Setting Science Agendas for Europe

The European Science Foundation provides a common platform for its Member Organisations in order to:

- **advance European research**
- **explore new directions for research at the European level**

Through its activities, the ESF serves the needs of the European research community in a global context.

This applies well to MatSEEC

ESF Member Organisations

ESF is an independent association of 80 Member Organisations

- research funding organisations
- research performing organisations
- academies and learned societies

in 30 countries

ESF covers all scientific domains

Standing Committee domains

- Humanities
- Social Sciences
- Life, Earth & Environmental Sciences
- Medical Sciences
- Physical and Engineering Sciences

Expert Board/Committee domains

- Marine Sciences
- Polar Sciences
- Space Sciences
- Radio Astronomy
- Nuclear Physics
- **Materials Science &Engineering**

ESF Activities

Strategic Plan 2006-2010

SCIENCE STRATEGY	SCIENCE SYNERGY	SCIENCE MANAGEMENT
Forward Looks	EUROCORES Research Programmes	Peer Review support
Science Policy Briefings	Research Networking Programmes	Coordination of EUROHORCs projects
Exploratory Workshops	Research Conferences	Coordination of ERA projects
		Implementing agent for the COST office through EC contract

Member Organisation Fora

MatSEEC

- **Materials Science and Engineering Expert Committee**
- First ESF Expert Committee:
  - established since 1990s
  - established within ESF
  - to have limited time mandate
  - to have mission focussed on **foresight**
- 1st meeting October 2009
- 2nd meeting 10-11 March 2010
- 3rd meeting 4-5 October 2010

MatSEEC: 23 participating organisations

- **Austria:** Fonds zur Förderung der wissenschaftlichen Forschung in Österreich (FWF)
- **Belgium:** Fonds National de la Recherche Scientifique (F.R.S.- FNRS) ; Fonds voor Wetenschappelijk Onderzoek - Vlaanderen (FWO) ;
- **European** Materials Forum / **European** Materials Research Society (EMF/E-MRS)
- **European** Space Agency (ESA)
- **Finland:** Suomen Akatemia/Finlands Akademi ; Suomen Tiedeakatemiain Valtuuskunta/Delegationen för Vetenskapsakademierna i Finland
- **France:** Centre National de la Recherche Scientifique (CNRS)
- **Germany: Deutsche Forschungsgemeinschaft (DFG) ; Max-Planck-Gesellschaft (MPG) ; Hermann von Helmholtz Gemeinschaft Deutscher Forschungszentren (HGF) ; Fraunhofer Gesellschaft**
- **Italy:** Consiglio Nazionale delle Ricerche (CNR)
- **Norway:** Norges Forskningsråd
- **Poland:** Polska Akademia Nauk (PAN)
- **Portugal:** Fundação para a Ciência e a Tecnologica (FCT)
- **Slovenia:** Slovenska Akademija Znanosti in Umetnosti (SAZU)
- **Spain:** Consejo Superior de Investigaciones Cientificas (CSIC)
- **Sweden:** Vetenskapsrådet (VR)
- **Switzerland:** Schweizerischer Nationalfonds (SNF)
- **UK:** Engineering and Physical Sciences Research Council (EPSRC)

MatSEEC members and observers

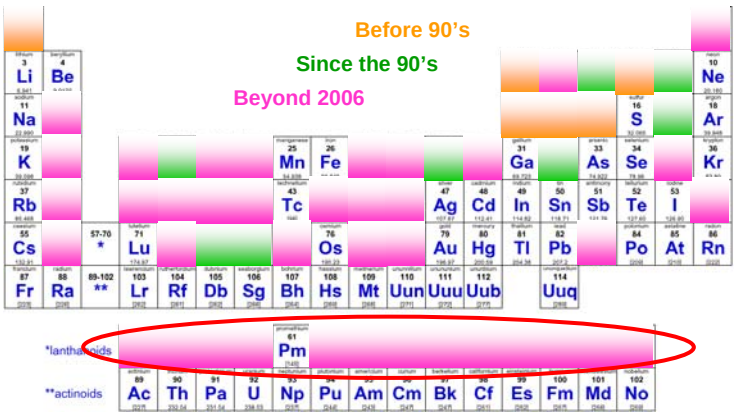
MatSEEC Committee Members

- **Prof. Günther Bauer (Chair) - AT**
- **Prof. Neil Alford - UK**
- **Dr. Patrick Bressler - DE**
- **Prof. Anne Borg - NO**
- **Prof. Joao Pedro Conde PT**
- **Dr. Urs Dürig CH**
- **Prof. Agustin R. Gonzalez-Elipe ES**
- **Prof. Hermann Grimmeiss EMRS**
- **Dr. David J. Jarvis - ESA**
- **Prof. Dr.-Ing. Anke Kaysser-Pyzalla - DE**
- **Prof. Krzysztof Jan Kurzydlowski - PL**
- **Prof. Roberto Lazzaroni - BE**
- **Prof. Risto Nieminen - FI**
- **Prof. Eva Olsson - SE**
- **Prof. Radovan Stanislav Pejovnik - SI**
- **Prof. Francesco Priolo - IT**
- **Prof. Eckhard Quandt - DE**
- **Prof. Dierk Raabe - DE**
- **Prof. Anne-Christine Ritschkoff** - FI
- **Prof. Robert Singer - DE**
- **Dr. Constantin Vahlas** - FR
- **Prof. Paul Van Houtte - BE**

Observers

- **Dr. Martyn Chamberlain - EC**
- **Dr. Renzo Tomellini – EC**
- **Prof. Hans Jörg Fecht (ESSC)**
- **Carmen Hubert (NSF)**

Materials Innovations
Elements Employed in Silicon Technology



Rare Earth Elements (REE)

W. Riess, IBM Zürich

MatSEEC Mission I : foresight

- *Taking account of the existing situation*

- Identify Materials Science Engineering priorities and objectives for the period out to 15+ years, for, and in, research, infrastructure, capacities, etc.

MatSEEC Mission II: recommendations

- Recommend how to achieve the objectives and priorities by means of actions and programmes either by national agencies, or by European organisations such as the European Commission and the European Strategy Forum on Research Infrastructures, (ESFRI).

MatSEEC Mission: assessment and advice

- Complementary to the foresight mission, to:
  - Act as a consultant body for the international materials science and engineering community providing information and advice to National Funding Agencies, the European Parliament, the European Commission, and Governmental Agencies on issues of relevance to Materials Science and Engineering.
  - Monitor and report on the evolution of research and development in all fields of materials to inform European decision makers in Europe.
  - Provide expert assessment and evaluation

MatSEEC – Why an umbrella organisation in Europe?

- Multidisciplinarity and economic potential of materials science and engineering calls for an independent strategic view so that science community can give much needed advice to policy makers in a coordinated way.
- Look ahead at the training we give current and up-coming scientists, skills needed to transfer research to technology
- Materials science and engineering community have a fundamental role in innovation

Most difficult to address

- Consensus in the European scientific community that within Europe there is enough knowledge and competentcies to compete with other countries: but also in materials science quite often the transfer from basic science to innovation and industry is insufficient.
- Matseec will explore the origin of this, develop programmes to counteract fragmentation, suggest proper mechanisms generic ways of open up boundaries, investigate whether or not sufficient infrastructure is available

How to ensure that recommendations are adopted?

- Matseec has direct support from over 20 major national funding organistaions toegther with ESA, E-MRS and EMF so that these organisation will amplify recommendations and communicate through 79 of the ESF member organisations and Policymakers at the EU and the EU parliament.
- Need to use to the optimum resources set aside for research, to maximise synergy

How to cope with the academic-industrial divide

- Committee membership includes engerineering professionals from industry and applied sciences institutes
- Members ensure the full breadth of the community
- Links to ERC and E-MRS, EMF

Who will benefit from Matseec?

From the point of view of a materials scientist and engineer:

- Better funding strategies
- More responsiveness to cutting edge research issues
- Lighter bureaucracy, quicker responsiveness, international funding
- Better research infrastructures

MatSEEC – Working Groups

1. Materials and challenges
2. Tools, facilities and infrastructures
3. Computational techniques, methods and materials design
4. Technology and knowledge transfer
5. What kind of funding?
6. Education and training
7. Public Outreach and visibility

Computational techniques, methods and materials design (WG: R. Nieminen)

- MSE: is becoming the example for simulation based science and engineering:
- (a)Predictive theoretical and computational methods: discovery and design of materials with new functionalities

- (b)Optimisation of processing routes for materials synthesis and preparation (chemical reaction, annealing, recovery)
- (c)Analysis and interpretation of experimental data
- Key: dramatic advances in methodologies for multi-scale simulations spanning several spatial and temporal scales

- First principles (quantum mechanical methods: cells with thousands of atoms)
- Mesoscopic simulations (kinetic Monte Carlo and cellular automata methods,
- Macroscopic limit: micromechanical, micromagnetism ect

Objectives

- European cooperation is crucial: no country large enough to have the needed and deep expertise in the underlying theoretical methods and their computational implementation
- European networking is crucial
- Pan-European network in computational materials science

Research challenges

- Multiscale materials simulation
- Non-equilibrium properties
- Programmable materials
- Strongly correlated and quantum materials

Computational challenges

- Mathematical methods
- Highly parallel computing platforms
- Special prupose processors
- Growth of databases: data mining:
- integrate data bases with other simulation platforms

recommendation

- Strong permanent research organisation with actives Nodes in several European countries.
- Selection of bottom-up networks with activities in specific topics: code development, research training, hands-on workshops
- Funding:national research councils

Electronic structure community

- Worldleading in atomic scale materials research
- But integration into a more materials based approach is lacking
- Cohesion of fragmented activities
- More systematic approaches to verification of simulation results, development of error estimates of computationally predicted properties

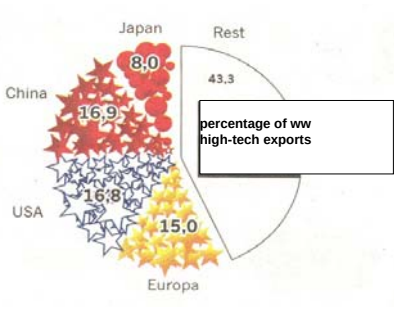
Central recommendations

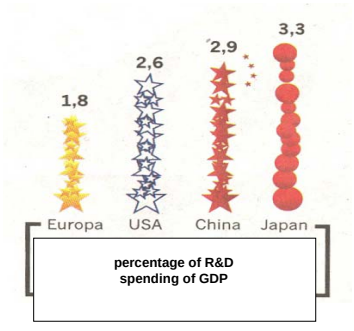
- CECAM as focal organisation with funding links to national organisations. Better links to experimental efforts, technology transfer to industry needs to be vigorously pursued.
- Code database developments and maintenance, distribution and support: more professional basis
- High level policy unit at CECAM: scientific priorities and advise funding agencies.

MatSEEC – Ongoing work

- **Preparing input for the FP8**
- Survey research infrastructures and tools
- Identifiy best practices at national and EU level
- Propose new funding schemes for collaborative research
- Raise awareness in the media and within the community

8th Framework programme

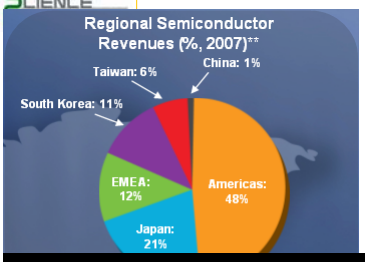




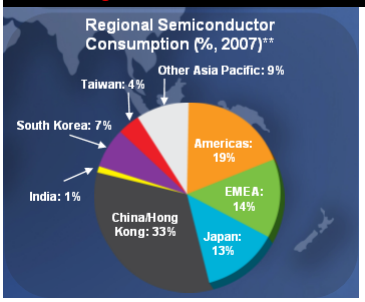
Source: Die Zeit

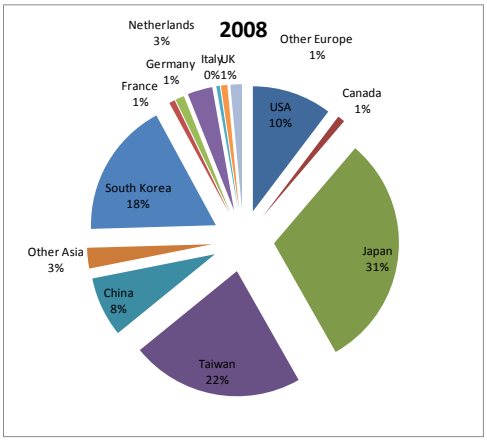
- Long-term and substantial investment in R&D needed, 1.8% of GDP are not enough!

Global Trends



How long is this model sustainable?





- Asia dominant in **OE/photonics**
- Asia owned 81% of global 2008 OE market of $356B
- Optical communication crucial for Exa-scale computers

Sources: OIDA, OIDA members, IOA members, PIDA, OITDA, EPIC

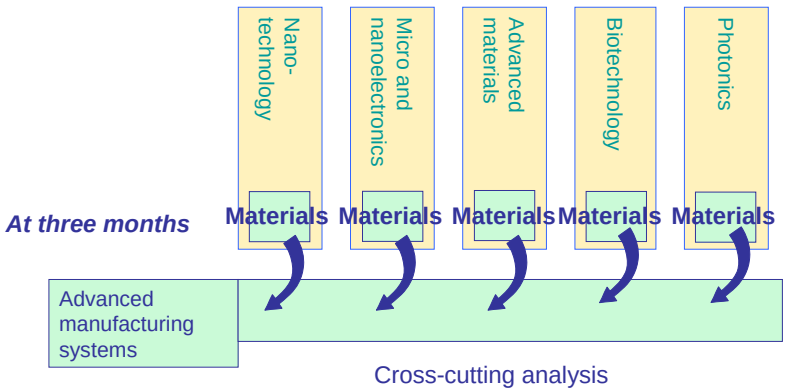
***Gartner WW Semiconductor Forecast, Nov 2008*

FP8: Key enabling technologies

- Increased focus on innovation: calls for proposals for the years ahead: should be designed to assure the **link between research output and industrial impact**
- Increased focus on technology transfer and EU wide supply chains
- Increased focus on **joint strategic programming and demonstration projects**

http://ec.europa.eu/enterprise/sectors/ict/key_technologies/index_en.htm

European Commission preparation of the 8th framework programme
Five KETs plus one cross cutting KET



What is new?

- 5 KETs are in a x-y matrix,

Consideration of

- Economical
- Financial
- Education apsects
- .....

Nanotechnology

- Development of smart nano and microdevices and systems
- Radical breakthroughs in vital fields: healthcare, energy environment and manufacturing
- Global market: $ 147 bn in 2007 , over $ 3 trillion by 2015
- Market share: US 40%, Europe 31%
- Global sales: manufacturing and materials 55%, electronics and IT 23%

Micro-and Nanoelectronics

- Intelligent control in many sectors transportation, aeronautics, space, auotmotive
- More efficient managment of electricity generation, storage, traqnsport, consumption
- Electrical grids, devices
- Market: $261 bn, mainly electronic data processing and telecom (automotive sector : 19% in Europe, 8% worldwide
- Europe: declining share of worldwide investments in microelectronics: only 10% in EU, 48% in Asia, Europes share declined from 21% in 2001 to 16% in 2000

Micro-and Nanoelectronics continued

- Total employment in Eurpoe is over 110000 plus 105000 in equipment manufactoring
- Europe: number of regions with critical mass and particular semiconductor competencies

Photonics

- Light: generation, detection and management
- Basis for economical conversion of sunlight into electricity
- Variety of components: LEDs, lasers, photodiodes
- EU strong position in solid state lighting, solar cells and laser assisted manufacturing

Photonics continued

- Global market in 2006: $ 565 bn,
- Global market for components: $ 356 bn in 2008, hgrows with annual rate of 3.1% up to 2020.
- „green“ photonics: (solar, LEDs lighting displays): grow from 8% to over 50% in 2010.
- $ 200bn global market for optoelectonic enbaled porducts (consumer display/TV, computing ect: expected to double in size by 2020
- European industry revenues: about $ 49 bn in 2006 growing rapidly

Advanced Materials

- Major Improvement in wide variety of fields
- Building, healthcare, transport, aerospace
- Facilitate recycling, lower the carbon footprint and energy demand, limit need for raw materials

Advanced Materials, continued

- EU: additional annual volume of € 55 bn over the next 5 to 7 years.
- Considerable potential in the area of energy (€ 19 bn: eg catalysts, batteries), environment € 12 bn (polymers and smart packaging) health (eg : tissue engineering) and transport (lightweight materials) and Infomation and communication technologies (ICT) (eg optical fibers and semiconductors)

Biotechnology

- Cleaner and sustainable process alternatives for industrial and food operations
- Progressive replacement of non-renewable materials currently used
- So far contribution of industrial biotech to EU rather modest but growing rapidly
- Biotech share of chemical production is from under 2% in 2005 to 9 to 13% in 2010: $ 130 – 180 bn,

Biotechnology continued

- Growth rate of 40- 50% for bio based chemicals compared to 3% for the overall chemical production
- Europe: world leader for key industrial biotechnologies such as enzyme technologies and fermentation
- Most important enzyme producers are located in Europe (80 in EU, 20 in US,
- Nearloy 70% of estimated $ 313 bn spent in 2006 on R&D of relevance to biotechnology by leading companies was spent by European firms

Optical technologies

- Photonic systems and processes
- Monitoring image analysis processes
- Intelligent sensors and signal processing

Advanced materials

- Materials science and engineering
- Assembly of multi materials
- New processes for surface processing

Members of HLG (EU) key enabling technologies

- **President**
- Mr Jean **THERME** (Director of CEA (French Atomic Energy Commission) in Grenoble).
- **Members**
- Prof. Luigi **AMBROSIO** (Director of the Institute for Composite Biomedical Materials).
- Mr Giorgio **ANANIA** (Chairman of Cube Optics).
- Dr. A-J **AUBERTON-HERVE** (CEO and President of SOITEC).
- Mr Andrea **BENASSI** (Secretary General of UEAPME).
- Mr Peter **BAUER** (CEO of Infineon).
- Dr. Daniel BERNARD (Scientific Vice President of ARKEMA).
- Mr Carlo **BOZOTTI** (CEO of STMicroelectronics).
- Prof. Hans-Jörg BULLINGER (President of Fraunhofer-Gesellschaft).
- Dr. Spase **DRAKU**L (CEO of THYIA Tehnologije).
- Mr Javier **EGUREN** (CEO of NICOLAS-CORREA).
- Ms Anne **De GUIBERT** (Research Director of Saft Group).

- Dr. Winfried **HOFFMANN** (President of the European Photovoltaic Industry Association, EPIA).
- Jochen **HOFMANN** (Staatssekretär in the Ministry of Economics).
- Dr. Andre **KOLTERMANN** (Group Vice President of Süd-Chemie).
- Prof. Erkki **LEPPÄVUORI** (President of VTT Technical Research Center of Finland).
- Mr Jan **MENGELERS** (President of the Netherlands Organization for Applied Scientific Research).
- Mr Jim **O'HARA** (General Manager Intel Ireland).
- Mr J Richard **PARKER** (Director at Rolls Royce).
- Mr Richard **PELLY** (Chief Executive of European Investment Fund).
- Dr. Wolfgang **PLISCHKE** (Board Member of BAYER).
- M. Luc **ROUSSEAU** (General Director in the Ministry of Industry).

EUROPEAN SCIENCE FOUNDATION

- Mr Frank **ROZELAAR** (Non-executive Chairman of QinetiQ).
- Mr Marc **van SANDE** (Chief Technology Officer and Vice President of UMICORE).
- Mr Gerald **SCHOTMAN** (Chief Technology Officer of Royal Dutch Shell).
- Dr. Lars **STROMBERG** (Vice President Vattenfall AB).
- Mr David **Willetts** (Minister of State for Universities and Science).

www.esf.org

Tasks fo the HLG

- 1. To assess the competitive situation of the relevant technologies in the EU with a particular focus on industrial deployment and their contribution to address major societal challenges;
- 2. To analyse in depth the available public and private R&D capacities for KETs in the EU (on all levels); and
- 3. To propose specific policy recommendations for a more effective industrial deployment of KETs in the EU.

Key enabling technologies

- Mastering these: being at the forefront of managing the shift to a low carbon knowledge –based economy
- Important role in R&D, innovation and cluster strategies of many industries: crucial to ensure competitiveness of European industries in knowledge economy

Key enabling technologies

- EU has very good research and development capacities in some key enabling technology areas
- But **no so successful** in translating research results into commercialised manufactures goods and services
- KETs: systemic relevance for developing new goods, services, restructuring of industrial processes , secure research, development and innovation base in Europe

Matseec: When asked what is needed:

We can't answer:

- More money
- Better recognition for materials

These things come only when a good strategy is put in place and delivers

Suggestions welcome:

Matseec@esf.org

- http://ec.europa.eu/enterprise/sectors/ict/key_technologies/index_en.htm