the Manufacturing Ecosystem

Societal balance

!! Thematic are for example – Under review

"Services"

Education & Training

"Teaching/Learning Factory"

- Networked European learning "space"
- EIT / AVM KIC labelled education programmes
- Networked education services (MOOCs, SPOCs, serious games)
- Access to existing courses and equipment
- Transdisciplinary programmes for training
- programmes for technology management and implementation
- Teaching Factory projects
- KIC Academy (vocational & professional learning)
- Training the trainers
- Learning during the work
- Coaching for organizational learning
- International training for SMEs
- Support new disruptive career paths
- Qualification System (from EQF level 2 to level 8)
- European Training observatory for Added Value Manufacturing
- Create manufacturing awareness and interest for young talents
- Align students with the most recent skills and competences

Business & Entrepreneurship

"Entrepreneurial Factory"

- New business models and value chains
- Intrapreneurs and innovation space
- Long term strategy management
- Access to Finance
- Toolset of manufacturing entrepreneurship
- Mentoring program
- Proactive know-how
- Support/prepare new technologies implementation
- Pilot projects
- Foresight (for SMEs) & Technology scouting, monitoring, road mapping
- Innovation sprints / SCRUM
- Cloud-based architectures
- Market analysis for research results
- Feasibility analysis for sustainable industrial applications
- Engineering and industrialization of research results
- Industrial uptake of solutions through spin-off or transfer

AVM KIC

Innovation & Research

"Innovation Factory"

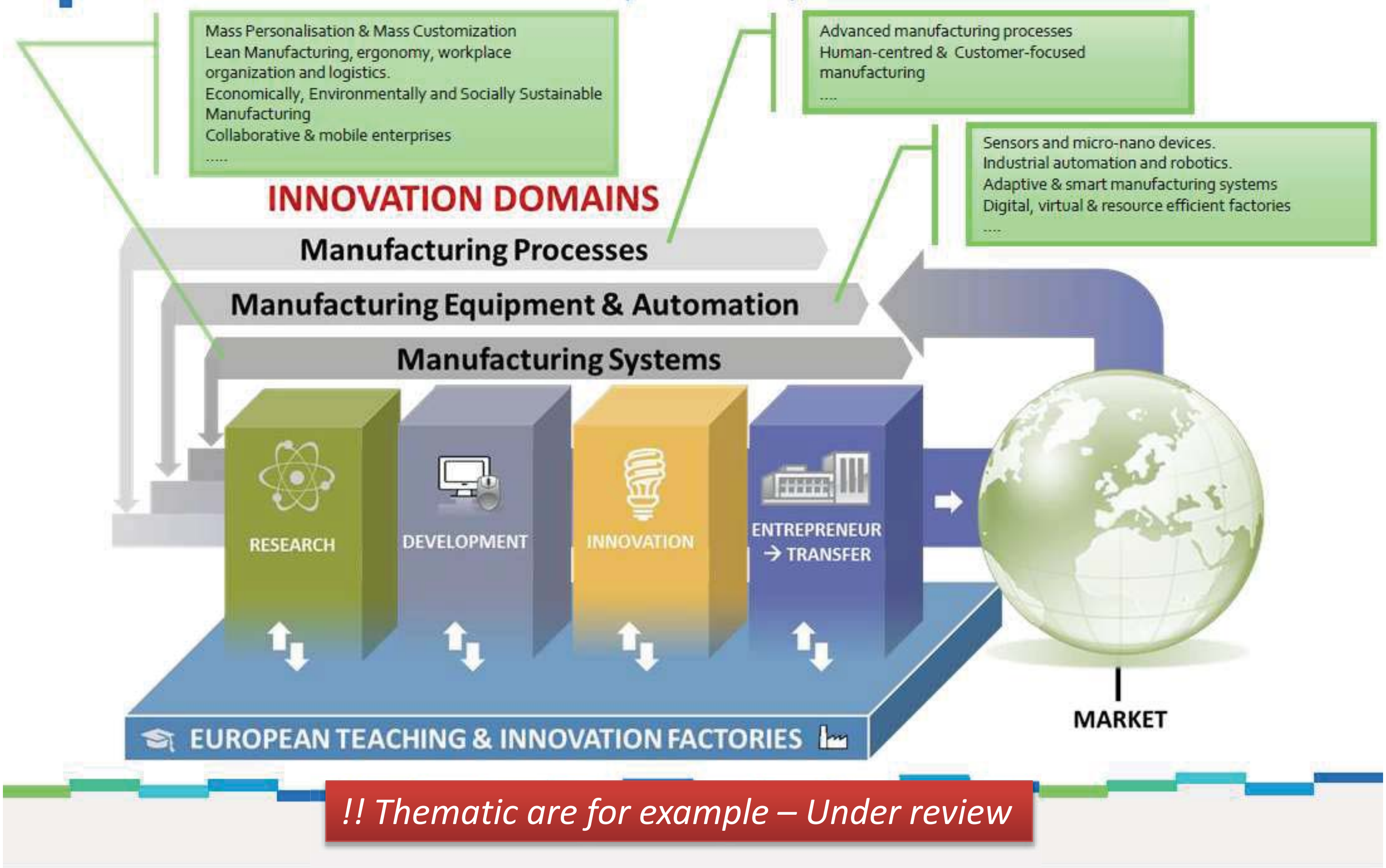
- Calls for project enrichment
- Provide additional content and focused funding (increase project results)
- Future lighthouse projects fitting and supporting AVM KIC strategy
- Evaluate projects in order to drive innovation
- Create added value through inter-project exchange and collaboration

Integrated Support Services

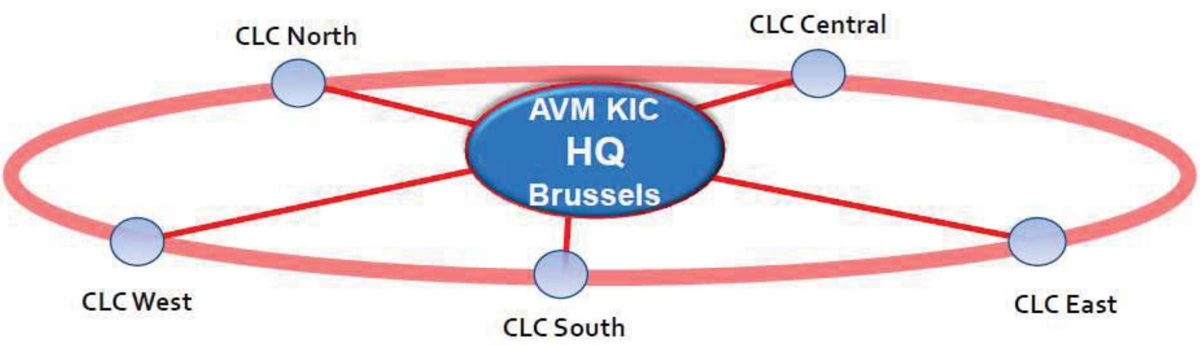
- Dialogue between R&D and industrial application
- Ramp up production
- Network of infrastructures
- Define standards
- Customer search: Map of competencies and infrastructure
- Information hotline
- Marketing of AVM KIC Services
- Improve attractiveness of first contact
- Road-show with Best-Practice examples
- Marketing of innovative products and services to the public

WORKING DOCUMENT V12

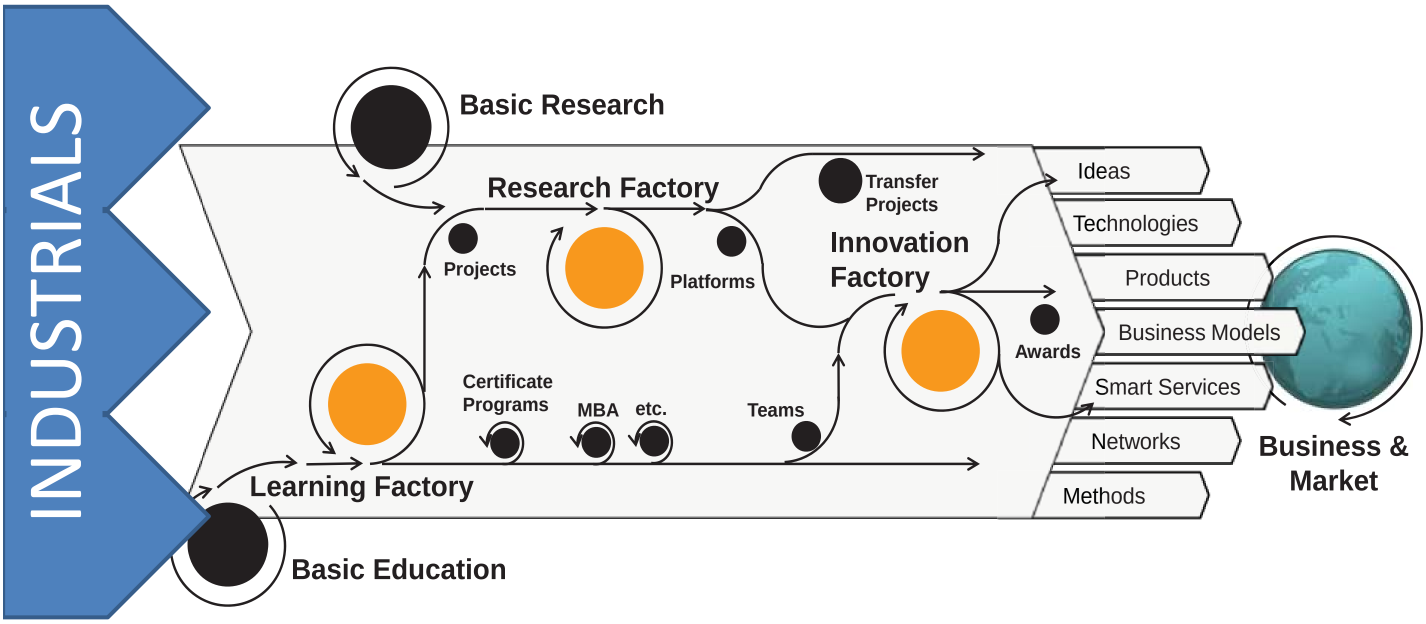
Innovation Domains (preliminary, to be modified)



CLCs in the AVM KIC

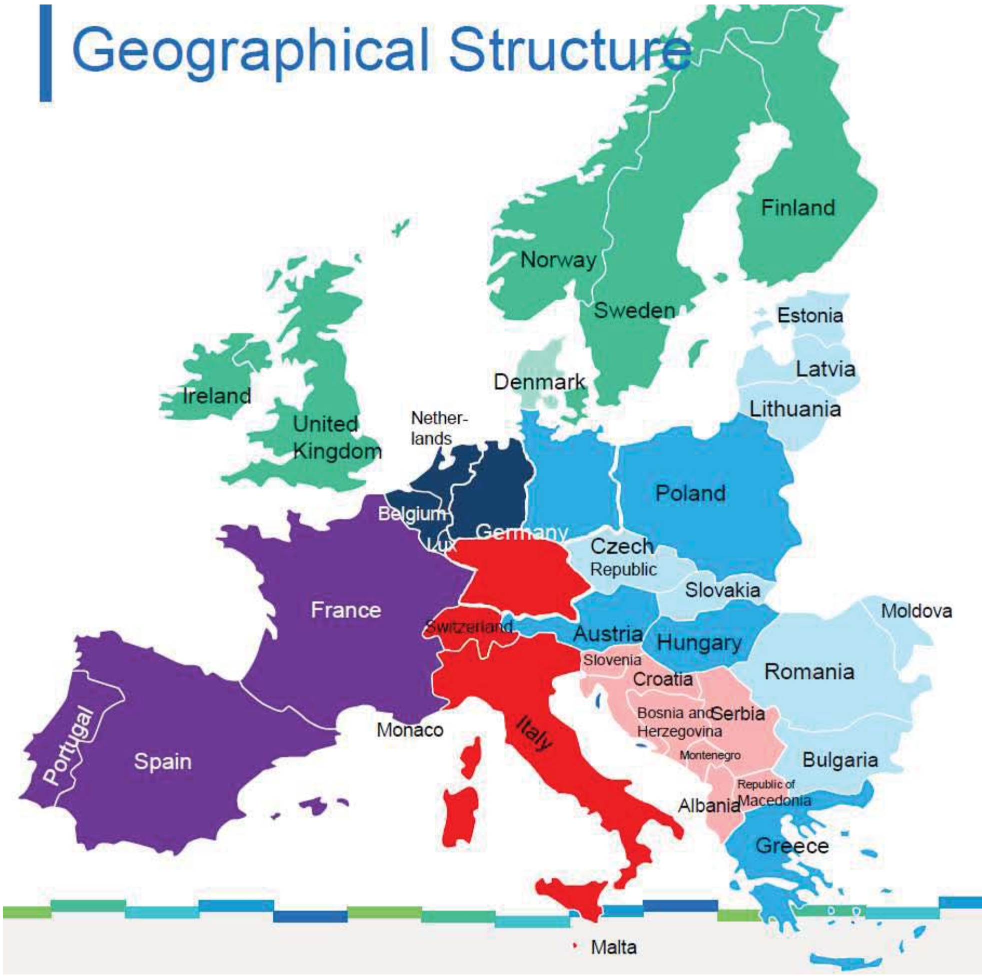


From MANUFUTURE/EFFRA



The KIC AVM as a Europe wide “factory” for research, learning and innovation

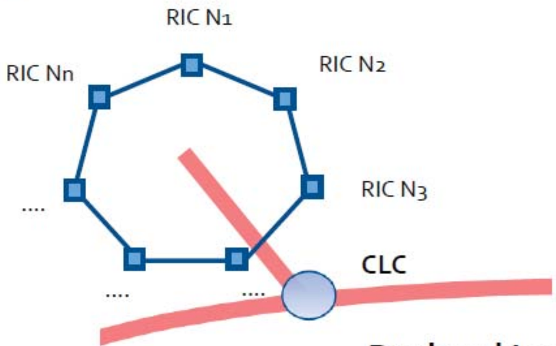
Geographical Structure



Under consolidation

CLCs regions

CLCs & RICs in the AVM KIC



Regional Innovation Centres (RICs)

- RICs scheme provides an original pan-European regional innovation model.
- RICs facilitate the engagement of regional priorities and strengths in the definition and implementation of the KIC approaches.
- RICs can emphasize their own themes and work on subjects of interest to the local industry.
- RICs help "attract" political & financial regional support for the KIC.
- RICs can cooperate with more than one CLC. They are attached to a CLC just for coordination / management purpose.
- RICs network provides less developed regions with the opportunity to get help.
- RICs scheme is flexible and allows that additional RICs can be added later on.

What is/could be a CLC? What is/could be a RIC?

CLC represents a community characterised by a thematic

- CLCs lead and are central to the innovation activities
- CLCs are responsible for the KIC AVM Radar
- CLC are responsible for creating and sustaining the links between RICs
- CLCs are members of the governing board
- CLCs lead, coordinate training and education activities

RIC are the closest element to Operations

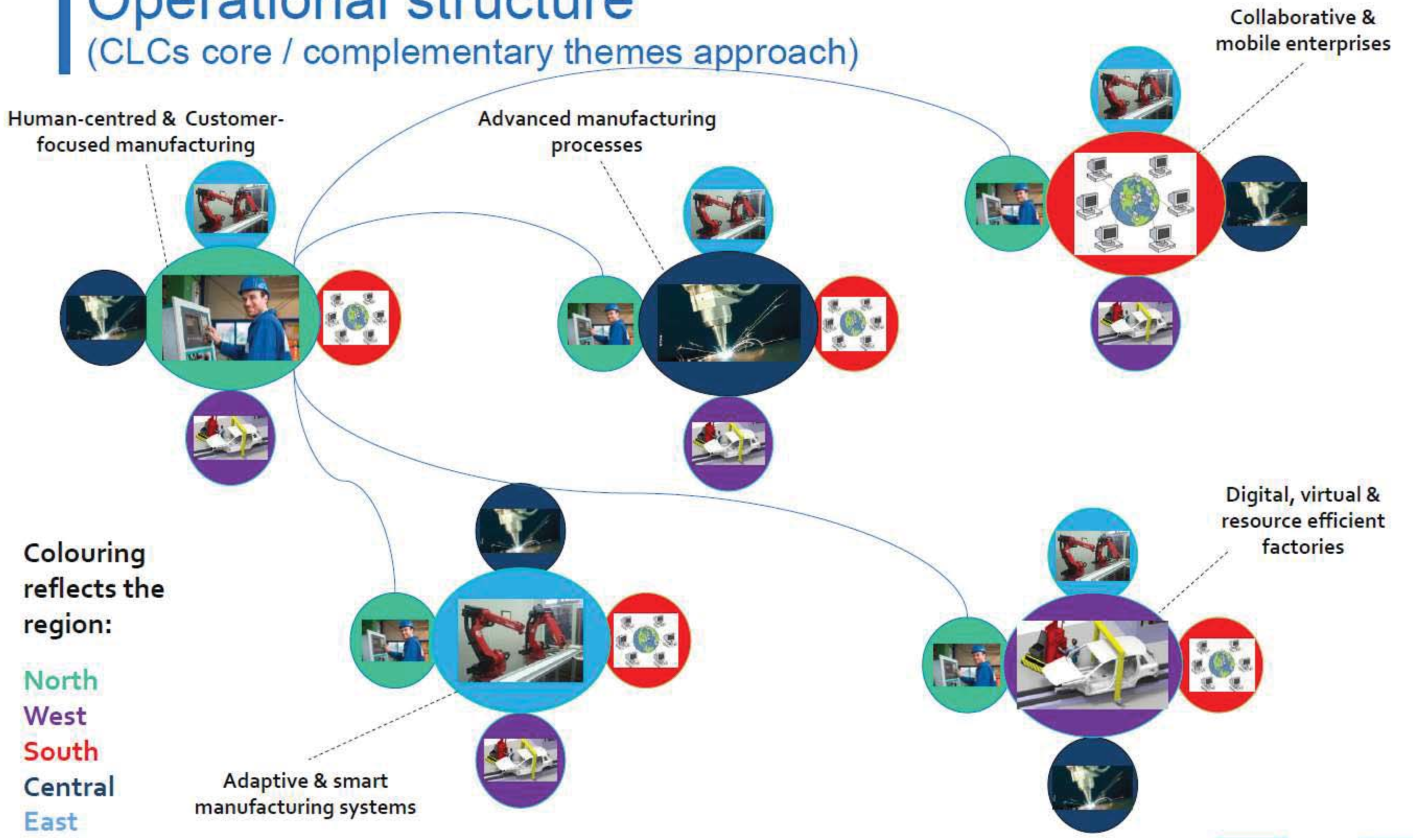
- A RIC is administratively attached to one CLC
- RIC has to coordinate its KIC activities considering "Ecosystem" and S3 and Region in line with CLCs
- RIC federates its nearest ecosystem and manage the pipeline processes
- RIC participates to the definition of the CLC business development
- Main role of a RIC is the technology transfer
- A RIC is identified as Competence Centres for thematic (and for one or more sectors) and expose Platforms
- RIC network are organised according to a matrix (value chain/sector) and is represented by one leader

Naturally Market uptake and Impact will be at the level of RIC

KIC Added Value Manufacturing

Operational structure

(CLCs core / complementary themes approach)



!! Thematic are for example – Under review

Proposal Preparation
Organisational Structure

Steering Committee

Chairs:

Chryssolouris G., Prof. (LMS) | Klocke F., Prof. (Fraunhofer IPT)

Members:

Beltran E. (Mondragon)	Korder G. (it's OWL)	Stahre J. (Chalmers)
Byrne G. (UCD)	Metternich J.(PTW Darmstadt)	Tolio T. (ITIA-CNR)
Caldeira J. (ANI/Manufuture)	Monostori L. (SZTAKI)	Tuokko R. (Tampere Uni)
Chlebus E. (Wrocław Uni)	Myklebust O. (SINTEF)	Vanden Abeele D. (CEA LIST)
Gerhard D. (TU Wien)	Reynaerts D. (KU Leuven)	
John P. (HVM Catapult)	Sol E. (TNO)	

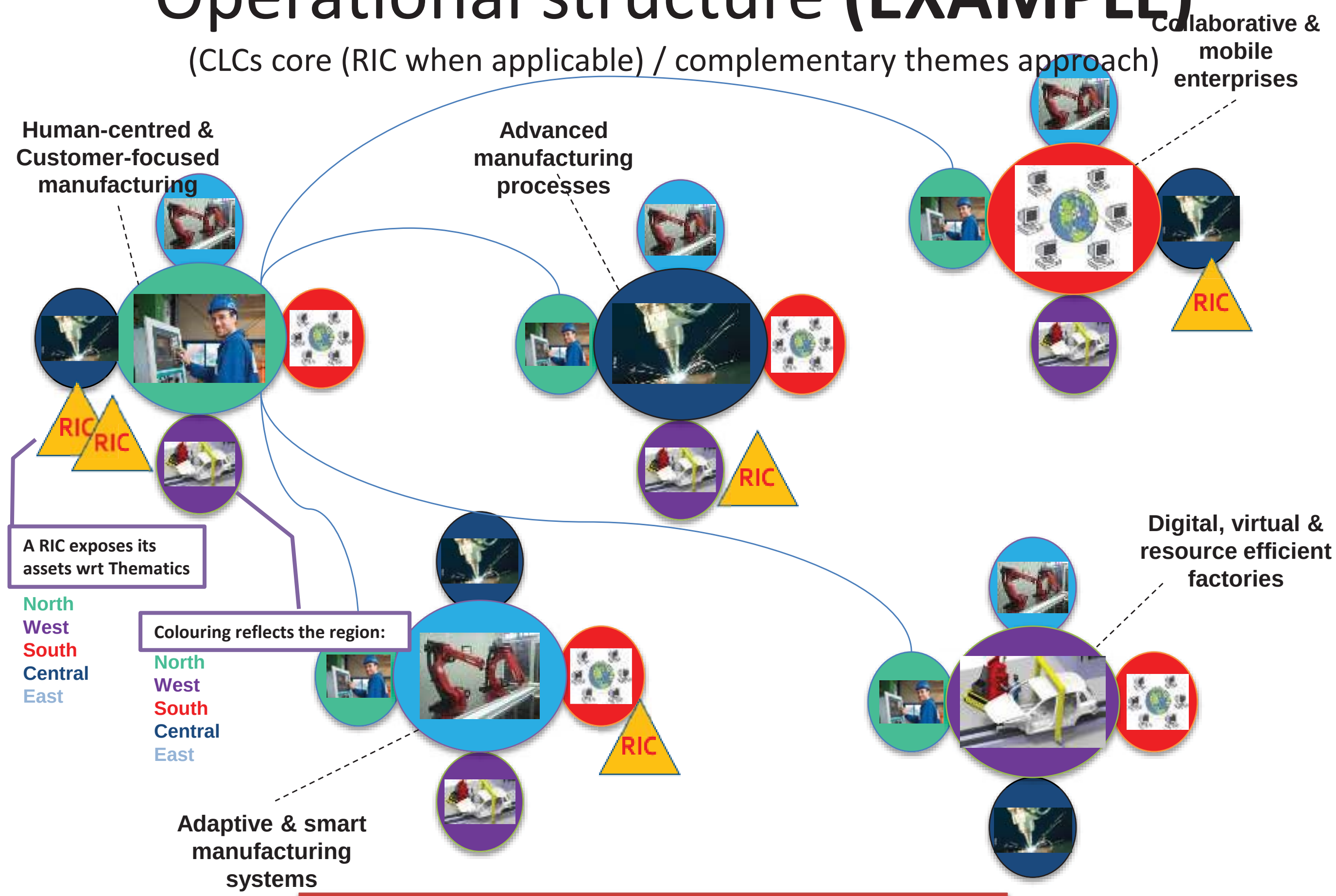
Project Office - Members

Bueno R. (TECNALIA)	Hoercher G. (Fraunhofer IPA)	Mavrikios D. (LMS)
Demmer A. (Fraunhofer IPT)	Junai A. (TNO)	Taisch M. (PoliMilano)

KIC Added Value Manufacturing

Operational structure (EXAMPLE)

(CLCs core (RIC when applicable) / complementary themes approach)



!! Thematic are for example – Under review

THEMATICS – AN IDEA OF …

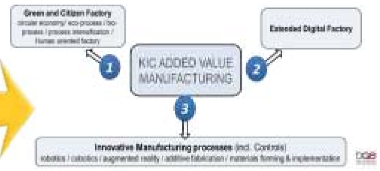
KIC Added Value Manufacturing

KIC ADDED VALUE MANUFACTURING

Contact: Didier VANDEN ABEELE
CEA List Deputy Director – European Affairs
didier.vanden-abeele@cea.fr - +33 6 78 13 81 18

Some rationale

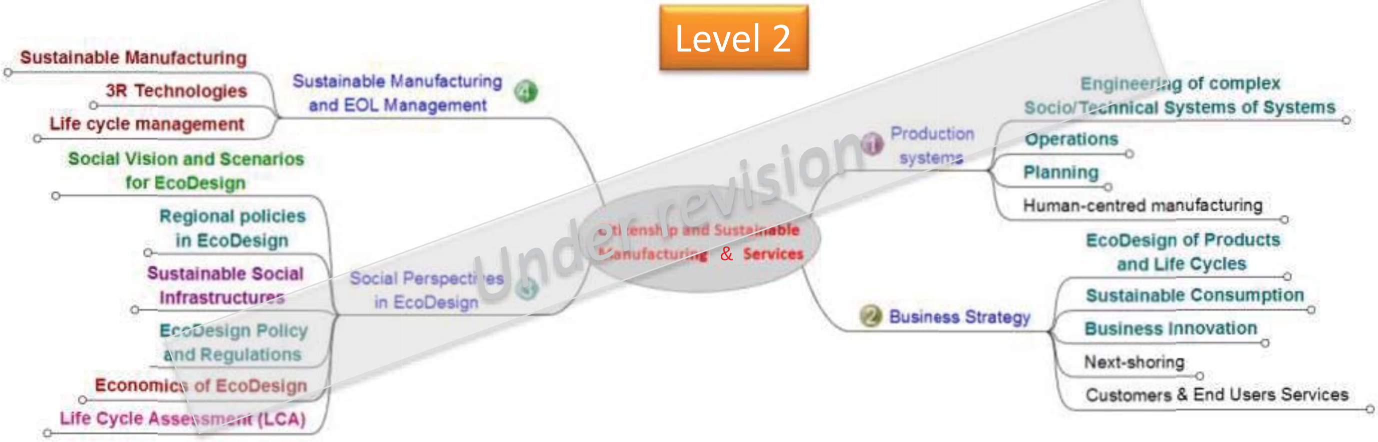
- Based on the proposal made by the core team in 2014
  - Already presented in the EU arena



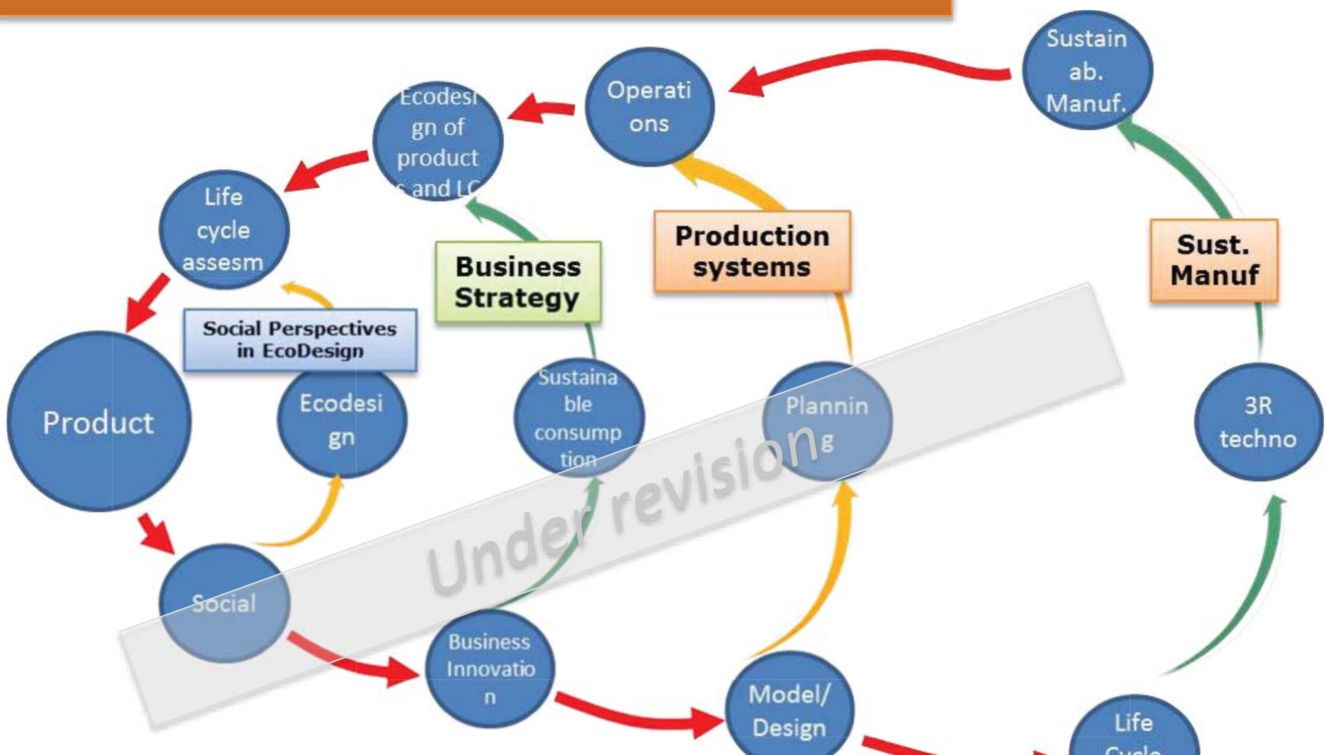
- The goal is to clearly identify the FR leadership on a federative thematic
  - Supporting a visionary perspective (5 years as ex)
  - Being a complement with the leitmotiv under preparation by other CLCs

- Consider the ***needs*** issued during the FR Industrials meeting in Feb 2015

FOR FRANCE

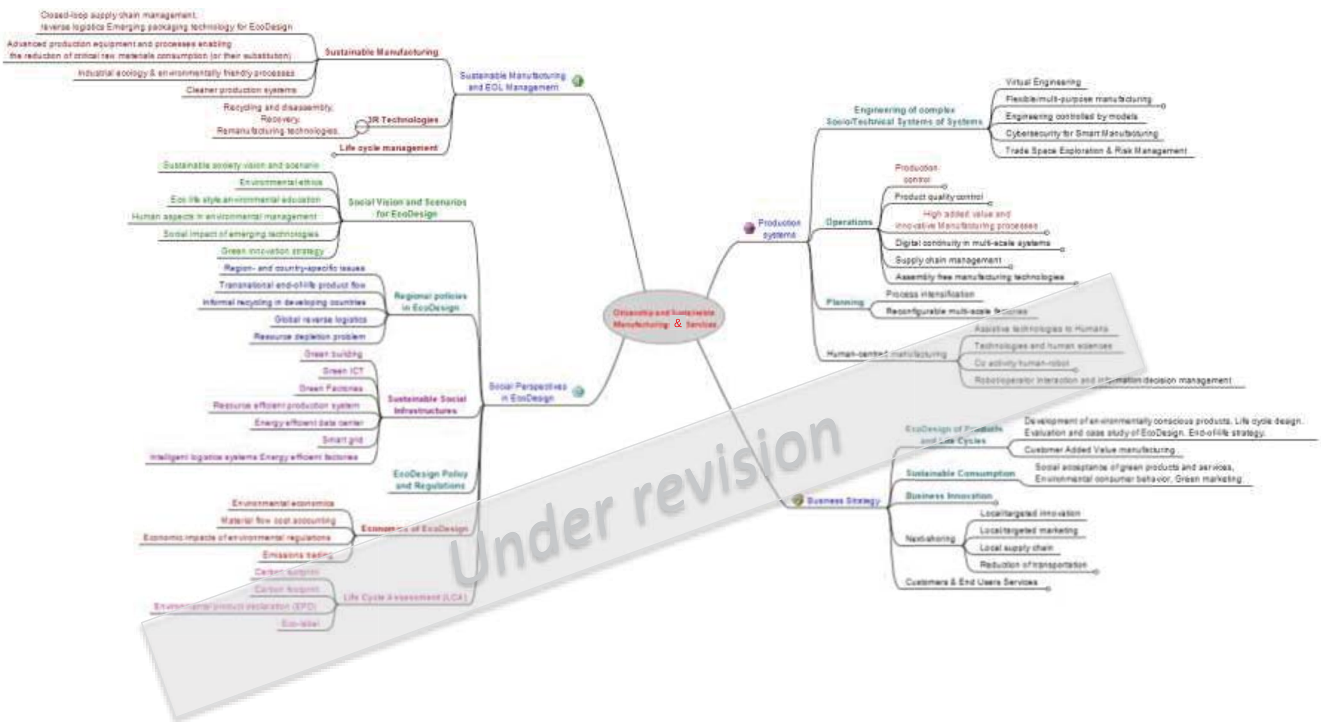


The concept of the
Human centric and Sustainable Manufacturing & Services



It's a prototype!

Level 3


Sustainable Manufacturing and EOL Management
Sustainable Manufacturing
Closed-loop supply chain management; reverse logistics Emerging packaging technology for EcoDesign
Advanced production equipment and processes enabling the reduction of critical raw materials consumption (or their substitution)
Industrial ecology & environmentally friendly processes
Cleaner production systems
3R Technologies
Recycling and disassembly; Recovery; Remanufacturing technologies.
Life cycle management
Social Perspectives in EcoDesign
Social Vision and Scenarios for EcoDesign
Sustainable society vision and scenario
Environmental ethics
Eco life style environmental education
Human aspects in environmental management
Social impact of emerging technologies
Green innovation strategy
Regional policies in EcoDesign
Region- and country-specific issues
Transnational end-of-life product flow
Informal recycling in developing countries
Global reverse logistics
Resource depletion problem
Sustainable Social Infrastructures
Green building
Green ICT
Green Factories
Resource efficient production system
Energy efficient data center
Smart grid
Intelligent logistics systems Energy efficient factories
EcoDesign Policy and Regulations
Economics of EcoDesign
Environmental economics
Material flow cost accounting
Economic impacts of environmental regulations
Emissions trading
&
Production systems
Engineering of complex Socio/Technical Systems of Systems
Virtual Engineering
Flexible/multi-purpose manufacturing
Engineering controlled by models
Cybersecurity for Smart Manufacturing
Trade Space Exploration & Risk Management
Operations
Production control
Product quality control
High added value and innovative Manufacturing processes
Digital continuity in multi-scale systems
Supply chain management
Assembly free manufacturing technologies
Planning
Process intensification
Reconfigurable multi-scale factories
Technologies and human sciences
Robot/operator interaction and information decision management
Business Strategy
EcoDesign of Products and Life Cycles
Development of environmentally conscious products. Life cycle design. Evaluation and case study of EcoDesign. End-of-life strategy.
Customer Added Value manufacturing
Sustainable Consumption
Social acceptance of green products and services, Environmental consumer behavior, Green marketing
Business Innovation
Nextshoring
Local/targeted innovation
Local/targeted marketing
Local supply chain
Reduction of transportation
Customers & End Users Services
Under revision

DRESDEN –
A CULTURAL TOWN

New Materials Concepts for Nonvolatile Data Storage

Ehrenfried Zschech[1,3], Thomas Mikolajick[2,3]

[1] Fraunhofer Institute IKTS Dresden, Germany
[2] namlab GmbH Dresden, Germany
[3] Technical University Dresden, Germany

Business Lunch Talk about Future Topics,
Brussels, 26th of January 2016

Ehrenfried.Zschech@ikts.fraunhofer.de

Micro and nanoelectronics: Explosion of complexity and application variety

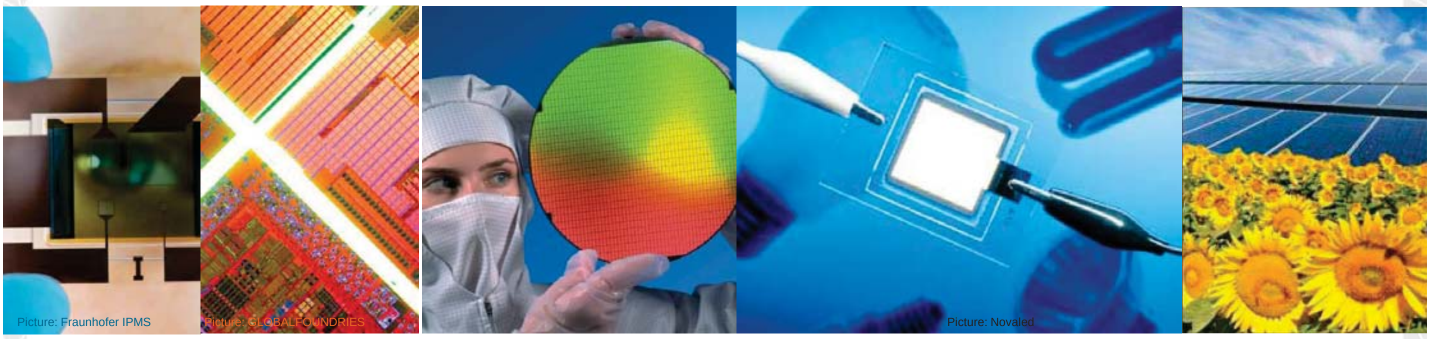
Driving forces: Functionality, Mobility, Connectivity,
Communication, Access to data, …
Internet of things, Industry 4.0, …

Fraunhofer
IKTS

DRESDEN – A TOWN OF SCIENCE AND INNOVATION

Fraunhofer
IKTS

dcn
dresden center for nanoanalysis



Picture: Fraunhofer IPMS
Picture: GLOBALFOUNDRIES
Picture: Novaled

PARTICULARLY IN ICT/MICROELECTRONICS AND ADVANCED MATERIALS

cfaed
TECHNISCHE UNIVERSITÄT DRESDEN
DRESDEN concept

3 Messages

This decade in microelectronics is the decade of materials science and engineering

Performance gap for memories forces novel device concepts and more nonvolatile memories

New nonvolatile memory concepts require development and integration of new materials

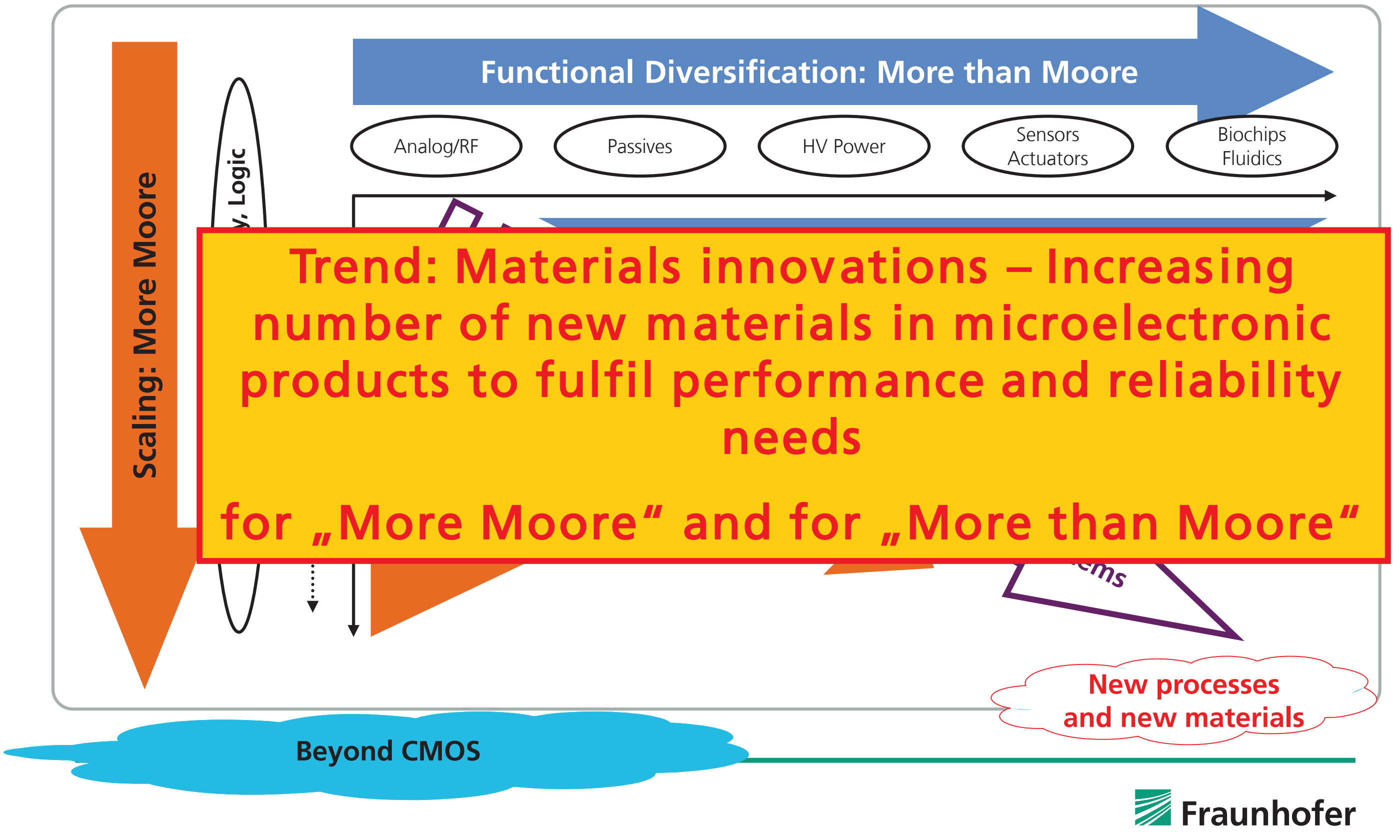
Micro and nanoelectronics:
Explosion of complexity and application variety

Semiconductor memory is an indispensable component and backbone of modern electronic systems.

Market need: Store more data at less cost !

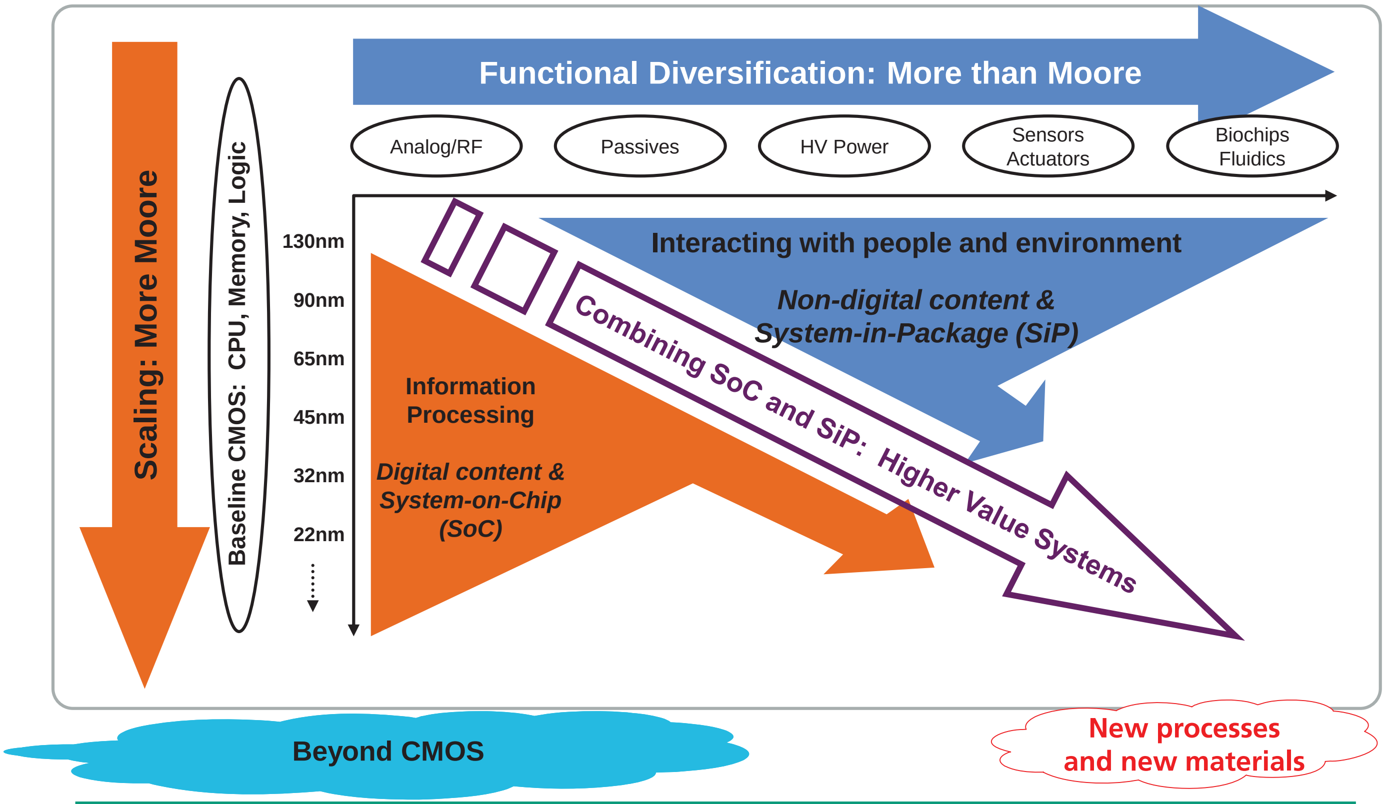
Driving forces: Functionality, Mobility, Connectivity, Communication, Access to data, …
Internet of things, Industry 4.0, …

Scaling „More Moore“ and functional diversification „More than Moore“ ➔ New processes and new materials



From International Technology Roadmap for Semiconductors: http://www.itrs.net

Perspectives for IT industry and nanoelectronics



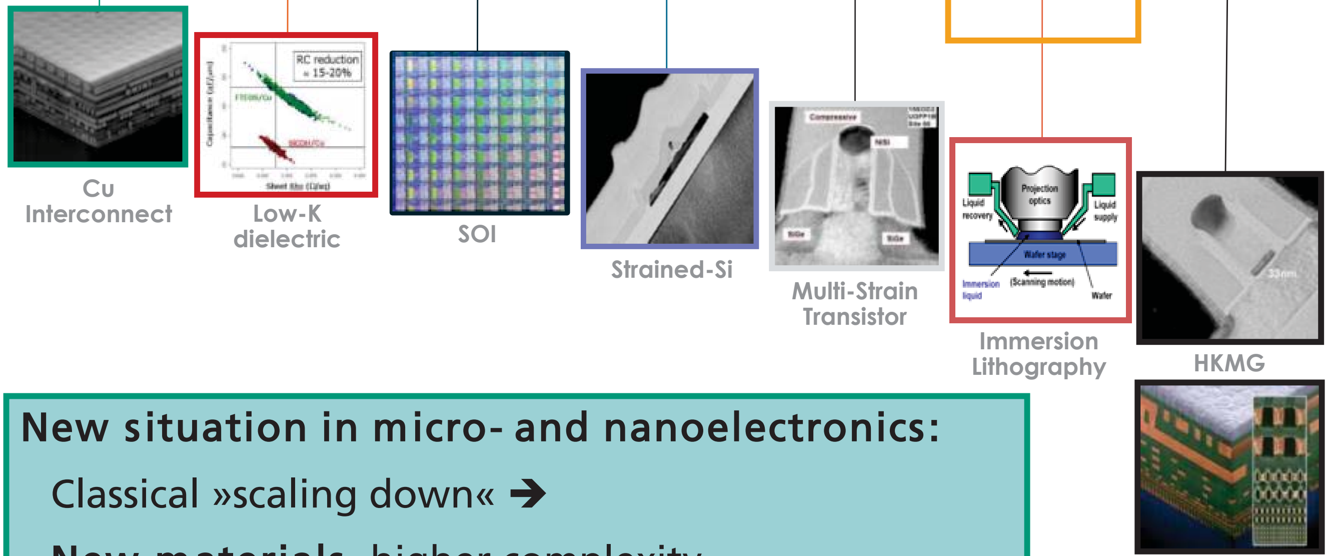
From International Technology Roadmap for Semiconductors: http://www.itrs.net

Fraunhofer
IKTS

Example: One decade at AMD/GLOBALFOUNDRIES: Most of the innovations are materials innovations

Courtesy: Globalfoudries Inc.

2000	2002	2003	2004	2006	2008/09	2010
180nm	130nm	130nm	90nm	65nm	45nm	32nm



New situation in micro- and nanoelectronics:

Classical »scaling down« ➔

New materials, higher complexity …

Fraunhofer IKTS

EUROPEAN COMMISSION / European Research Area / 7th Framework Programme

The impact of MATERIALS is growing

particularly for electronics

Impact of advanced materials technology on ICT, Energy & Biotech. (% growth attributable to advanced materials)

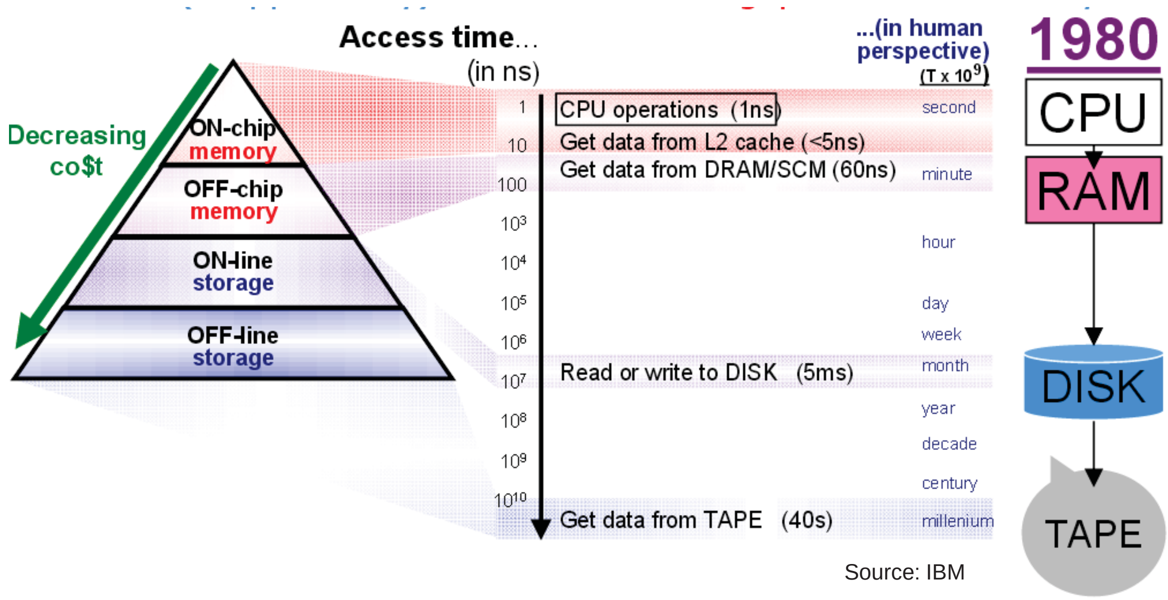
	1970	1980	1990	2000	2010	2020	2030
ICT	15	25	40	55	65	75	85
Energy	10	15	30	45	55	65	70
Biotech.	5	10	20	30	45	55	65

Advanced materials have an earlier & greater impact in ICT (incl. electronics), followed by Energy (incl. construction) and Biotechnology (incl. health)

Source: Sanford M. Moskowitz, « The Advanced Materials Revolution », John Wiley & Sons Inc, 2009

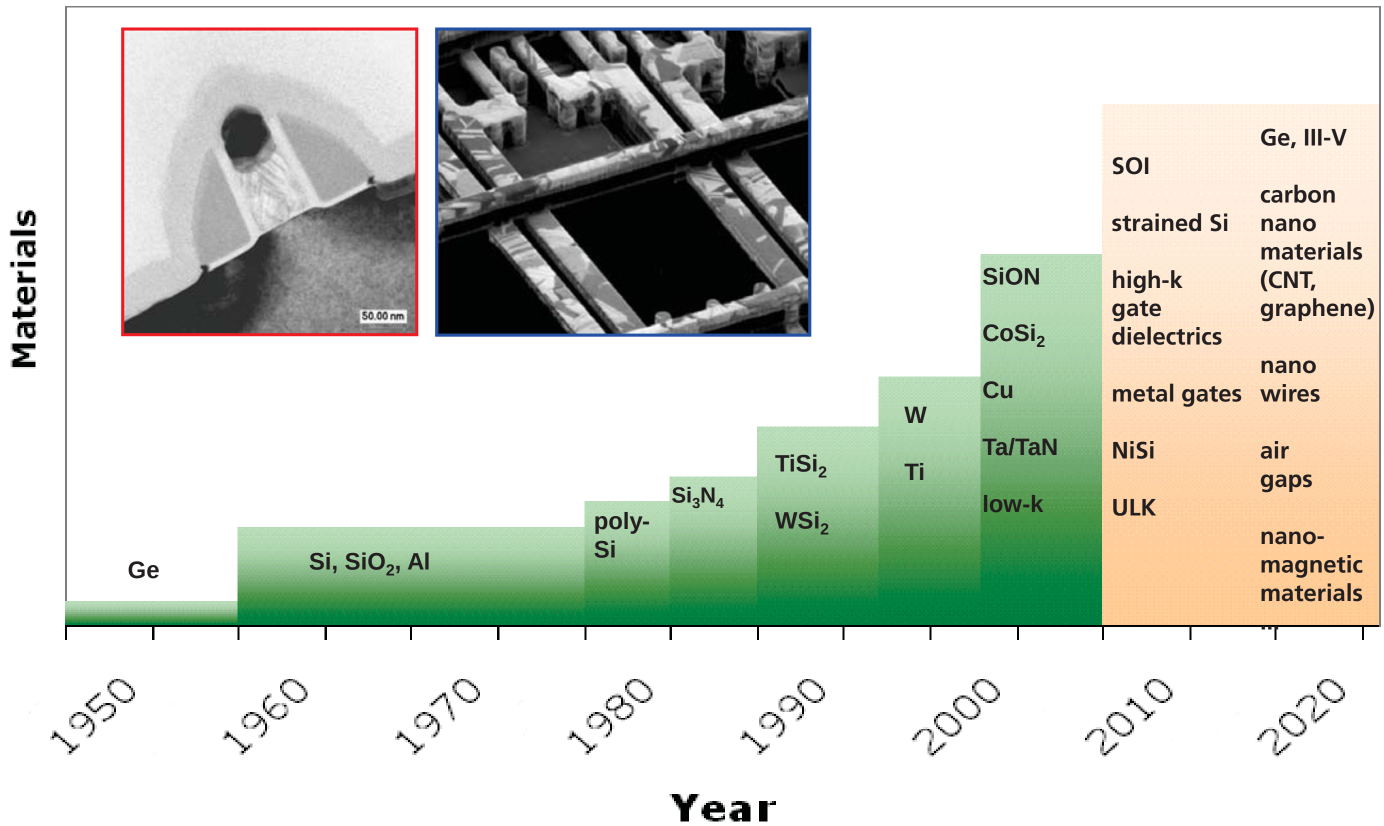
COOPERATION

The memory hierarchy

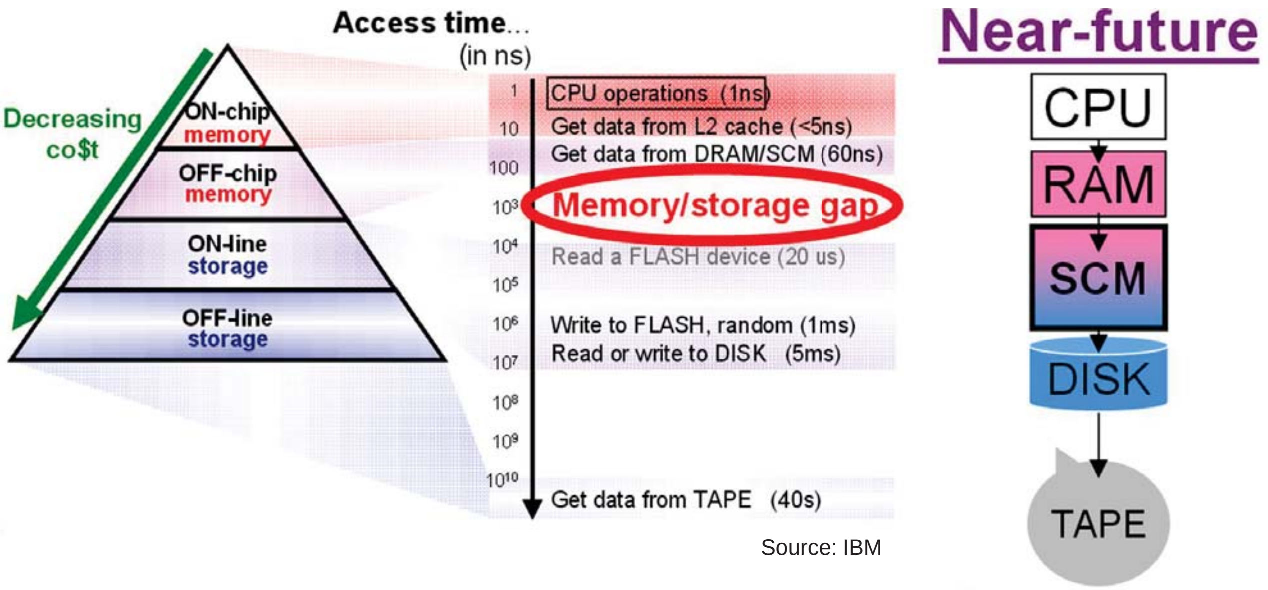


- Semiconductor memories all were Random Access Memories (RAM) in the 1980s
- Large performance gap between RAM and Disk / Tape

Implementation of new materials into the CMOS and "beyond CMOS" processes



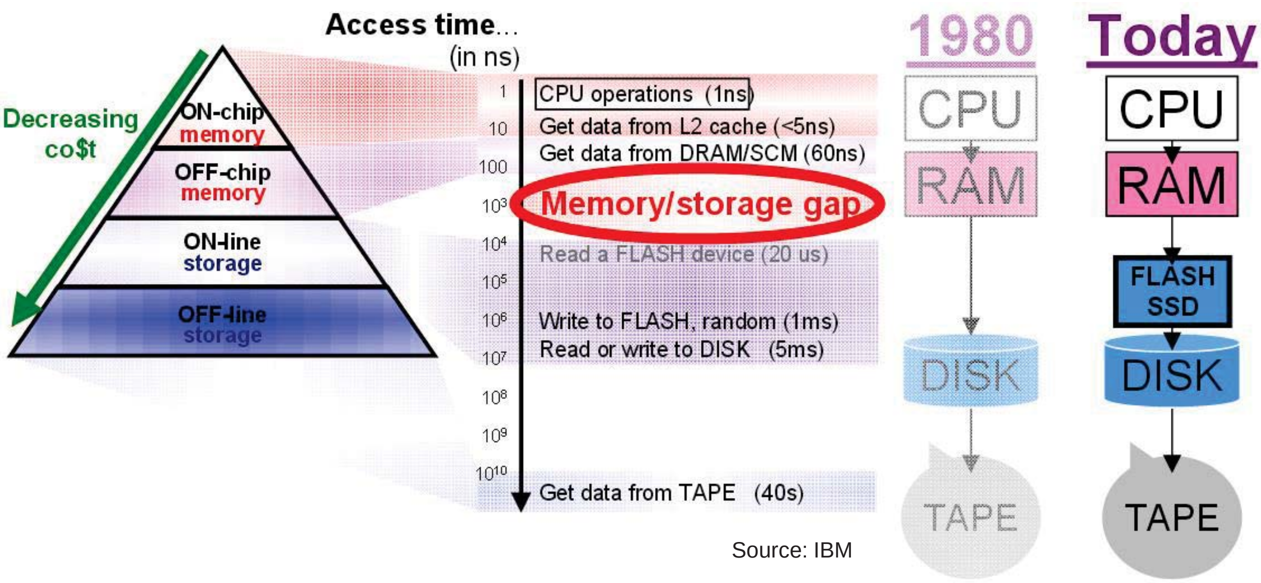
The memory hierarchy



Source: IBM

- New opportunities to bridge the performance gap by novel memory concepts
- Increasing demand for nonvolatile semiconductor memory

The memory hierarchy

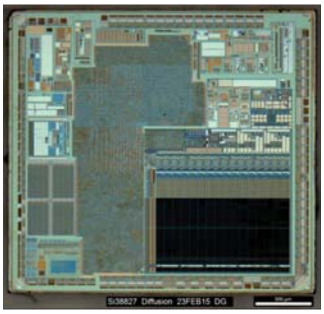


Source: IBM

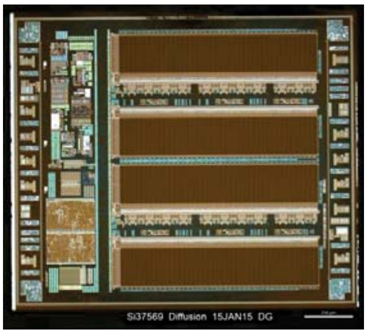
- Flash memories evolved as an important NON-RAM semiconductor memory
- Performance gap between Semiconductor Memory and Disk / Tape has reduced but is still significant

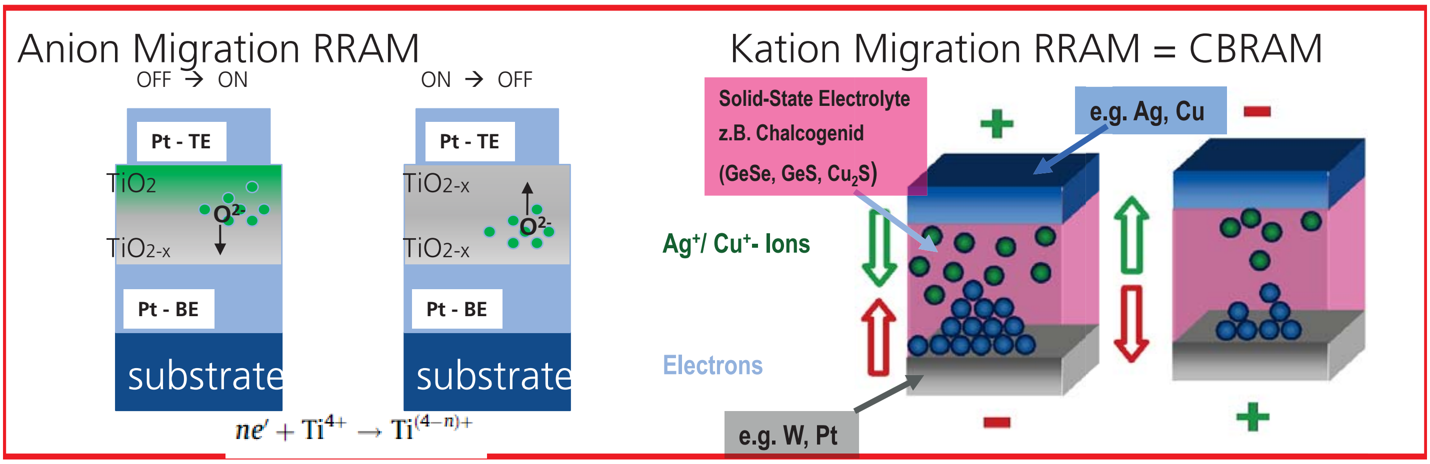
Emerging memory

Panasonic Anion Migration (Ta_2O_5) @ 180nm



Adesto 1M CBRAM @ 130nm





Emerging memory

Memory type	writing	reading
Ferroelectric	Electric Field	Charge
Magnetoresistive	Current / Magnetic Field Current (Spin Tourque)	Resistance
Phase Change	Current / Heat	Resistance
Thermochemical RRAM	Current / Heat	Resistance
Electrochemical RRAM (CBRAM)	Current / Charge	Resistance
Valence Change RRAM	Current / Charge / Heat	Resistance
Charge Based RRAM	Current / Charge	Resistance

Progress towards a viable new resistive memory technology relies on fully understanding the mechanisms responsible for switching and charge transport, the failure mechanisms, and the factors associated with materials reliability.

(J. S. Meena, S. M. Sze, U. Chand, T. Y. Tseng, Overview of emerging nonvolatile memory technologies, Nanoscale Research Letters 2014, 9:526)

Summary and outlook

This decade in microelectronics is the decade of materials science and engineering:

New thin film materials with specific properties will be needed ➔ functionality, performance and reliability

Performance gap for memories forces novel device concepts and more nonvolatile memories:

Conventional memory concepts (SRAM, DRAM, Flash) will be replaced by emerging new memory technologies

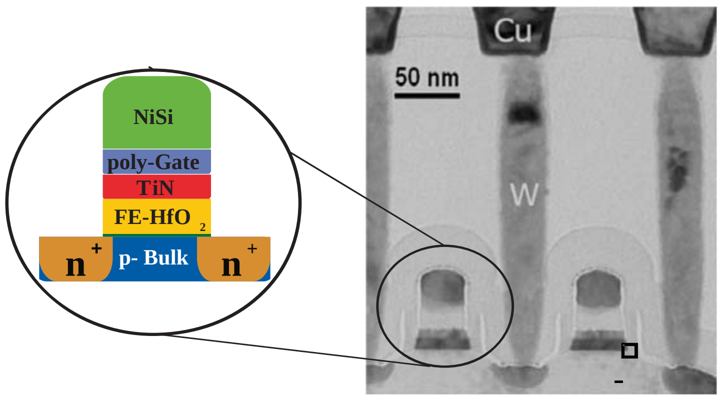
New nonvolatile memory concepts require development and integration of new materials:

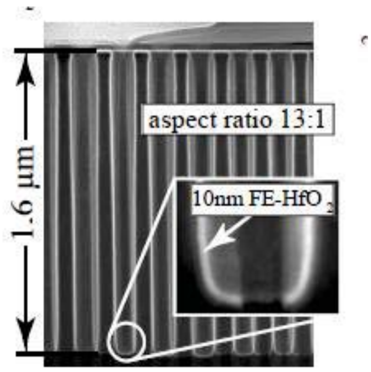
Computational materials science, including materials modeling and materials characterization, is needed to evaluate materials compatibility and the potential for integration into new memories/products

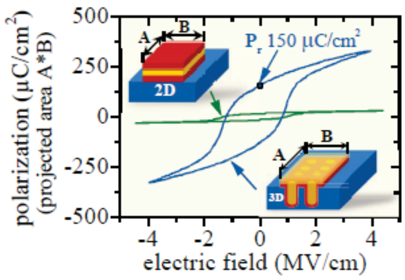
Emerging memory

3D integrated ferroelectric Hafnium Oxide

TEM cross section and I-V characteristics of ferroelectric FET integrated into 28nm technology







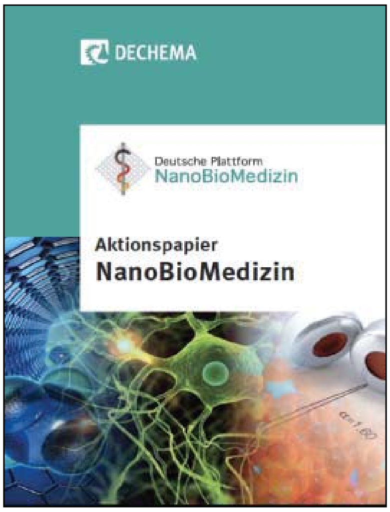
- 3D Integration of PZT with oxide electrodes is problematic
- Ferroelectric Hafnium Oxide shows much better properties

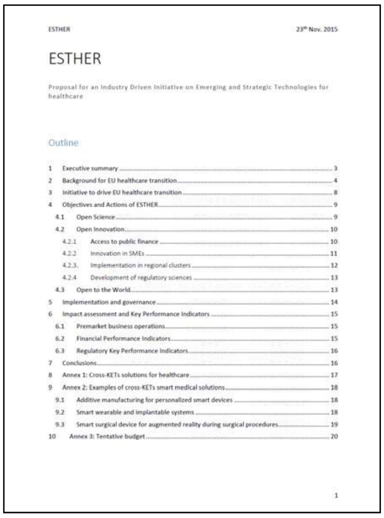
J. Müller et al., IEDM, 2013
P. Polakowski et al., IMW, 2014

Thank you !

Contact: ehrenfried.zschech@ikts.fraunhofer.de

Strategic papers




ESTHER 23th Nov. 2015

ESTHER

Proposal for an Industry Driven Initiative on Emerging and Strategic Technologies for healthcare

Outline

1

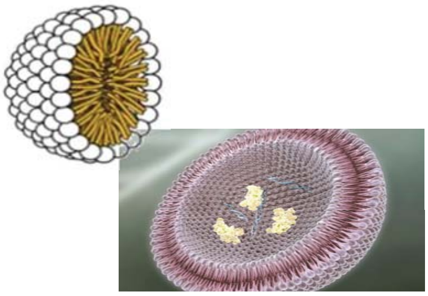
Deutsche Plattform
NanoBioMedizin

Emerging and Strategic Technologies for Healthcare

KLAUS-MICHAEL WELTRING,

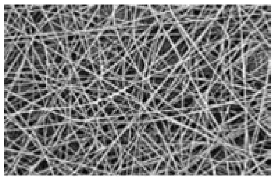
CHAIRMAN OF THE GERMAN PLATFORM NANOBIOMEDICINE

Nanomaterials for Medizin

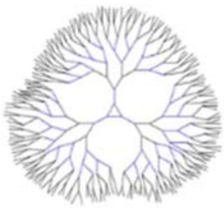


Micelles & Liposome

Proteins, ex. Albumin

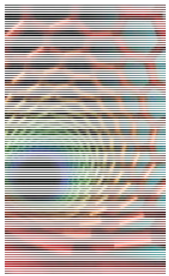


3D-Nano structures



Polymers, ex. Dendrimers

Nano structured surface

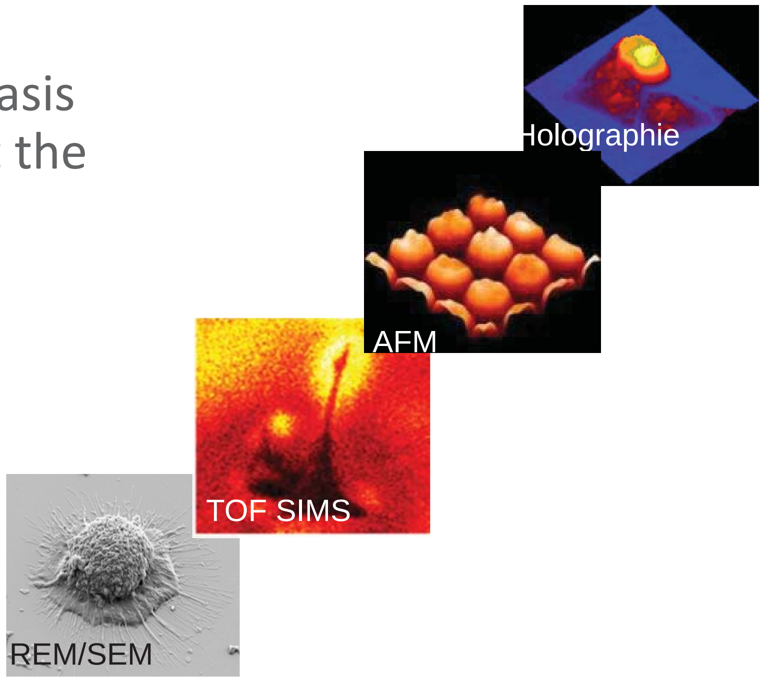


Nano tubes

Basis for Nanomedicine

High resolution tools for analysis of the molecular basis of desease development at the nano scale

- Precision Medicine

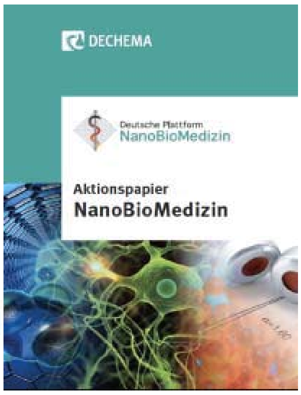


German platform NanoBioMedicine

Inauguration

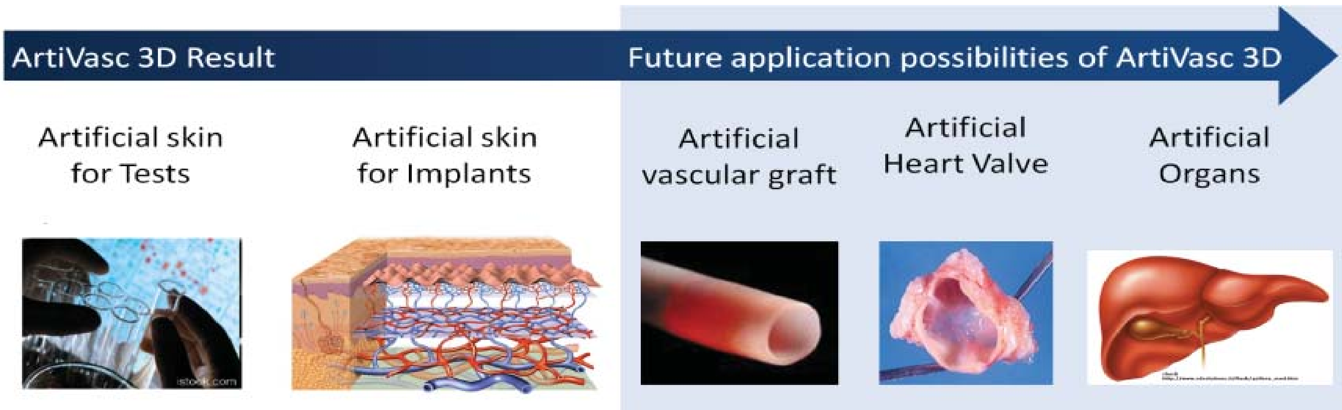
- 4. March 2015 at Frankfurt
- 90 Participants from research, industry SMEs, politics and regulators
- Communication platform and strategic „Think Tank“
- Representation of the German community at the European and international level

➢Definition of R&D and translation topics for Germany


DECHEMA
Deutsche Plattform NanoBioMedizin
Aktionspapier
NanoBioMedizin


DECHEMA
NanoBioMedizin
Forschungsbedarf und Randbedingungen zur Integration der Nanotechnologie in biomedizinische Anwendungen
Positionspapier
des
ProcessNet Temporären Arbeitskreises „NanoBioMedizin“
Deutsche Plattform NanoBioMedizin
ProcessNet

Cross-KETs for Medicine



Therapy

- Long circulating drug carrier
- Targeting across barriers
- Nanoactives
- Knowledge based therapy systems
  - Combination therapies
  - New validated biomarkers
- Producibility, stability, shelf life, etc.
- Pre-clinical characterisation services
- Ecotoxicology

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Diagnostics

- Multi parameter diagnostics (multi modal, multiplexing)
- Liquid biopsy
- Point-of-care diagnostics (Lab on a chip)
- Therapy monitoring
- Next generation sequencing (Prevention, Stratification)
- Sensors (in, on, outside the body)
  - Biocompatible and fuctionalysed surface
  - Energy supply (self sustaining systems)
- Big Data
- Standardisation, robustness, cost, …

Translation

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- Better information and training about regulation
- Interdisciplinary education and training
- Continue and improve successful translation concepts
  - Translation centers for Reg. Med.
  - Industry in Clinic
  - Industry incubators
  - Pre-clinical characterisation services
- Clinical research professorships
- Integrated funding from nanomaterial -> clinic (incl. clinical phase I-IIa)
- Full coverage of new value chains

Regenerative Medicine

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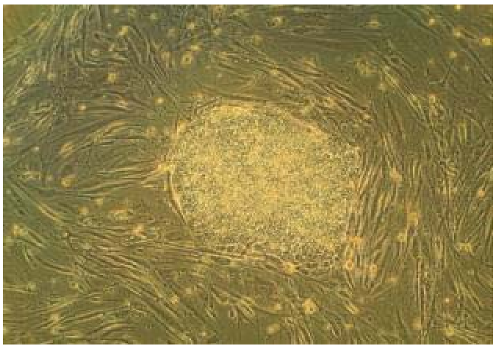
- Design of biocompatible and functionalised 3D-biomaterials
- Better knowledge about biology of tissue
- Immune modulation and long term immune toxicology of implants
- Vascularisation and innervation
- Homing of stem cells
- Encapsulation of cells
- Shelf life and sterilization
- „Feedback loop" development (basis science vs clinical needs)
- Large animal models vs rodents



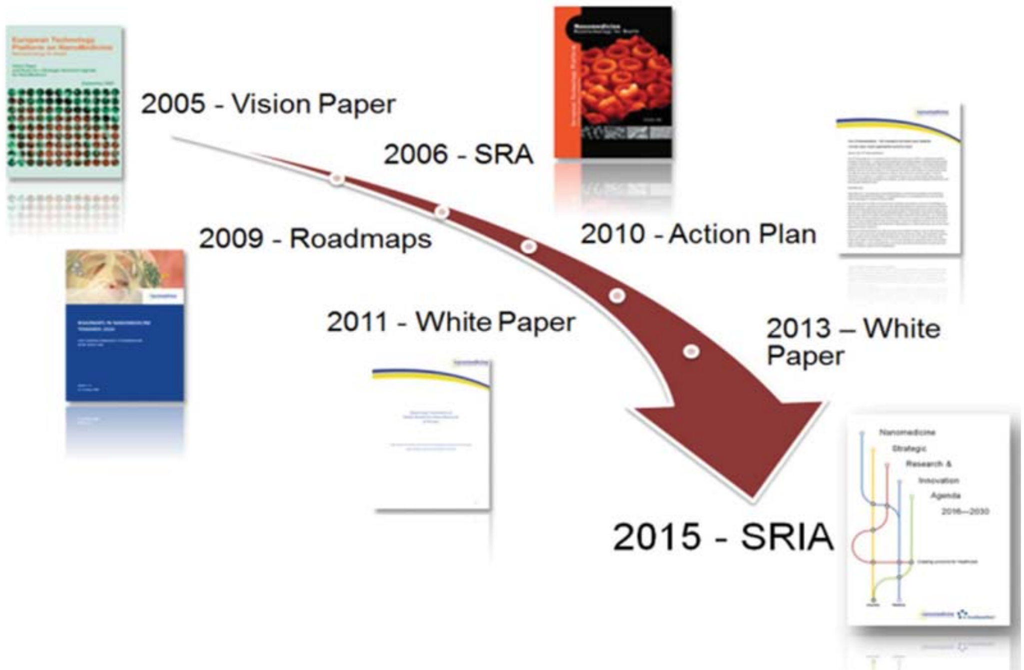
Strategic R&I Agenda

- Unmet Clinical Needs
  - Atherosclerosis
  - Cancer
  - Cardiovascular
  - Neurodegenerative
  - Infection
  - Diabetes
  - Arthritis
  - Other diseases

➢ Nanomedical and Cross-KETs Solutions

➢ Implementation

ETP Nanomedicine



The Medical Technologies transition

Cross technologies
- Convergence of (Key Enabling) Technologies
  - Nanotechnologies, advanced materials, micro/nano electronics, manufacturing, biotechnologies, photonics, ICT

Cross industries
- Pharma
- Medical devices
- Biotech
- IT, IoT

Cross business models
- IVD associated with therapy : companion tests, predictive biomarkers
- Combined therapies, combination products, borderline products : drug releasing stents
- Connected diagnostics

The Healthcare transition

from **acute** medical interventions towards **preventive** strategies

from the use of **blockbuster “one-size-fits-all**” towards the **personalised** approach

from **supportive** treatments aiming towards a **complete** cure

From **clinic** to **remote t**reatment **(digital health)**

What is ESTHER ?

"…A European initiative launched by the EU Commission and the healthcare industry within the framework of Horizon 2020 to raise competitiveness of European Medical Technologies industries by developing and manufacturing innovative healthcare technologies, in a changing regulatory and economic environment…"

Health 2.0

Digital health : convergence of the digital and genomic revolutions with health, healthcare, living, and society.

- Tele-health
- Mobile Health
- Electronic Health Record
- Wireless Health

Turn over : €220 bn in 2020

Venture investment $4.1 billion (2014), a 125% increase year-over-year. It surpasses Medical Devices

Pionneers : Apple, Google, Qualcomm, Verizon, IBM…

Actions

1. **Foster research, development and innovation towards smart and connected medical devices**
   - Strategic Research and Innovation Agenda (SRIA) for smart connected Medtech
   - MultiKETs collaborative project to de-risk the opportunity sufficiently to enable private investment
2. **Accelerate the translation process of smart medical solutions on healthcare markets**
   - Access to public finance
   - Market access
   - Regional clusters
   - Regulatory sciences
3. **International interactions**
   - Increase attractiveness of Europe for global healthcare industries
   - Training and exchange of personnel between EU and emerging economies

Vision

Make Europe the leading place to invent, develop, manufacture and implement innovative cost effective healthcare solutions

Objectives

1. ESTHER will **drive the convergence** of technologies, business models and industries

2. ESTHER will **facilitate the efficient translation** of clinical needs into healthcare solutions based on smart medical devices

3. ESTHER will **enable sustainable healthcare systems** within the EU

4. ESTHER will ensure that the **EU smart Medtech products** and services **become the global benchmark** in safety and affordability

Stakeholders

More to come….

Deutsche Plattform NanoBioMedizin

Thank you for your attention!

ESTHER Task Force

EC	« Rest of the world »
Maj-Inger NILSSON	Françoise CHARBIT
Heico FRIMA	Klaus-Michael WELTRING
Fergal DONNELLY	Paul GALVIN
Andreas LYMBERIS	Patrick BOISSEAU
Bernd RAINER	Bertrand LOUBATON
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Contents

A Business Perspective: On the use of Nano-Materials for Printed Circuit Board Fabrication

Dr Pufinji Maclean Obene
Operations Director
Precision Varionic International
Swindon, UK

#1.2 : A Business Perspective: On the use of Nano-Materials for Printed Circuit Board Fabrication

"At the heart of the search for the formulation of products for sustainability lies the integration of process and ingredient sources. To this end the nature of the source must be compatible with the manufacturing technology. In many process systems core to the broad concept of sustainability is the flexibility of additive manufacturing"

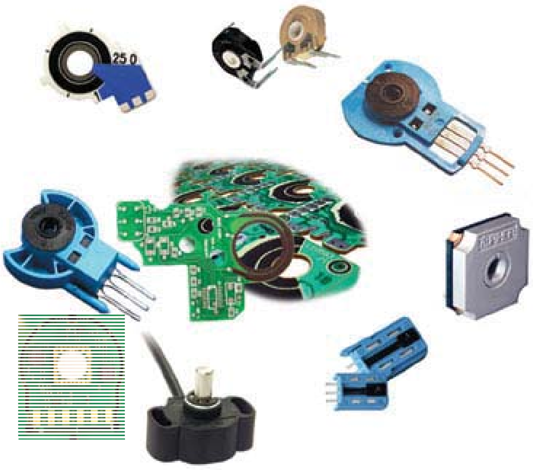
- What does this really mean?
  - If you are going to introduce a different way of what is currently being done now and successfully,
  - What you introduce must be
    - Sustainable: Industry must be capable of manufacturing the raw ingredients.
    - Compatible: The final look must be no different from what is already being used.
    - Processable: The manufacturing technique and output specification must be comparable or better.
    - Economical:
      - If it costs more forget it.
      - If it costs only just a little bit less, OEM's may not think it worthwhile to change.
      - If it saves you up to 25% from existing state of the art, then maybe you have a chance.

#1.1: A Business Perspective: On the use of Nano-Materials for Printed Circuit Board Fabrication

- Development of Nano Materials and its application is well funded by both EU and National Governments within the EU
- Nano-Materials are sold by major material companies.
- However there is very little uptake in the Industries that matter. i.e. Automotive, Electronics, Communications, Consumer, Medical, FMG etc.
- Why?:
  - Perceived limitation in processing the technology?
  - Not robust enough?
  - No real advantage gained?
  - Technology too new? Uptake from OEM's difficult?
- Nano-Materials sold by material companies are mostly sold for R&D and small sample prototypes.
- **Thus EuroRoads needs to drive ME's, SME's, RTO's and HEI's to make sure the uptake is less difficult for OEM's and the final customer (All Of Us).**

#1.4: Nano Materials in Automotive Sector?

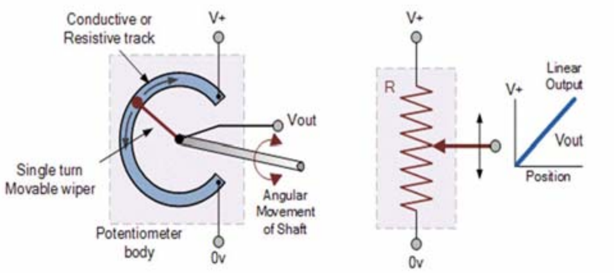
- The market revenue for automotive sensors is estimated to reach $31 Billion by 2020, at a CAGR of 7.72% between 2015 and 2020.
- In 2015 an estimated 2,760 million automotive sensor units was supplied to the market. i.e. in 2015 for automotive sensors alone, **nearly 3bn PCB's could have be manufactured more economically using nano-materials.**
- The world volume for ALL SECTOR PCB fabrication is even greater!! (> 60,000 million PCB's)
- If we want Nano-Materials to be effective and taken seriously these are the typical markets EuroRoads funding needs to address.



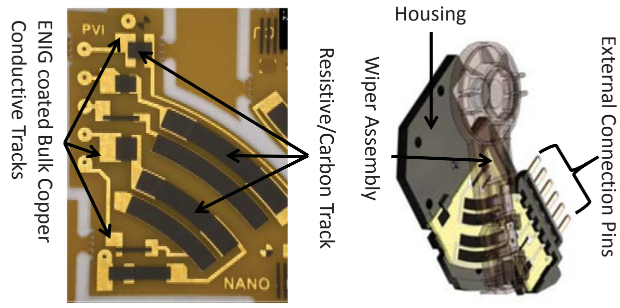
Type (Temperature, Position, Inertial, Pressure, Image, and Others), Application (Powertrain, Chassis, Exhaust, Body Electronics, Safety & Control, Telematics, and Others)

#1.3: Difference between a Sensors and PCBs

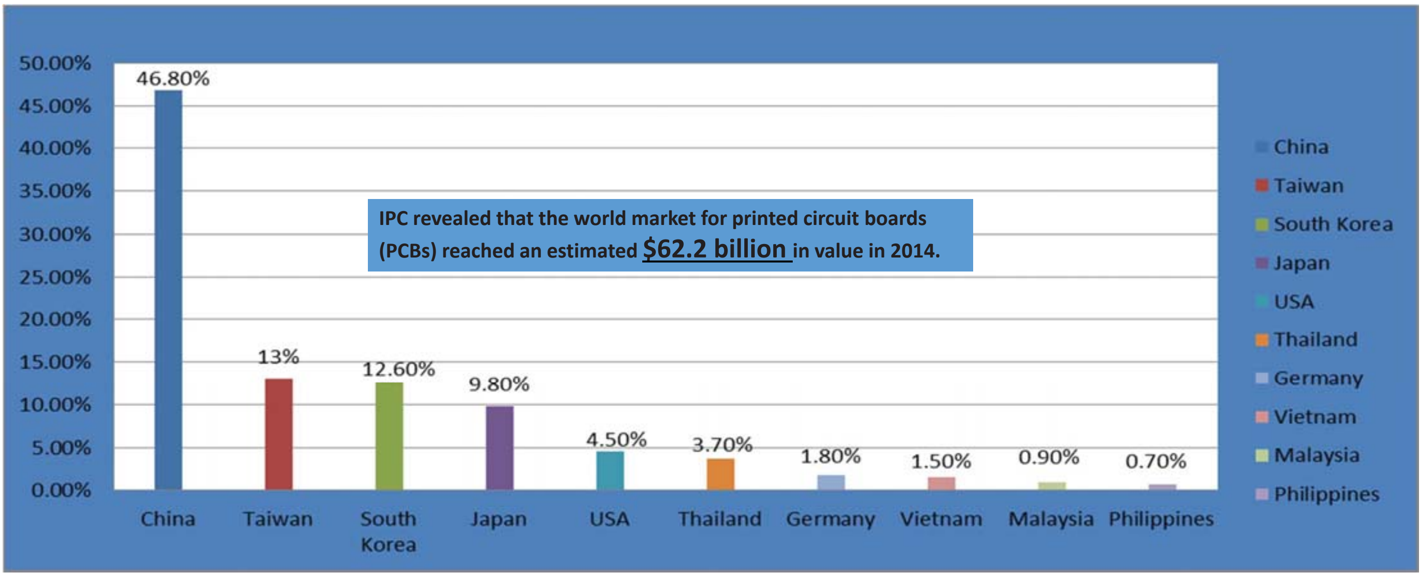
- In the automotive sector potentiometric sensors are used to measure and control movement across a wide range of sub-systems within the car, such as: **movement** of **control pedals**, movement of **steering wheel**, movement of **wing mirrors**, movement of the **engine valves** etc…
- There are two main types of potentiometric design:
  - Contact Devices: whereby there is a physical contact between a wiper and the resistive track (Shown)
  - Contactless Devices: whereby the principle of 'induction' is used to create a connection between the wiper (usually a magnet) and sensing element, thereby enabling contactless systems (Not Shown)
- Both types sensor require PCB with conductive as well as resistive elements which together defines the PCB circuit, a housing to hold the PCB and wiper in alignment as well has to make connectivity to the outside world.



Schematic of a contact potentiometric system



#2.1: World PCB Fabrication Market



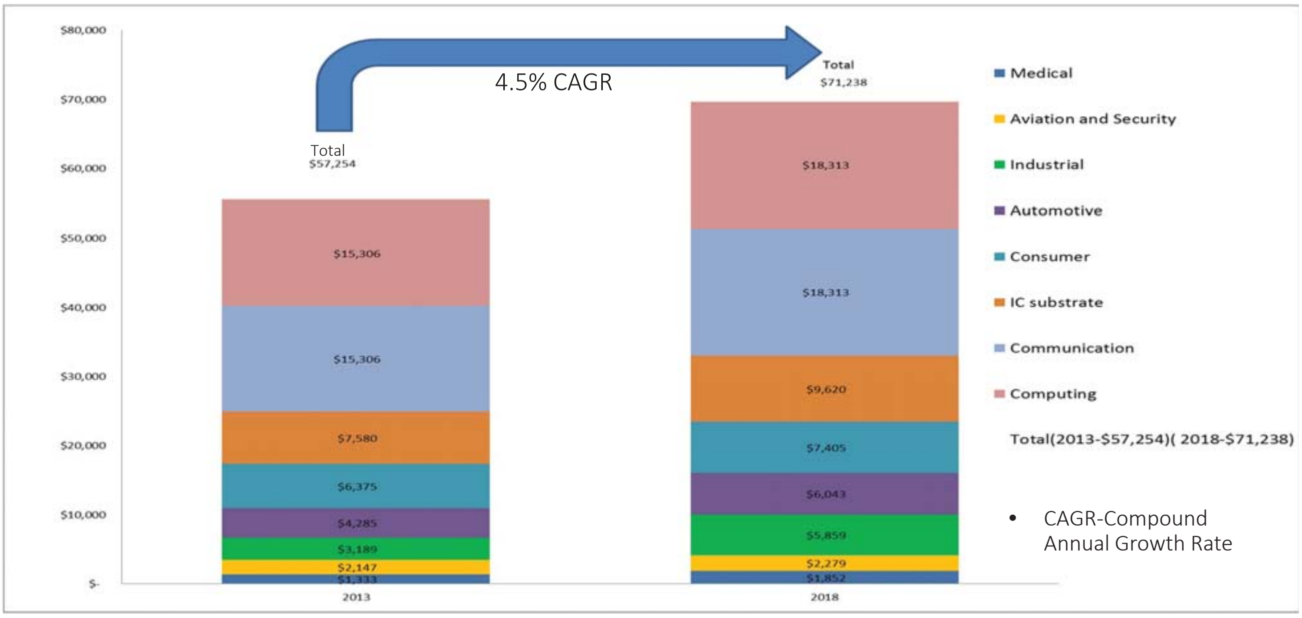
Source: IPC world production Report for 2014 IPC – Association Connecting Electronics Industries

The PCB Market

- **#2.1: World PCB Fabrication Market**
- **#2.2: Top 10 World PCB Manufacturers**
- **#2.3: Total PCB Market by Segment**
- **#2.4: PCB Market by Type**
- **#2.5: Ten year forecast market data for conductive inks and paste across different market segments (USD millions)**

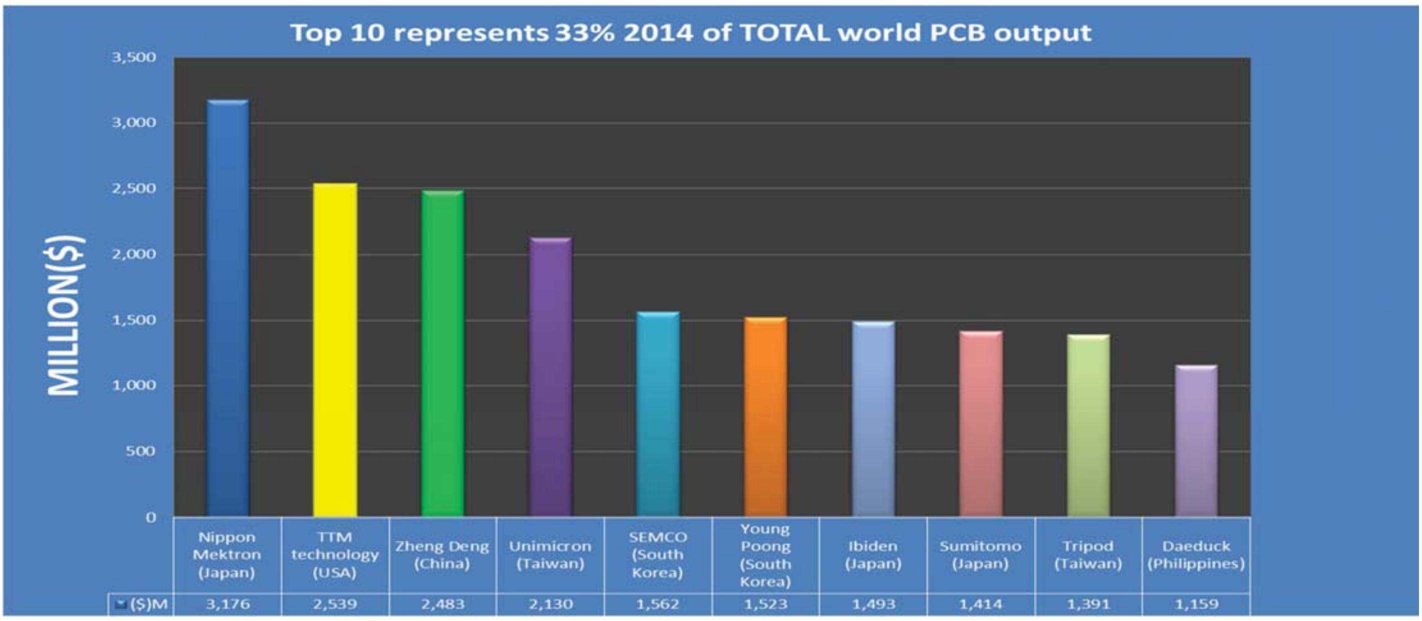
#2.3: Total PCB Market by Segment

PVI EuroRoads



#2.2: Top 10 World PCB Manufacturers

PVI EuroRoads



#2.5: Ten year forecast market data for conductive inks and paste across different market segments (USD millions)

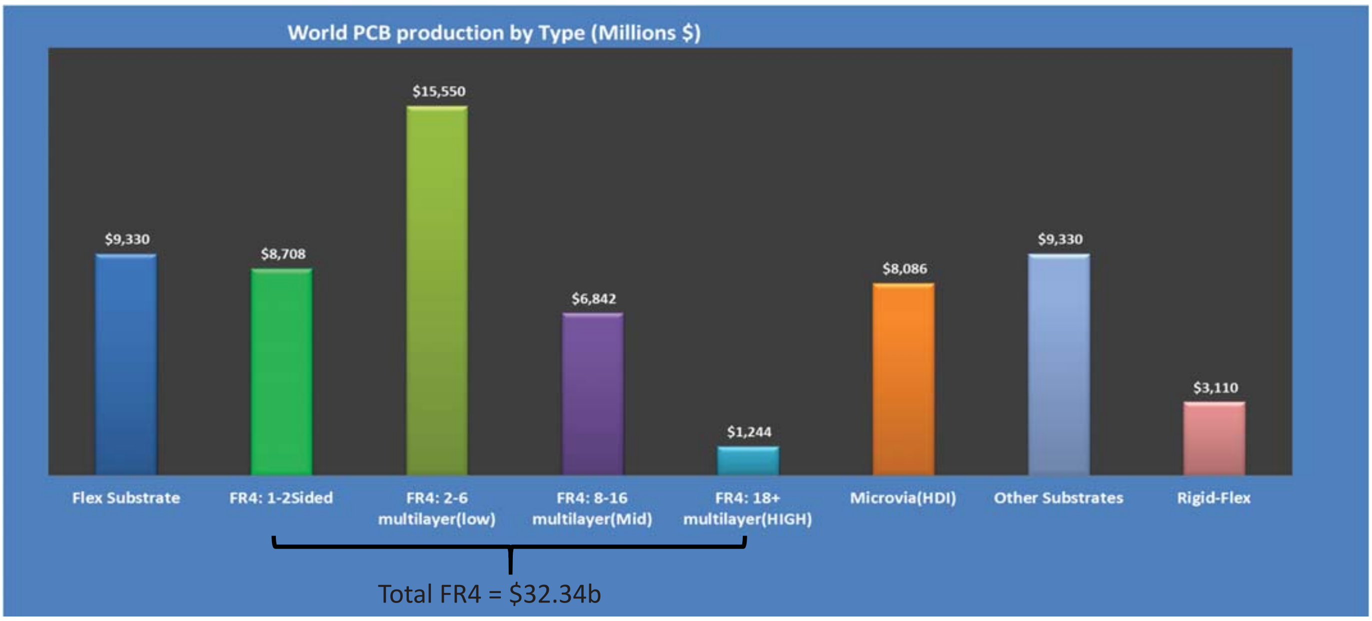
Application	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
c-Si	1509.6	1530.9	1567.5	1602	1630	1668.5	1696.7	1728	1763	1802.6	1862.8
a-Si	58.8	59.6	68	71.2	73.6	70.3	74.6	66.2	59.7	69.8	58.3
RFID	0.03	0.05	0.08	0.12	0.2	0.3	0.4	0.8	1.5	2.9	2.9
Automotive (window defroster)	122.8	126	129.4	132.8	136.1	139.1	142.1	144.9	147.7	150.4	153.2
Automotive (indoors)	14.6	32.2	53.4	73.2	89.3	101.2	109.6	115.4	119.4	122	121.9
Touch (ITO replacement)	7.7	16	25.1	33	41.4	48.7	56.3	62.2	68.2	70.9	70.7
Smart phone touch (bezel)	222.9	248.2	266.8	279.4	288	294	298.2	301.4	303.7	305.3	303.7
Tablet phone touch (bezel)	299.3	322.1	338.7	345.3	351.4	352.4	357.7	358.4	359	357.8	350.6
Notebook phone touch (bezel)	47.8	57.4	66.2	73.1	79.1	85.3	90	93.7	98.5	101.2	103.5
Smart packaging	4.3	5.4	5.8	5.9	5.9	5.8	5.7	5.6	5.5	5.5	5.5
Logic and memory	2.5	3.7	4.9	7.4	10.8	14.6	18.9	23.7	32.7	42.6	44.2
Sensors	1.9	1.9	1.9	1.9	2	2	2	2	2	2	2.1
Total	**2,292.2**	**2,403.5**	**2,527.8**	**2,625.3**	**2,707.8**	**2,782.2**	**2,852.2**	**2,902.3**	**2,960.9**	**3,033.0**	**3,079.4**

Source: IDTechEx

- Conductive ink and paste business is a large market that will generate **2.4 billion USD in 2016 in revenue at the ink/paste level**. This market however is segmented, consisting of many emerging and mature markets.
- Overall, the market will experience **2.7% CAGR over the coming decade**, although growth will be unevenly spread with several target markets experiencing rapid growth while others decline/stagnate. This represents both opportunities as well as risk for all market participants.

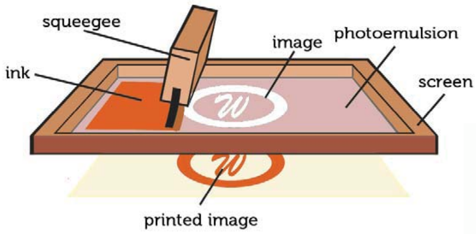
	2016	2025
All conductive Ink and Pastes Across all Market Sectors	€ 2,403,500,000	€ 3,097,400,000
Average Cost / Kg	€ 1,132	€ 1,146
Silver Flake Powder Conductive Paste	€ 1,505,180,000	€ 1,733,980,000
% Silver Powder Conductive Paste	62.6%	56.0%

#2.4: PCB Market by Type

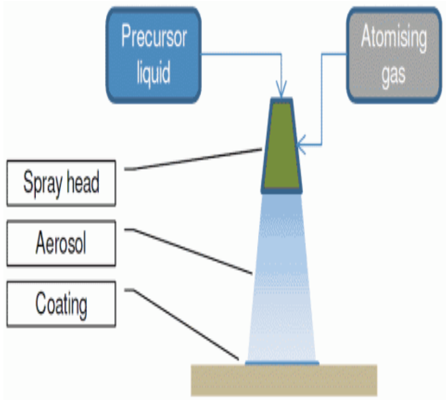


Three Delivery Systems for Nano Materials in PCB Fabrication

ESJET



Screen Printing



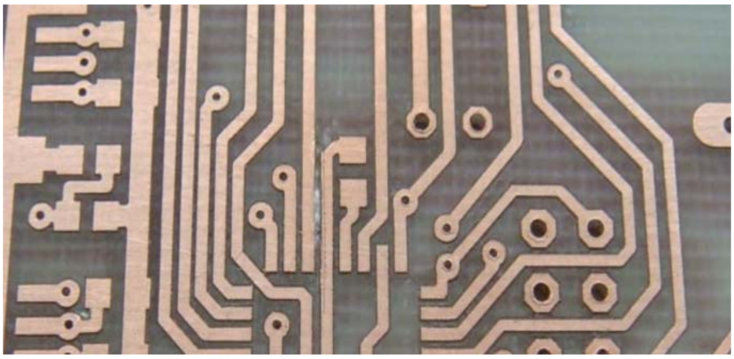
AAID

PCB Manufacturing (1-2 Sided PCBs)

- **#3.1: Comparison with Current State of the Art (1-2 Sided PCBs)**
- **#3.2: Mechanical Lapped Nano-Copper Ink versus Current (Visual Comparison)**
- **#3.3: Completed Research Precise** - Printed electronics for automotive analogue sensors based on 1-2 Sided PCBs
- **…….**
- **#3.14: Typical Cost Saving for 1-2 Sided PCBs using Pre-Preg PCB's with in-house drilling, scoring and routing**
- **…….**

#3.2: Mechanical Lapped Nano-Copper Ink versus Current

Process from PVI Nano Copper on FR4



Commercial Copper Clad on FR4

#3.1: Comparison with Current State of the Art (1-2 Sided PCBs)

- **Current State of the Art:** Many subtractive process elements
  - They involve numerous sequence steps which are expensive, wasteful (produce chemical waste) & have high power consumption.
  - Requires expensive capital equipment for manufacture.
  - Prototyping is lengthy and expensive (especially for small production runs).

€2,150K- €3,000K-Starting Capital Typical Investment

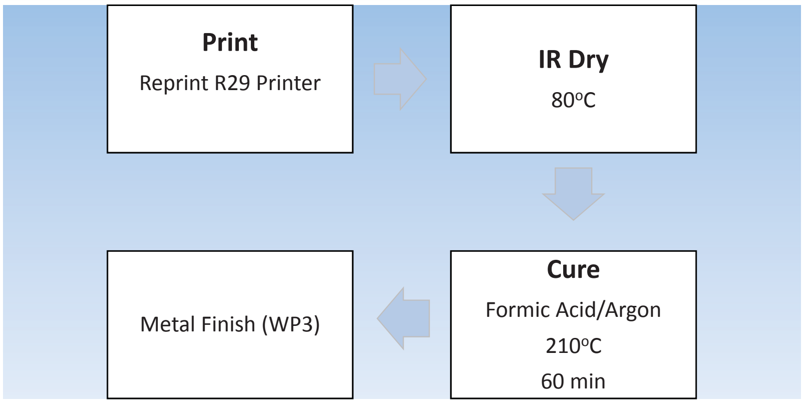
- **New State of the Art:** No Subtractive process elements. All additive
  - Significantly reduce the environmental impact, allowing us to meet National Government and EU legislation.
  - Lower materials and energy usage.
  - Reduced sensitivity to labour costs through the use of highly automated processes.
  - Reduced CAPEX requirements.
  - Greater flexibility allowing faster and cheaper prototyping and manufacturing.

Screen Printer (€50K) + Reflow Oven (€60K) + ENIG Line (€40K)

#3.4: Vacuum Oven Curing (No Laser Sintering)

- Nth Iteration Ink Formulation Meeting required specifications

Paste	Curing Conditions	Print Thickness (µm)
CP-PLS-291014R1	210 deg. C under Formic Acid/Argon for 1 hour	16



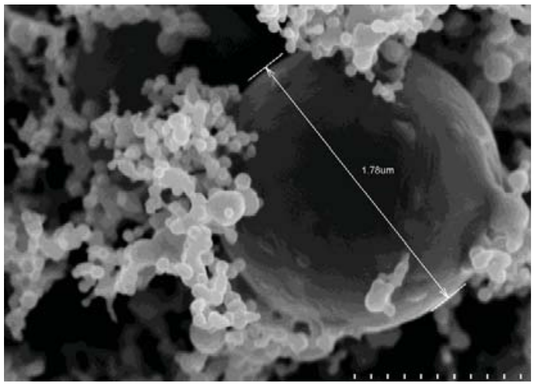
#3.3: Completed Research Precise - Printed electronics for automotive analogue sensors based on 1-2 Sided PCBs

- Project Precise demonstrated the ability to manufacture 1-2 sided PCB substrates for potentiometric sensors within the EU using printed electronics to achieve manufacturing cost nearly 25-30% lower than is currently achievable using sub-contractors in the far-East.

#3.7: Step towards an additive manufacturing philosophy

EurORoads

- Manufacturing process is based on advanced conductive micron and nano particles into pastes, followed by
  - Standard printing :
    - Screen Printing
  - Drying Technique (Only for 2 Sided)
    - Convection Air Oven
    - ~~Infra-Red~~
  - Curing Technique:
    - ~~Laser Sintering (Ink #1, Ink #2)~~
    - ~~Vacuum Oven Curing (Ink#3)~~
    - Reflow Air Furnace Curing (Ink#3)
- The nano-copper allows for a highly densified, highly conductive structure to be produced that is comparable with PCB technology whilst offering a process that can achieve finer line track resolutions.

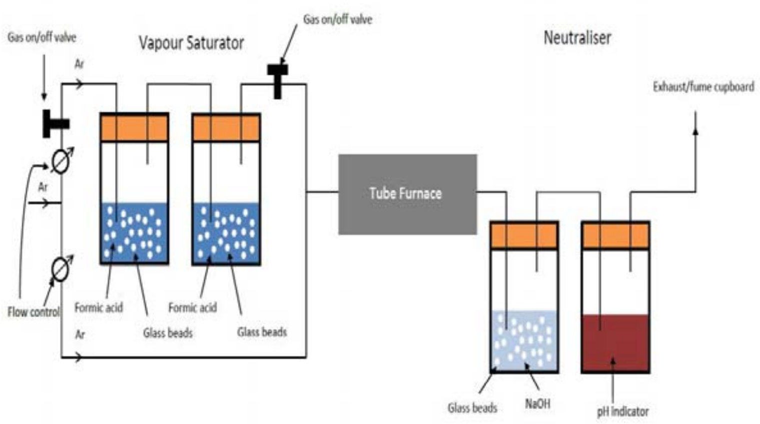


SEM Pictures of Cyclone Material Run 605 Uncoated Pre formulation. Nano copper particles clustered around micron sized copper particles. Particular attention is given to particle size ratio and volume. Semi Optimised here at 40:1.

#3.5: Curing process developed

EurORoads

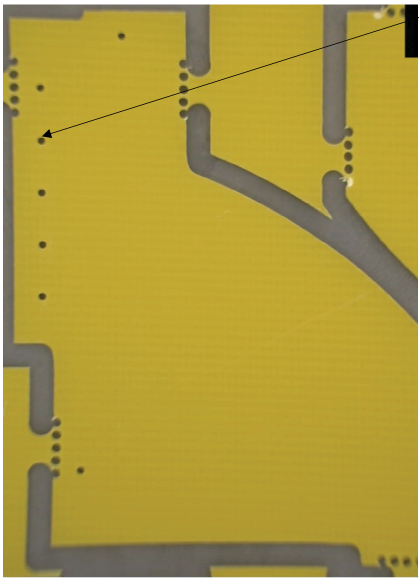
Modified existing equipment and built in-house to make sure it works!!

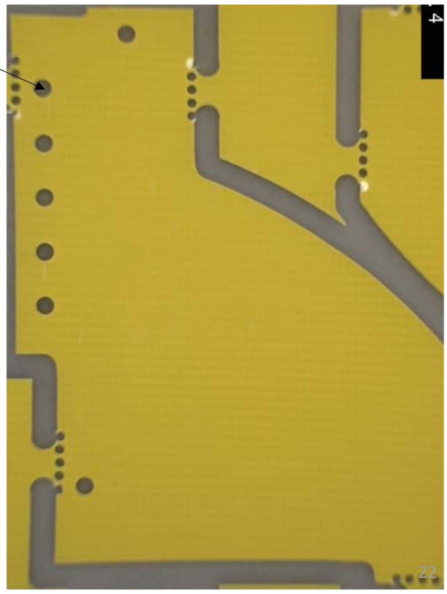


Newly Purchased Equipment Yields even better results !! “Temperature Profiled Curing”

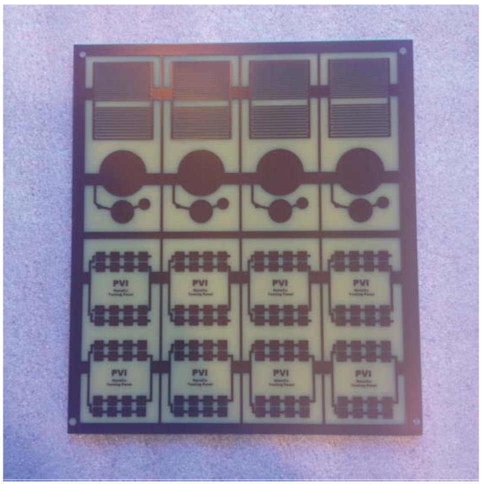
#3.9: Start of with blank FR4 substrate

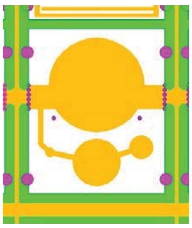
Different hole size

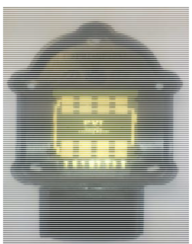




#3.8: PVI Universal Test Panels







Adhesion Test

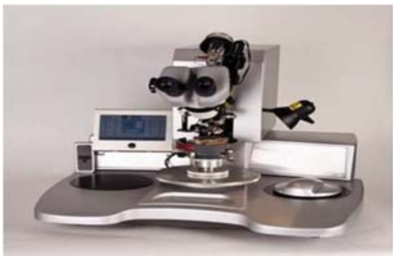
- Test performed in accordance with ISO 4624 using Delfesko Positest AT Manual adhesion tester
- The dolly is to be attached to sample area using Araldite 2011

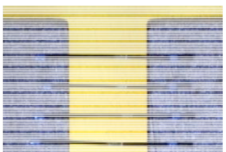
Conductivity

- Test performed with Jandel Four Point Probe

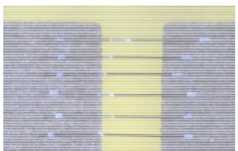
Wire Bonding

- Test performed iBond5000 Wedge Wire Bonder





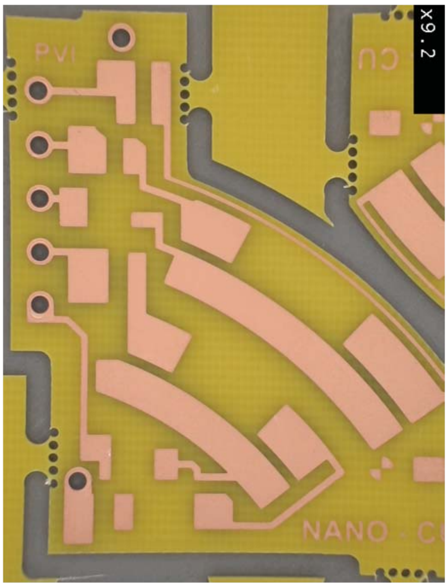
Bonded with Supplier Sample



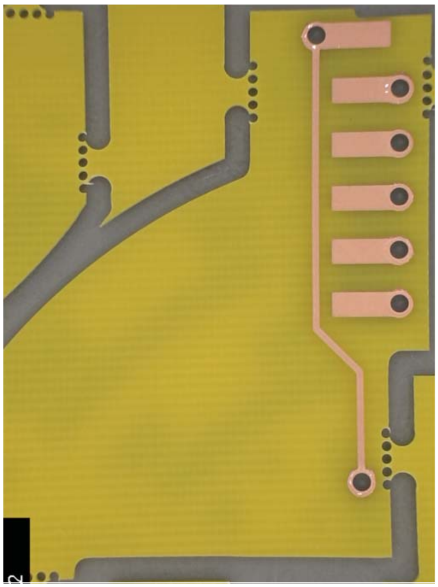
Bonded with Nano-Cu Sample

#3.11: ATV Oven Cure

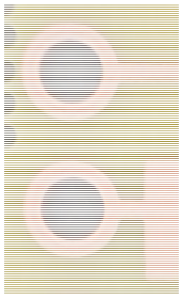
TOP



BOTTOM

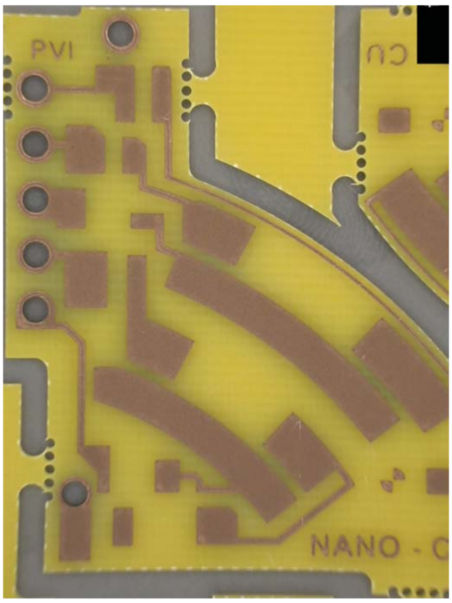


Print thru hole

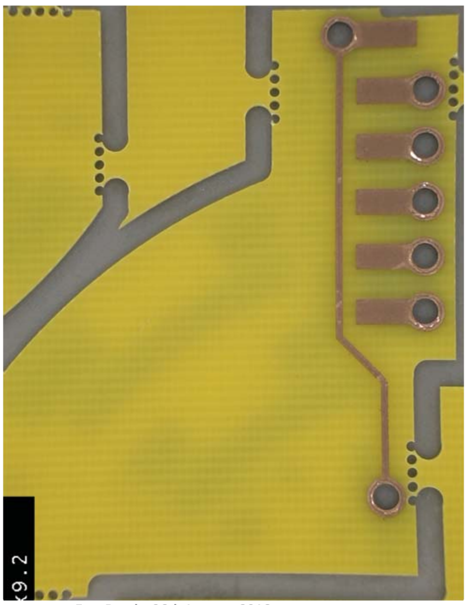


#3.10: Print Nano-Cu

TOP



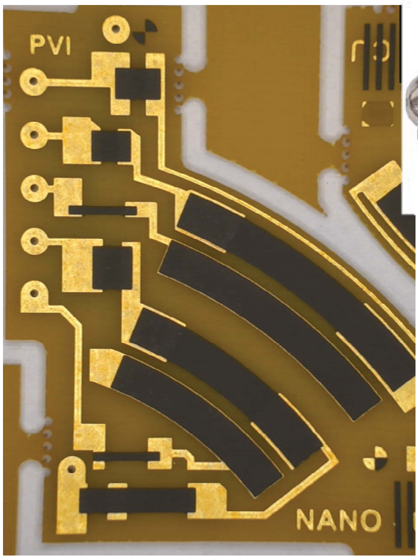
BOTTOM

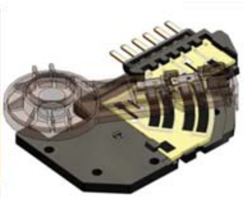


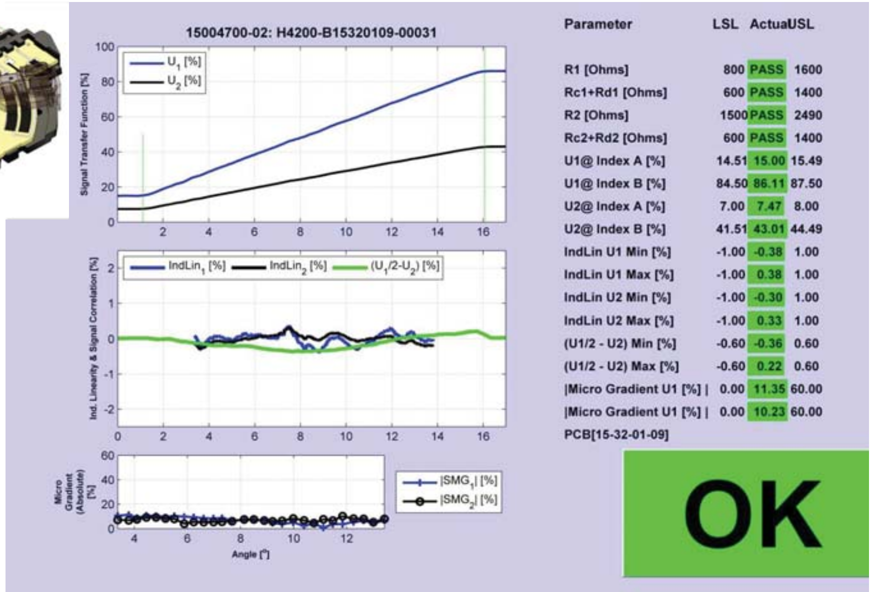
NOTE:
Dry at 130^{o}C by 10 min

Print thru hole

#3.13: Print Carbon

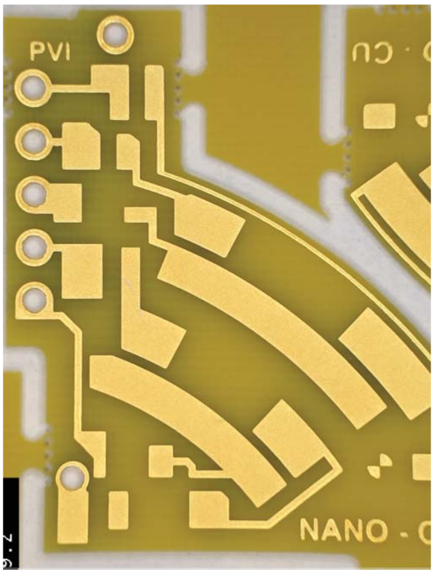


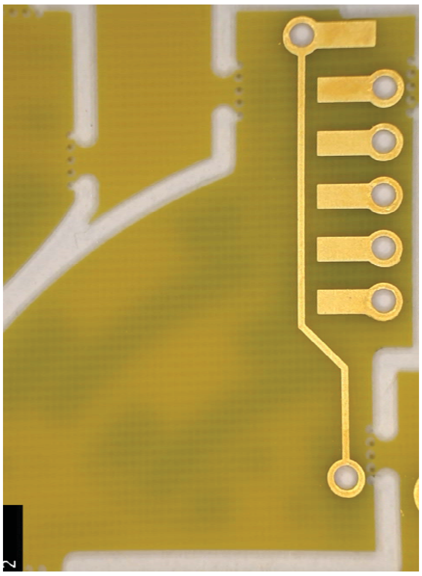




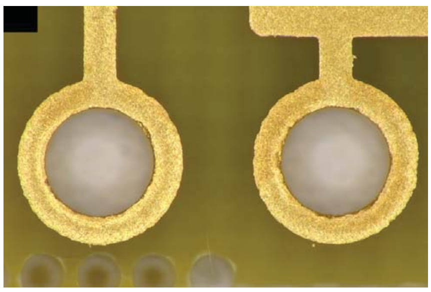
#3.12: ENIG or Other Process

TOP BOTTOM



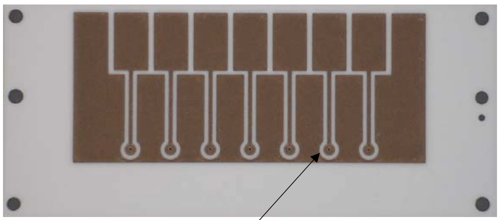


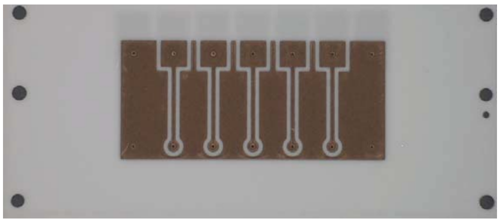
Print thru hole



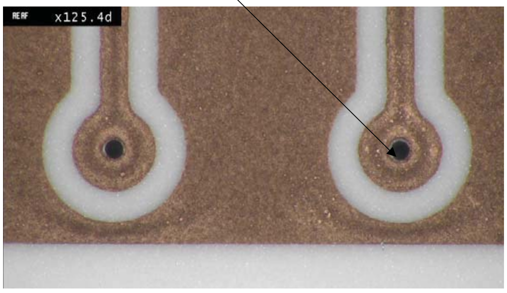
#3.15: Ceramic Nano Copper Print

Top

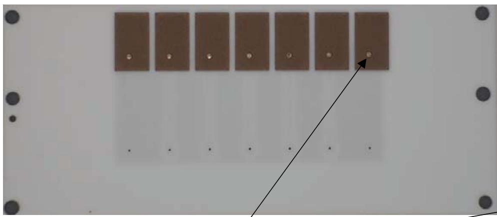


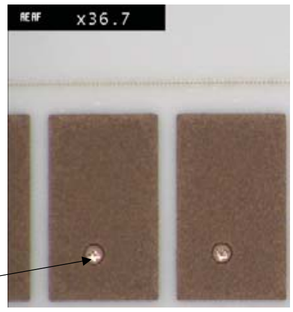


Electrode holes



Bottom





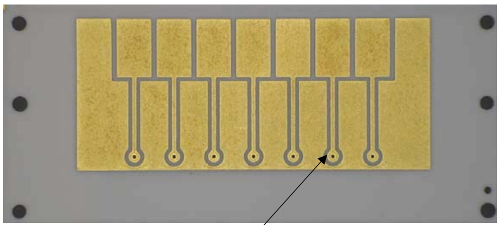
Print thru hole

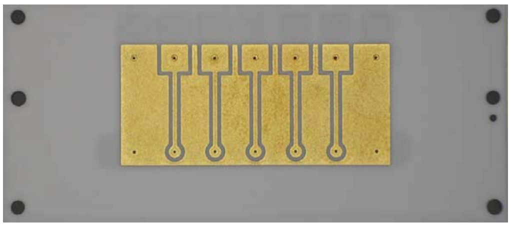
#3.14: Typical Cost Saving for 1-2 Sided PCBs using Pre-Preg PCB's with in-house drilling, scoring and routing

RFQC036868 Poti	**Standard Potentiometer**	**Nano Potentiometer**	**Δ**	**%Δ**
PCB, Inks, Packing and Other Material Costs	£0.16	£0.07	£0.09	56.25%
Direct Labour Cost	£0.03	£0.04	-£0.01	-33.33%
Overhead Cost	£0.05	£0.06	-£0.01	-20.00%
Unit Manufacturing Cost	£0.24	£0.17	£0.07	**29.17%**

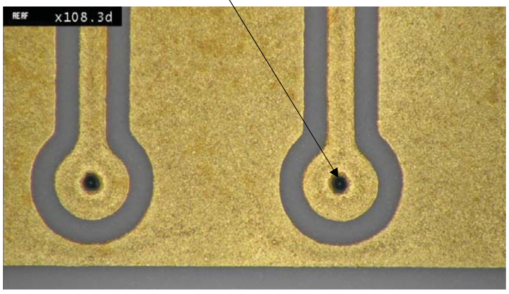
#3.17: ENIG

Top

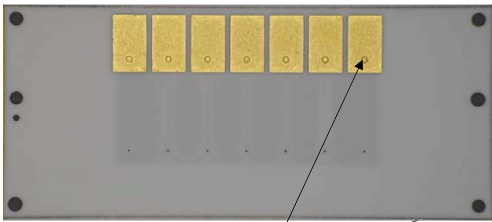


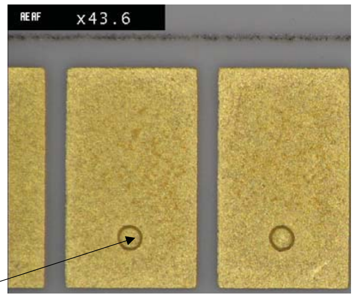


Electrode holes



Bottom

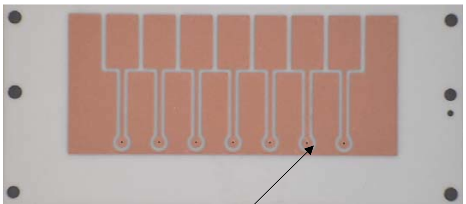


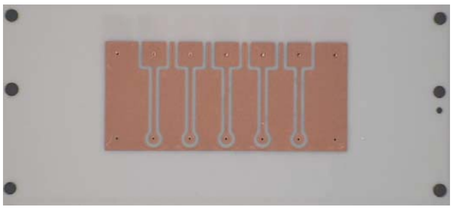


Print thru hole

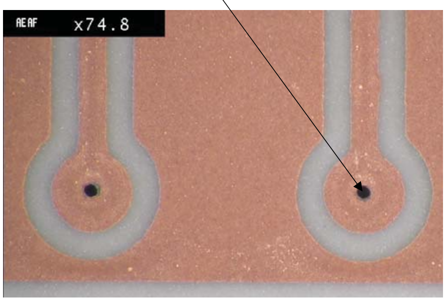
#3.16: Ceramic Post Cure

Top

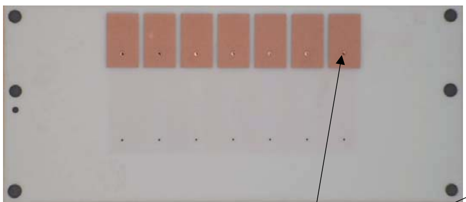


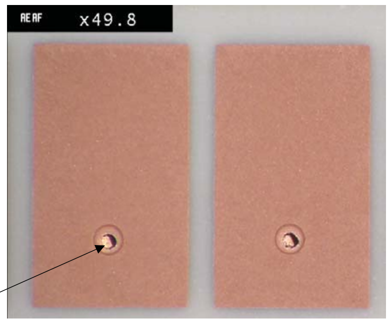


Electrode holes



Bottom





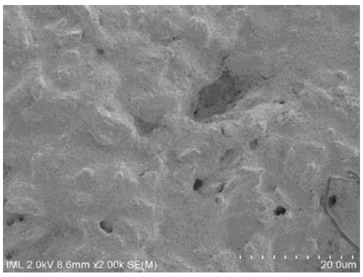
Print thru hole

PCB Manufacturing: Multi Layer

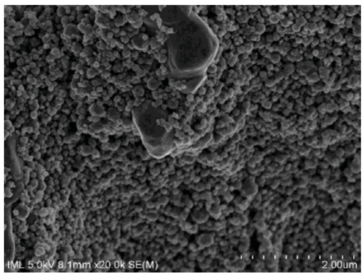
- **#4.1: Multi Layer PCBs**
- **#4.2: Multi Layer Manufacturing Process…….**
- **#4.3: Typical Cost Saving for Multi Layer PCBs using Pre-Preg FR4 with in-house drilling, scoring and routing…….**

#3.18: SEM Images: Control Sample

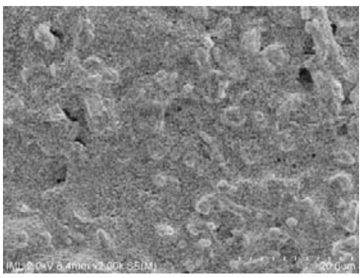
Uncured @ 20 µm resolution



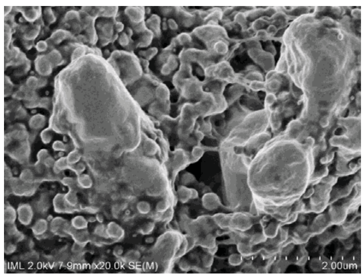
Uncured @ 2 µm resolution



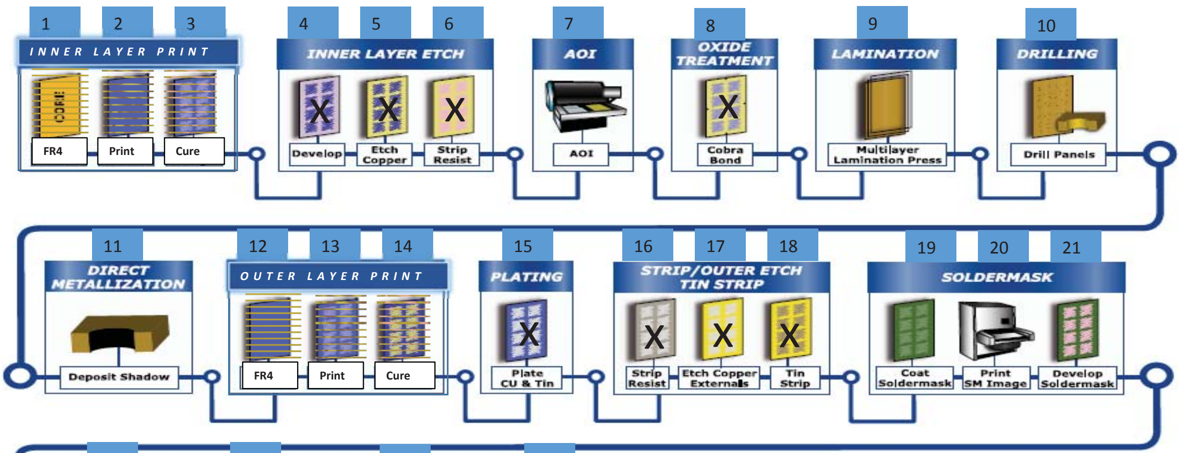
Cured @ 20 µm resolution



Cured @ 2 µm resolution



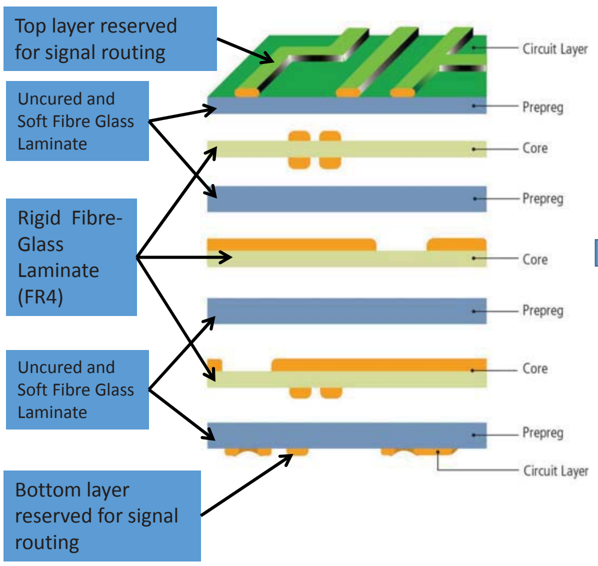
#4.2: Multi Layer Manufacturing Process



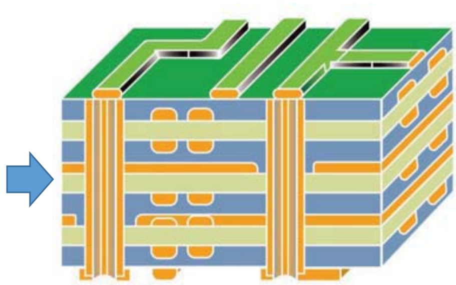
	Current State of Art	Nano-Copper Process
# of Process Steps / N Layers	**6*N + 19**	**3*(N+1) + 7**

#4.1: Multi Layer PCBs Described

Multi-layered stack up – The copper organization of multiple layer PCBs with the intent of having specific signal and ground planes on certain layers for routing convenience as well as for electromagnetic shielding purpose.

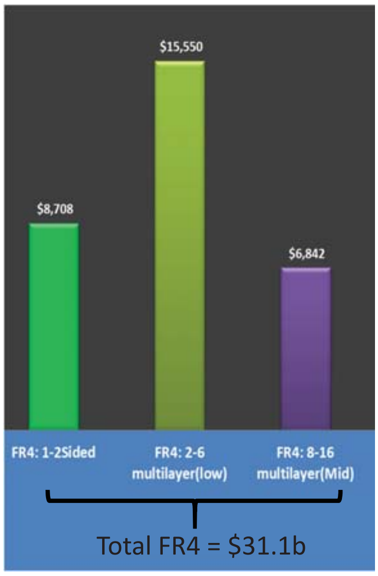


LAMINATION PRESS
Pressure and heat are applied to the material, which causes the Pre-preg to "flow" and bind the layers together.



Nano-Fabrication PCB Business Model

- What if we able to convert just a small proportion of this mature PCB fabrication to that based on nano-cu ink based PCBs
- How much revenue will be generated by the **Nano-PCB Factory**
- How much revenue will be generated by the **Nano-Ink Supplier**
- How many tonnes of Nano-Cu Ink will be produced every year
- How Many Job will these revenues produce within the EU



#4.3: Typical Cost Saving for Multi Layer PCBs using Pre-Preg FR4 with in-house drilling, scoring and routing

Job Name	PVI Test Panel
Size	145 x 160 mm
Material	FR4 If Other, Specify
Finish	Immersion Tin - RoHS
No of Copper Layers	10
Copper Weight	1.0 (oz per sq ft)
PCB Thickness mm	1.6 If "Other", Specify
Qty (min 3)	5000
Country	UK Mainland

	Current State of Art		Nano-Copper Process		Δ	%
Copper Layers	Process Steps	Unit Costs	Process Steps	Unit Costs		
1	25	€ 3.59	13	€ 1.87	€ 1.72	48%
2	31	€ 4.43	16	€ 2.29	€ 2.15	
4	43	€ 5.45	22	€ 2.79	€ 2.66	
6	55	€ 7.11	28	€ 3.62	€ 3.49	
8	67	€ 9.97	34	€ 5.06	€ 4.91	
10	79	€ 13.04	40	€ 6.60	€ 6.44	

#5.2: FR4: 2-6 & 8-16 Multi Layer & 1-2Sided Cost Model

	Current State of Art		Nano-Copper Process					
Copper Layers	Process Steps	Unit Costs	Process Steps	Unit Costs	Δ	%	Nano-Cu Sales / Unit	Nano-Copper Ink Paste (g)
1	25	€ 3.59	13	€ 1.87	€ 1.72	48%	€ 0.075	0.0731
2	31	€ 4.43	16	€ 2.29	€ 2.15		€ 0.113	0.1096
4	43	€ 5.45	22	€ 2.79	€ 2.66		€ 0.188	0.1827
6	55	€ 7.11	28	€ 3.62	€ 3.49		€ 0.264	0.2558
8	67	€ 9.97	34	€ 5.06	€ 4.91		€ 0.339	0.3289
10	79	€ 13.04	40	€ 6.60	€ 6.44		€ 0.414	0.4019

Market Share	PCB Type	PCB Sales	Nano-Cu Ink Sales	Nano-Cu Ink (tonnes)
2%	FR4: 1-2Sided	€ 161,968,800	€ 12,264,443	11.90
2%	FR4: 2-6 multilayer(low)	€ 289,230,000	€ 21,057,490	20.44
2%	FR4: 8-16 multilayer(Mid)	€ 127,261,200	€ 7,983,673	7.75
	Total	€ 578,460,000	€ 41,305,607	40.09

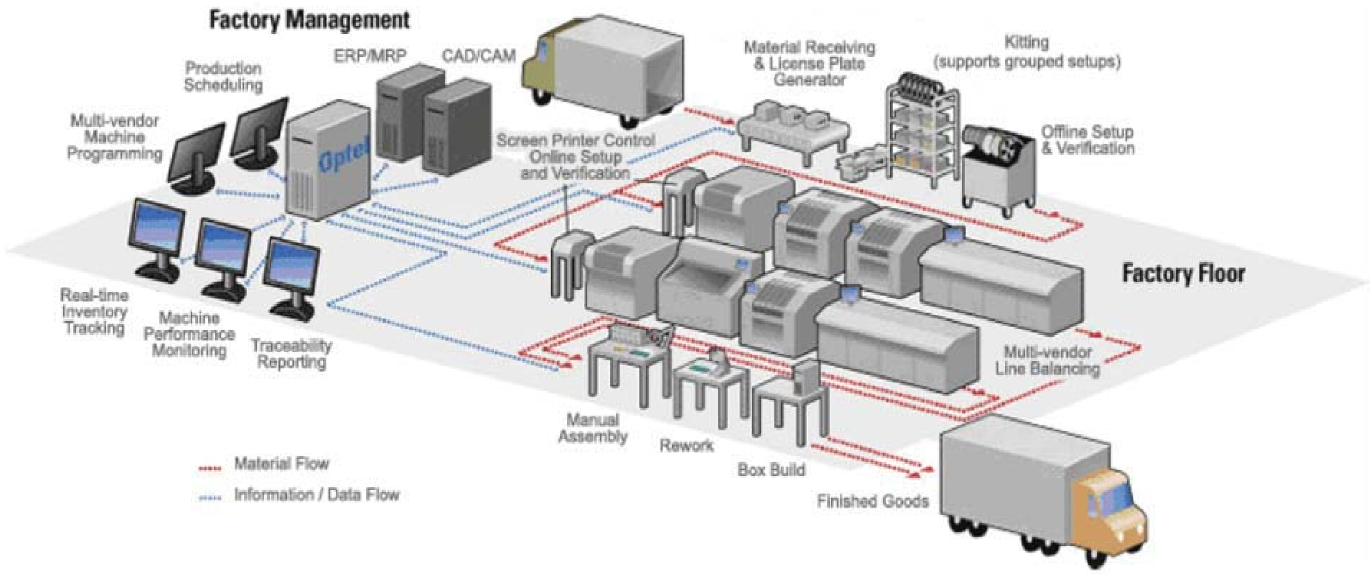
#5.1: FR4: 1-2Sided Cost Model

Material	Cost / g	Density (g/cm3)	Cost/cm3
Nano-Copper Ink Paste	€ 1.0304	0.210	€ 0.2164

Expected to reduce significantly with higher demand

RFQC036868 Poti	Standard Potentiometer	Nano Potentiometer	Δ	%Δ
PCB, Inks, Packing and Other Material Costs	€ 0.208	€ 0.091	€ 0.12	56.25%
Direct Labour Cost	€ 0.039	€ 0.052	-€ 0.01	-33.33%
Overhead Cost	€ 0.065	€ 0.078	-€ 0.01	-20.00%
Profit	€ 0.094	€ 0.094	€ -	0.00%
Unit Sales Price	€ 0.406	€ 0.221	€ 0.18	**45.51%**
Nano-Cu Sales / Unit		€ 0.0167		
Nano-Copper Ink Paste (g)		0.0162		

#5.4: Next Steps: Vision Nano-PCB Factory of the Future (Highly Automated)



#5.3: Potential Jobs Created* & Societal Savings

Market Share	PCB Sales	Nano-Cu Ink Sales	Nano-Cu Ink (tonnes)	Potential Jobs Created	Extra Profit or Societal Saving ?
2%	€ 578,460,000	€ 41,305,607	40.09	4,488	€ 273,632,345
5%	€ 1,446,150,000	€ 103,264,017	100.21	11,220	€ 684,080,863
10%	€ 2,892,300,000	€ 206,528,033	200.43	22,440	€ 1,368,161,726

*
- Medium Labour Earning of €29,000 per Year
- (Direct Labour Cost + Indirect Labour Cost)/Sales Revenue ≈ 21%

Thank You

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Operations Director
Precision Varionic International
Swindon, UK