

Facts & Figures



ExtremeMat is an Integrated Project, co-funded by the European Community under the NMP priority of the Sixth Framework Programme for Research and Technological Development:

Title: New Materials for Extreme Environments

Project reference: NMP3-CT-2004-500253

Acronym: ExtremeMat

Start date: 2004-12-01

Duration: 60 Months

Budget: approx. 35 million €

EU funding: 17.4 million €

Contact

Prof. Dr. Dr. Harald Bolt
Max-Planck-Institut für Plasmaphysik
85748 Garching, GERMANY
Phone: +49-89-3299-2141
E-Mail: harald.bolt@ipp.mpg.de

Disclaimer:

This publication reflects only the authors' view. The European Community is not liable for any use that may be made of the information contained therein.

© 2006 Bayern Innovativ GmbH, www.bayern-innovativ.de

Photos courtesy of and © by: UMMS SAV www.umms.sav.sk, SIEMENS AG www.siemens.com, AREVA/Claude Pauguet www.areva.com, DLR www.dlr.de, UKAEA www.ukaea.org.uk, ALSTOM www.alstom.com. Layout: necas GmbH, www.necas.de.



Jülich GmbH, Jülich, Germany • Max-Planck-Institut für Plasmaphysik, Garching, Germany • National Centre for Scientific Research "Demokritos", Attiki, Greece • Nuclear Research & Consultancy Group v.o.f., Petten, The Netherlands • Paul Scherrer Institut, Villigen PSI, Switzerland • United Kingdom Atomic Energy Authority, Oxfordshire, United Kingdom

Industry

Ansaldo Ricerche S.p.A., Genova, Italy • Archer Technicoat Ltd., High Wycombe, Great Britain • AREVA NP SAS, Paris la Défense, France • AREVA NP GmbH, Erlangen, Germany • Bayern Innovativ Gesellschaft für Innovation und Wissenstransfer mbH, Nuremberg, Germany • EADS Deutschland GmbH, Munich, Germany • Empresarios Agrupados Internacional, S.A., Madrid, Spain • FN S.p.A. Nuove Tecnologie Servizi Avanzati, Roma, Italy • MT Aerospace AG, Augsburg, Germany • Materials Engineering Research Laboratory Ltd, Hitchin, United Kingdom • National Nuclear Corporation Limited, Cheshire, United Kingdom • Plansee SE, Reutte, Austria • SGL Carbon GmbH, Meitingen, Germany • Siemens AG, Munich, Germany

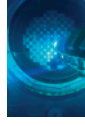
The FP6 Integrated Project ExtremeMat

New Materials for Extreme Environments

Heading towards breakthroughs in



Electronics



Advanced Fission



Aerospace



Fusion



Various Spin-off Applications



Funded by the European Community under FP6



The Challenge

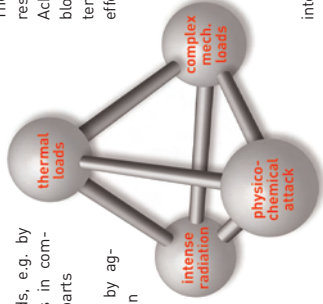
At the beginning of the 21st century, the conventional production industry is undergoing a dramatic change towards an innovative, high-tech, knowledge-based industry. Increasing competition on the global market constantly demands for new and better products and services.

However, in many fields the development of new top-end products and systems has reached limits set by the capabilities of currently existing materials.

Consequently new materials have become a key driver at the forefront of industrial innovation.

One major challenge is materials which have to provide functions in extreme environments, characterised by:

- High temperatures and heat fluxes with frequent, rapid changes
- Complex mechanical loads, e.g. by thermally induced strains in compounds or actively cooled parts
- Physico-chemical attacks by aggressive media, e.g. oxygen and hydrogen radicals, atoms
- Strong irradiation causing structural changes and defects



The Answer

Common loading conditions and common underlying materials issues exist in many different industrial application fields, like

- electronics (power electronics, optoelectronics, high temperature microelectronics etc),
- advanced fission (Generation IV reactors, e.g. very high temperature reactors),
- aerospace (thrusters, engines, protection shells etc),
- nuclear fusion (plasma-facing components)
- and in a number of further separate applications like high power brake systems, gas turbine combustion chambers etc.

The underlying materials issues can not be successfully resolved by singular and isolated approaches in each field. Achieving a real breakthrough to overcome existing roadblocks is beyond reach with conventional incremental materials development. It requires pooling the expertises and efforts from different fields in a single project.

This is the mission of the ExtremeMat Integrated Project, a large joint research project of 37 renowned institutions throughout Europe.

ExtremeMat brings together a critical mass of experiences, methods and tools of industrial and scientific partners from the above mentioned application fields into one single project. It uses their capabilities to jointly resolve underlying materials issues and to develop new multifunctional materials for top-end and new applications in extreme environments.

The Research Topics

The ExtremeMat materials research is structured in four interacting subprojects SP1, SP2, SP3 and SP4

SP1: Self-passivating Protection Materials

able to withstand high thermal and mechanical loads, with self-passivating properties under physico-chemically aggressive media and with passive stability under off-normal conditions:

- Temperatures up to 2000 °C. Heat flux up to 20 MW/m²
- Hydrogen, oxygen and other radicals
- Transient heat flux pulses and cool-down shocks up to 1000 K/s

SP2: Heat Sink Materials

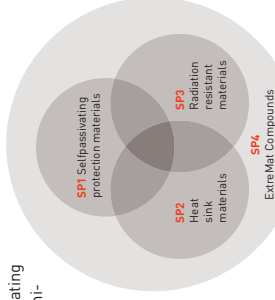
for high-temperature applications and the removal of extreme heat fluxes; e.g. composites with optimized nanoscopic interfaces capable of stable operation under high temperatures and large temperature changes:

- Thermal conductivity of 300-800 W/m K (comparable to Cu or higher)
- Reliable operation at up to 1000°C
- Tailored CTE in the range of 4-9·10⁻⁶/K
- No disintegration or deterioration at large temperature changes of up to 1000 K/s
- Good shape stability and joinability

SP3: Radiation Resistant Materials

for protective and heat flux applications, maintaining structural stability under very intense irradiation at lowest possible activation:

- Metallic materials (ODS steels, W-based alloys etc)
- Operation temperature up to 700 °C and more
- Neutron doses up to 150 dpa
- High-energy neutron fluxes above fission spectrum
- Carbon- or SiC-based materials
- Operation temperature up to 1000 °C
- Neutron doses up to 10 dpa
- Passive safety under off-normal conditions



SP4: ExtremeMat Composites

for industrial applications, based on new joining processes and functional interlayers, coatings and integrated diffusion barriers tailored for SP1, SP2 and SP3 materials:

- Improvement of wetting with molten brazing alloys
- Reduced residual stress from bonding processes
- Prevention of embrittlement by suppression of interfacial material diffusion at high temperatures
- Prevention of hydrogen permeation