



European Virtual Institute on Knowledge-based Multifunctional Materials AISBL

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01
**What can
KMM-VIN
offer to
industrial
customers?**



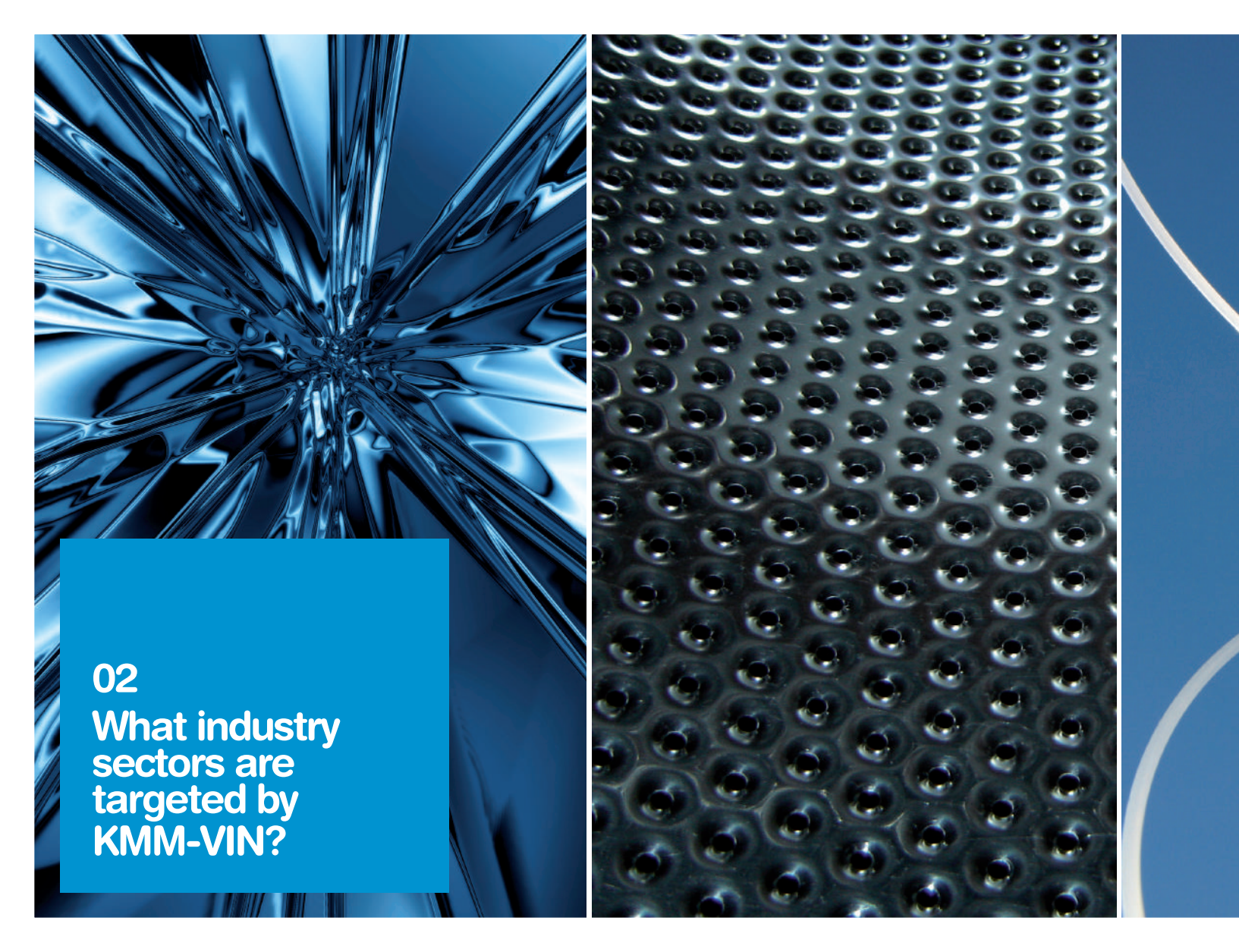
Operating with the most appropriate technology is crucial for every industry sector, and that is especially true for the increasingly sophisticated, knowledge-based engineering materials.

KMM-VIN partnership offers integrated solutions (“from idea to ready product”) of new structural and functional materials processed via cutting edge technologies. Our novel integrated solutions comprise:

- › Design of materials chemical composition, phase composition and structural models.
- › Verified and optimised materials technologies.
- › Complete characterisation of materials microstructure, properties and performance in service conditions.
- › Materials design by modelling of materials composition, properties and behaviour under complex thermomechanical loading conditions and harsh environments.

Our core competency lies in the following materials groups (abbreviated as KMM):

- › Advanced ceramics.
- › Metals and highly processed alloys .
- › Intermetallics and shape memory alloys.
- › Composites and functionally graded materials (ceramic-metal, ceramic-ceramic, metal-metal,...) with fiber-, nano- or microparticle, or interpenetrating reinforcement.
- › Thick and thin layers (layered materials, coatings, surface modification).
- › Biomaterials and bioinspired materials.
- › Innovative high temperature steels.
- › Joints of advanced materials.



02

**What industry
sectors are
targeted by
KMM-VIN?**



We address our research and service offerings primarily to the following sectors:

TRANSPORT, automotive, rail and maritime (e.g. elements of combustion engines, valvetrains, camshafts, brakes, sensors, actuators, devices for motion control).

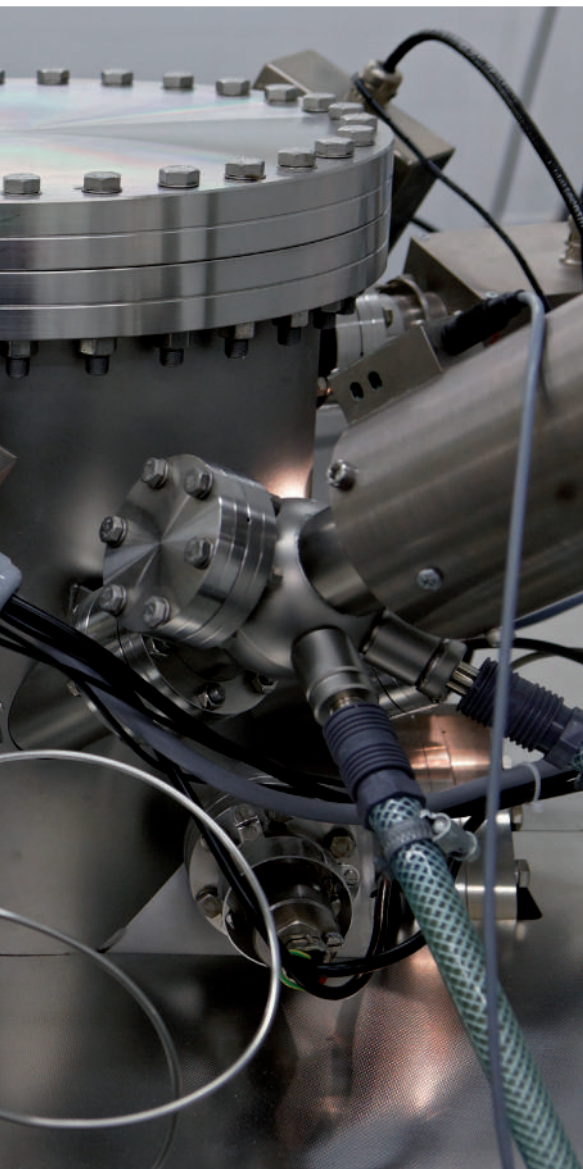
AEROSPACE and AERONAUTICS, (e.g. elements of aeroengines, turbine blades, exhaust systems).

ENERGY, conventional and renewable (e.g. headers, steam lines and turbines in steam power plants, hydrogen storage, heat exchangers burning devices of high-sulphur coal, oil drilling components, coils in thermonuclear reactors).

HEALTH, biomedical applications (e.g. substitution or repair of lost tissue function, sensors and actuators for control and support of many bodily functions).

ELECTRONICS, (e.g. MEMS, sensors, heat dissipation elements,...).

03
Keeping pace
with modern
methods and
technologies:
KMM-VIN
educational offer



In addition to the broad spectrum of research and services, the KMM-VIN partnership offers specialised workshops, educational trainings and practical courses tailored to the needs of industry sectors, SME's and academia on interested topics from the fields of materials design, processing technologies, fundamentals of chemical and physical processes, thermodynamics of complex materials, characterisation of materials microstructure and properties, modelling of materials properties and response to in-service conditions.



04 What is actually KMM-VIN?



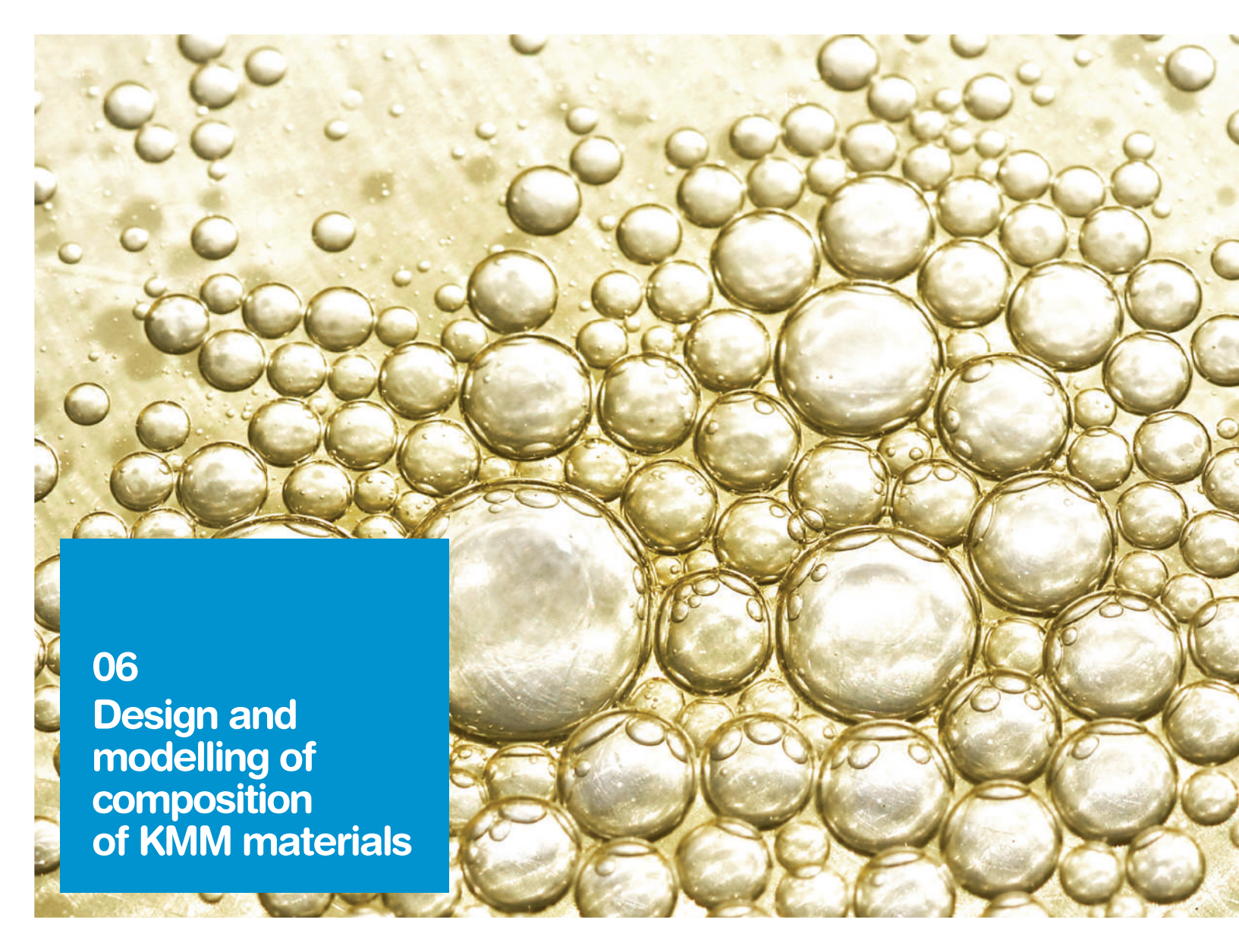
The European Virtual Institute on Knowledge-based Multifunctional Materials AISBL (KMM-VIN) is an international, non-profit organization (AISBL) head-quartered in Brussels and incorporated under Belgian law (entreprise no. 889 462 185).

It was established in 2007 by 29 founding members (institutions and individuals) as the most important deliverable of the Network of Excellence project KMM-NoE ("Knowledge-based Multicomponent Materials for Durable and Safe Performance) of the EU 6th Framework Programme. KMM-VIN is a single legal entity with a supranational character offering integrated basic and applied commercial research, educational and innovation activities in the field of knowledge-based structural and multifunctional materials. Now KMM-VIN partnership consists of 39 core and 33 associate members and is constantly growing.

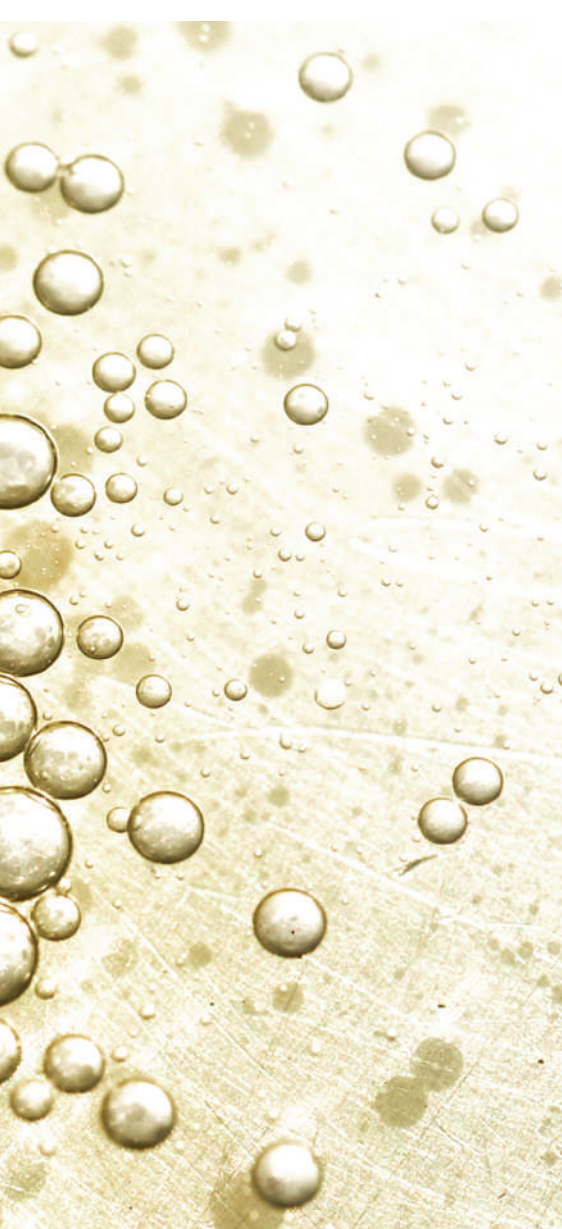
05
KMM-VIN
mission



The mission of KMM-VIN is to develop a new European model of integration and self-sustainable cooperation of the stakeholders in the area of knowledge-based structural and functional materials offering wide access to research, technology and development for industry, SMEs and academia via R&D projects, testing, analysis and consultancy services.

A microscopic view of numerous spherical droplets, likely water or oil, on a textured, yellowish-brown surface. The droplets vary in size and are densely packed, creating a complex pattern of highlights and shadows. A blue rectangular box is overlaid on the bottom left corner, containing white text.

06 Design and modelling of composition of KMM materials



Materials that can be processed by KMM-VIN members include, e.g.:

- › Advanced mono- and polycrystalline ceramics (SiC, AlN, ...), spinel ceramics, translucent ceramics.
- › Highly processed alloys (Ni, Al, Ti - alpha, beta and alpha+beta based alloys, ...).
- › Metal-ceramic composites: ceramic-matrix composites, metal-matrix composites, ceramic-ceramic composites, interpenetrating phase composites (CMC: $\text{Al}_2\text{O}_3/\text{Cr}$, $\text{Al}_2\text{O}_3/\text{Cr/Re}$, $\text{Al}_2\text{O}_3/\text{Mo}$, ZrO_2/Al , SiC/Cu, AlN/Cu; MMC: Cu/SiC, Al/SiC, Al/TiB₂, Al/Si₃N₄, Al/Al₂O₃, Ti/SiC; CCC: $\text{ZrO}_2/\text{Al}_2\text{O}_3$, SiC/C_f, SiC/C_p, ...).
- › Metal-ceramic functionally graded materials (FGM's - $\text{Al}_2\text{O}_3/\text{Cr}$, SiC/Cu, AlN/Cu, NiAl/Al₂O₃, FeAl/Al₂O₃, Fe₃Al/Al₂O₃, ...).
- › Layered materials ($\text{ZrO}_2/\text{Al}_2\text{O}_3$, Al/TiB₂, ...).
- › Coatings (Al/TiB₂, Ti/SiC, WC/Co, Si₃N₄, AlN, ...).
- › Innovative ferritic-martensitic steel grades and their coatings.
- › Surface modification.

Using the state-of-the art processing techniques for structural and functional materials, KMM-VIN members can provide chemical compositions, phase compositions and structural models of advanced materials to arrive at targeted values of physical, chemical and mechanical properties.

The end products comprise e.g. models of advanced bulk composites or FGMs with specified volume fractions of the constituent phases, the shape, the size and the distribution of the reinforcing phase which may be particles, fibers or interpenetrating networks. For functionally graded composites the respective structural profile is designed with number of layers, their thickness and mutual locations uniquely specified.

07
Processing
technologies
of KMM materials



KMM-VIN members have extensive experience and own specialised infrastructure to manufacture advanced structural and functional materials through:

- › **Powder metallurgy (PM)** for high performance ceramics (SiC , B_4C , BN , AlN , Si_3N_4) and composites based on these ceramics; other MMC, CMC, CCC and FGMs with different composition, intermetallics,...
- › **Melting, remelting and heat treatment** (high temperature steels, high nitrogen steels)
- › **Spark Plasma Sintering (SPS)** for WC-Co, YSZ-ytria stabilized zirconia, HA-hydroxiapatite,...
- › **Powder Spraying (PS)** for different kinds of coatings.
- › **Pressure assisted and pressureless infiltration** techniques for ceramic-metal composites with interpenetrating networks such Al_2O_3 -Cu, Al_2O_3 -Cu alloys, WC-Cu, WC-Cu alloys,...
- › **Self-Propagating High-Temperature Synthesis (SHS)** for e.g. intermetallics: Fe-Al, Ni-Al,...
- › **Injection & micro-injection** of ceramic & metal powders (Powder Injection Moulding, PIM) for Ni based intermetallics.
- › **High Pressure Die Casting** for Al alloys,...
- › **Plasma CVD and HVOF** for coatings by TiN , B_xC_y , plasma treatments,...
- › **PVD-Magnetron Sputtering** for metals (e.g. Al, Ti, Cr, Si, Pt...), alloys ($\text{Ti}_6\text{Al}_4\text{V}$ ...) and hard coatings (TiN , TiC , CrN ,...).
- › **Ion Implantation:** e.g. Ar^+ , N^+ , C^+ , metallic ions (Cr^+ ...).
- › **Welding, casting, forming**, heat treatment, coating of high temperature steels.
- › **Detonation gun.**

The image displays two cross-sectional views of a dark, rectangular mold. The left view shows a copper-colored metal block with a circular indentation on its top surface, seated within the mold. The right view shows a similar setup, but the metal block is partially covered by a dark, irregular layer, possibly a bonding agent or a different material, illustrating a different joining technique.

08
Joining of KMM
materials using
different bonding
techniques

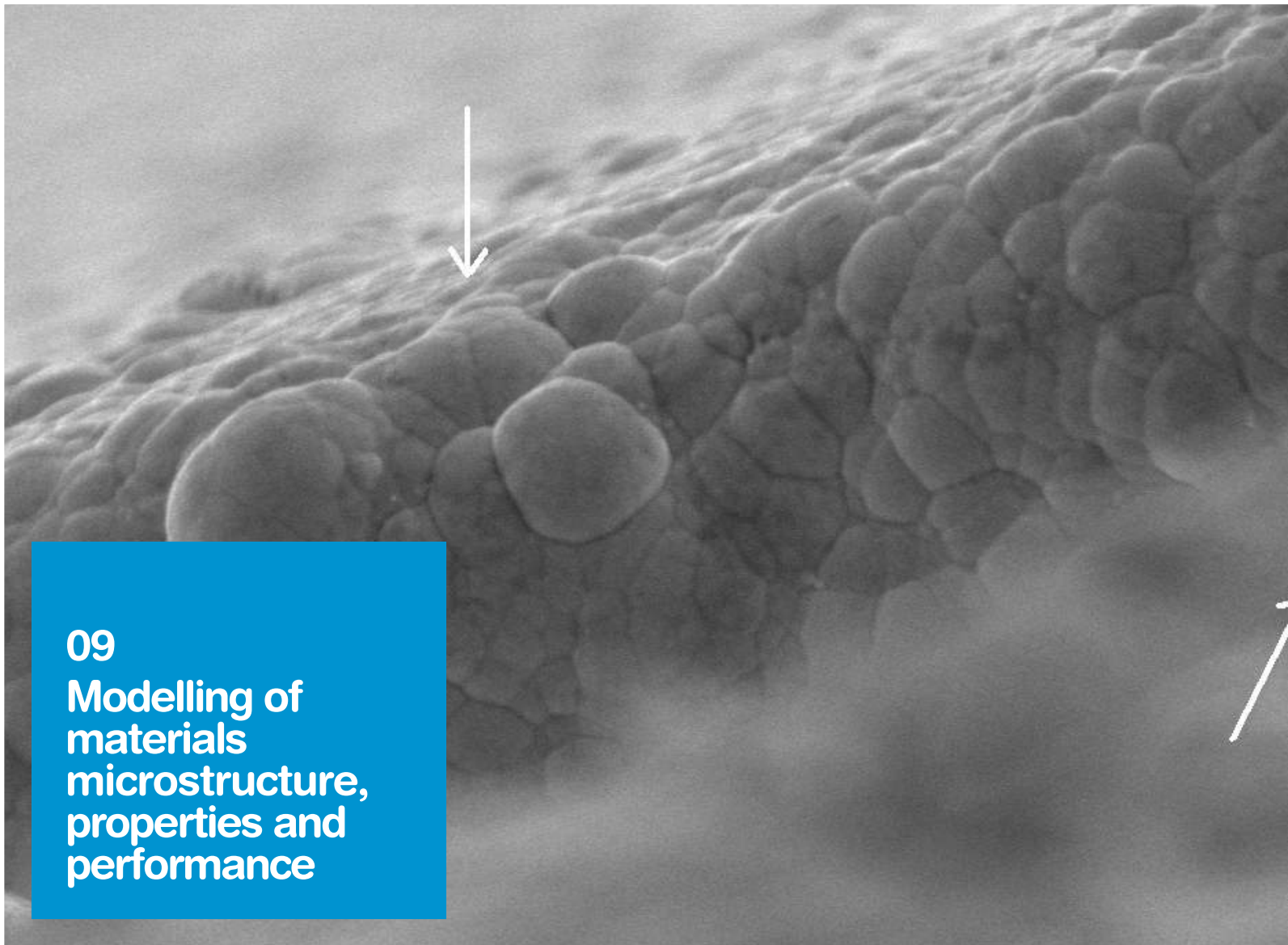


We offer the joining technology for, e.g.:

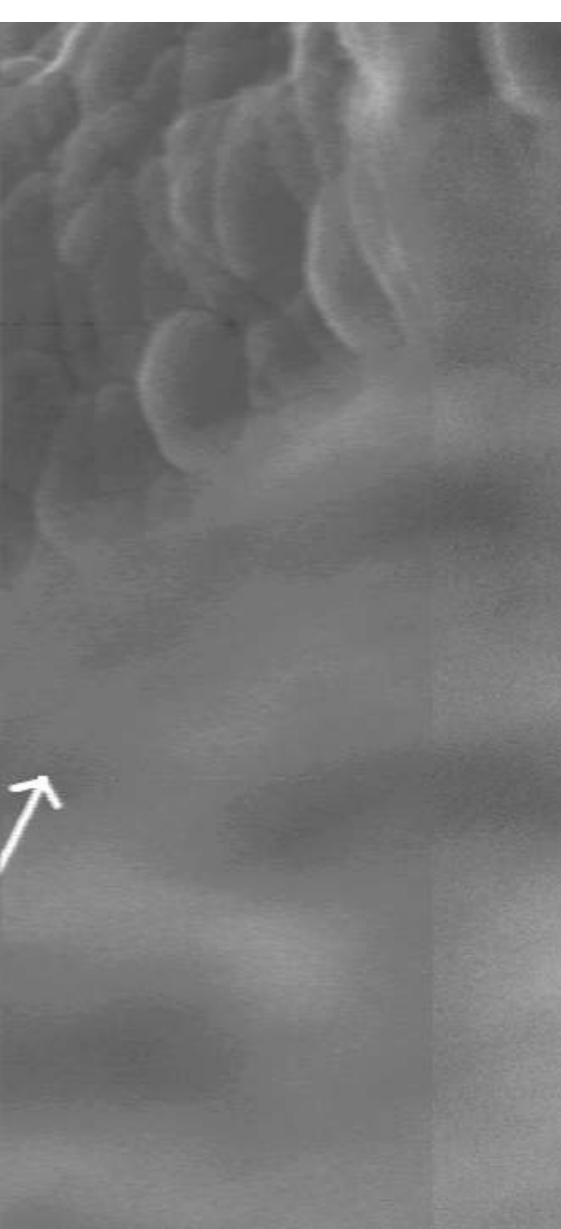
- › High temperature steels
- › Ti, Zr and their alloys.
- › Refractory metals (W, Re-W, Mo, Ti-Zr-Mo (TZM), Nb).
- › Intermetallics (Ni-Al, Fe-Al, Mo-Si, Ti-B).
- › Oxide ceramics (Al_2O_3 , ZrO_2).
- › Nitride ceramics (AlN , BN , Si_3N_4).
- › Carbide (SiC , B_4C , ZrC , WC).
- › Graphite.
- › Glass (borosilicate, silica).
- › Composites (SiC-Cu , C-C , $\text{Al}_2\text{O}_3\text{-Al}$, $\text{Al}_2\text{O}_3\text{-Cr}$, $\text{Al}_2\text{O}_3\text{-Cu}$, $\text{Al}_2\text{O}_3\text{-Mo}$, $\text{Al}_2\text{O}_3\text{-ZrO}_2$, $\text{Ni/Al-Al}_2\text{O}_3$, $\text{Fe/Al-Al}_2\text{O}_3$).

Using:

- › Brazing (e.g. torch-, furnace-, induction-, dip-, ultrasonic and laser- or electron-beam for precision assemblies).
- › Self-propagating high-temperature synthesis SHS (e.g. for refractory metals, ceramics or intermetallics).
- › Active brazing.
- › Soldering (resistance-, torch-, wave-, ultrasonic-, induction-, dip-).
- › Diffusion bonding.
- › Friction welding.
- › Micro welding.
- › Stir welding.
- › We also produce welding consumables (metal cored wires, flux cored wires, laser sealed cored wires).



09
**Modelling of
materials
microstructure,
properties and
performance**



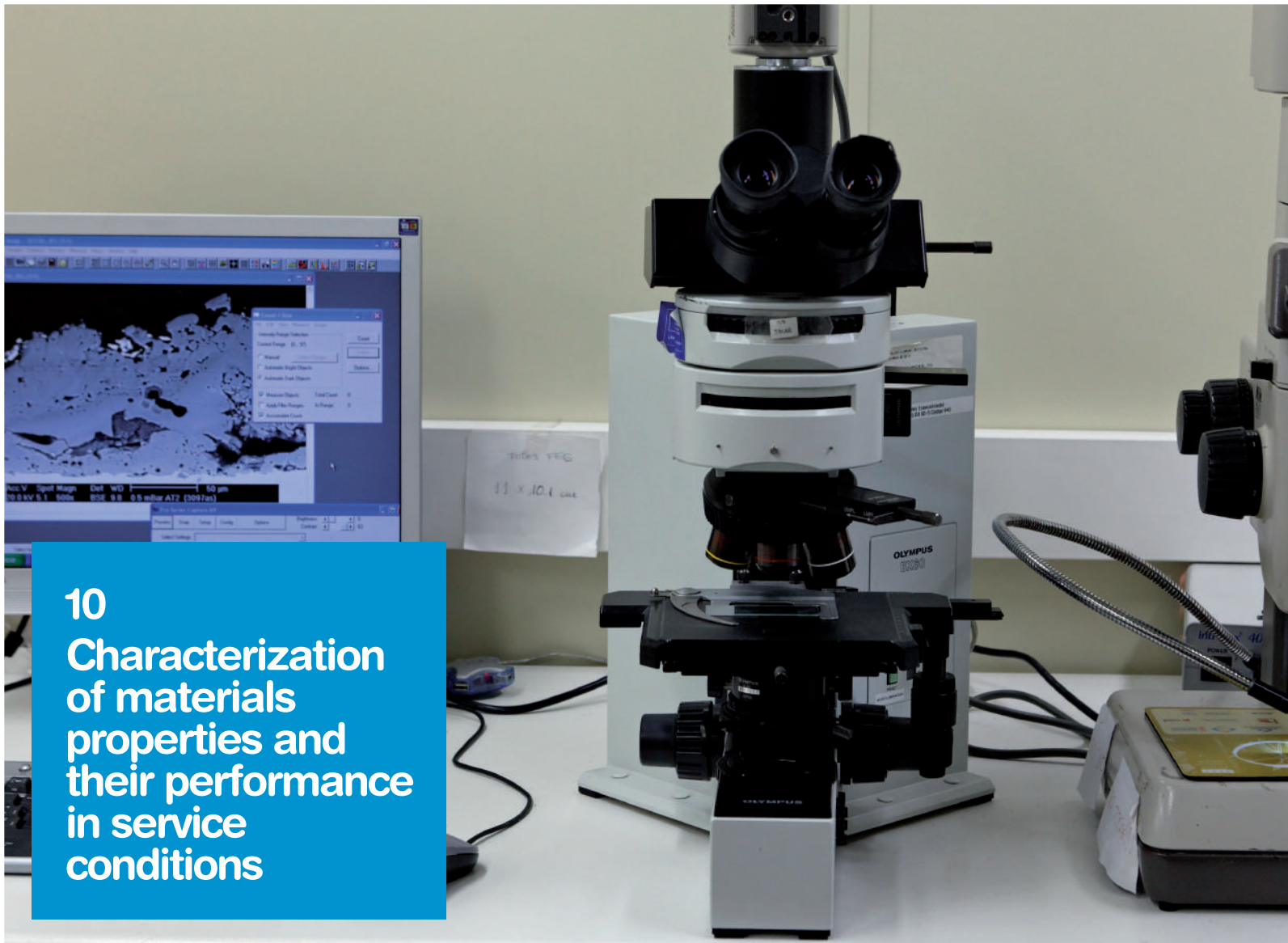
KMM-VIN members have considerable expertise in modelling of:

- › Materials design through atomistic approach and ab initio methods.
- › Microstructure by optimisation methods to arrive at required material properties.
- › Effective thermoelastic and transport properties of complex materials using effective continua/feld methods and multiscale approaches with advanced numerical simulations.
- › Microcracking during processing (e.g. due to cooling of a two- or multi-phase material) through numerical methods using voxel simulations of the computer micro-tomography (micro-CT) images of real microstructures.

For materials performance under real working conditions KMM-VIN subconsortia can provide:

- › Novel constitutive and numerical modelling of deformation response.
- › Models of damage and wear development.
- › Modelling of oxidation and corrosion in chemically aggressive environment.
- › Models of ultimate failure modes in structural elements.
- › Models of fatigue of graded systems under cyclic thermal and mechanical loads.
- › Lifetime predictions for advanced materials under such service conditions.
- › Simulation of layer delamination and cracking via the cohesive zone model.
- › Computational modelling of residual stresses by nonlinear finite elements coupled with atomistic models with use of the 3D images of the material microstructure via advanced electron microscopy techniques and computed micro-CT.

10 Characterization of materials properties and their performance in service conditions





We offer state-of-the-art characterization techniques to investigate:

- › Materials macro-, micro- and nanostructure:
SEM, TEM, EDS, XRD, EDAX, MICRO-CT; measurements of zeta potential of the submicrometer and nanometer powder particles in water suspensions; viscosity; pore size distribution in powder compacts.
- › Materials physical and mechanical properties, e.g.:
Density, thermal expansion, conductivity.
Internal friction, interfacial shear strength (push in and pull out tests).
Elastic moduli, micro- and nanohardness.
Tensile-, impact- and bending strength. Creep (up to 1150°C), creep-fatigue, creep crack growth (CCG).
Fracture toughness and other fracture parameters. Fatigue, low and high cycle fatigue (LCF-HCF), fatigue crack growth (FCG).

We also offer advanced testing of materials resistance to:

- › Aggressive environment.
- › Wear.
- › High temperatures and thermal shocks.
- › Corrosion (hot corrosion - isothermal and high temperature, high temperature erosion-corrosion, salt fog corrosion).
- › Oxidation (steam and air cyclic and isothermal).

As well as:

- › Lifetime fatigue testing in bending, tension, or compression (RT-600°C, in different media).



11

Life-cycle and risk analysis of KMM materials





KMM-VIN offers Life Cycle Assessment (LCA) including:

- › Analysis of the contribution of the life cycle stages to the overall environmental load to prioritize improvements on products or processes.
- › Comparison between products for internal or external communications.

Two main ISO standards are used, i.e. ISO:2006 14040 and ISO:2006 14044. The LCA consist of four main steps:

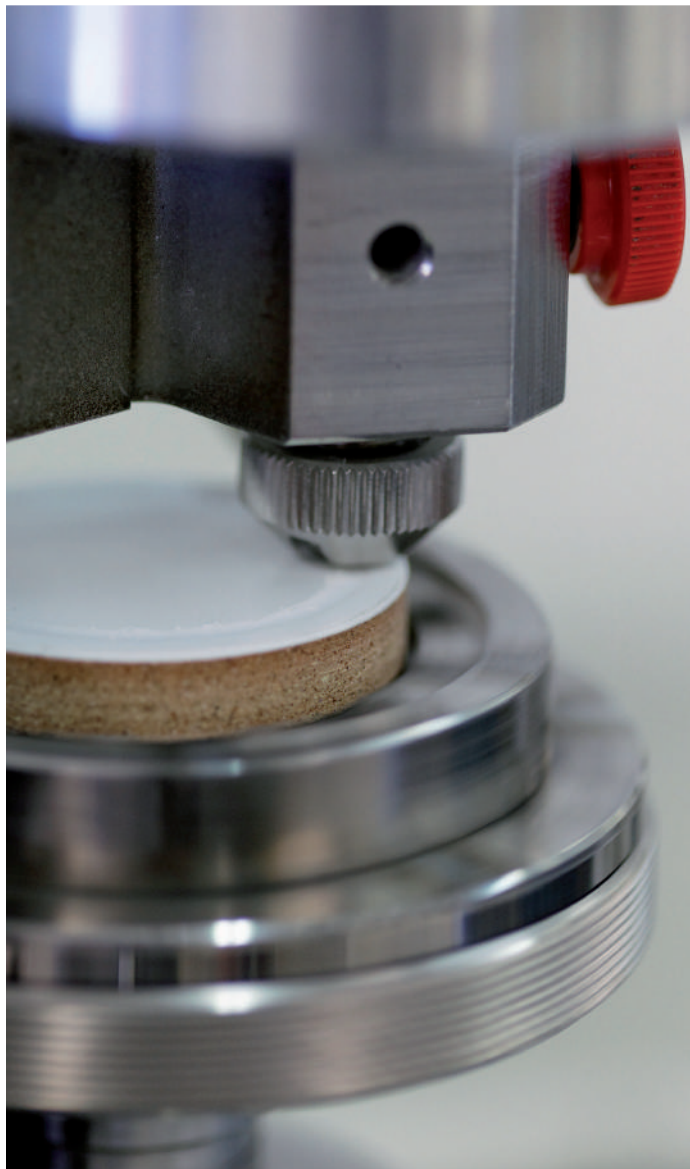
1. Defining the goal and scope of the study.
2. Making a model of the product life cycle with all the environmental inflows and outflows (life cycle inventory, LCI stage).
3. Understanding the environmental relevance of all the inflows and outflows (life cycle impact assessment, LCIA stage).
4. Interpretation of the results.

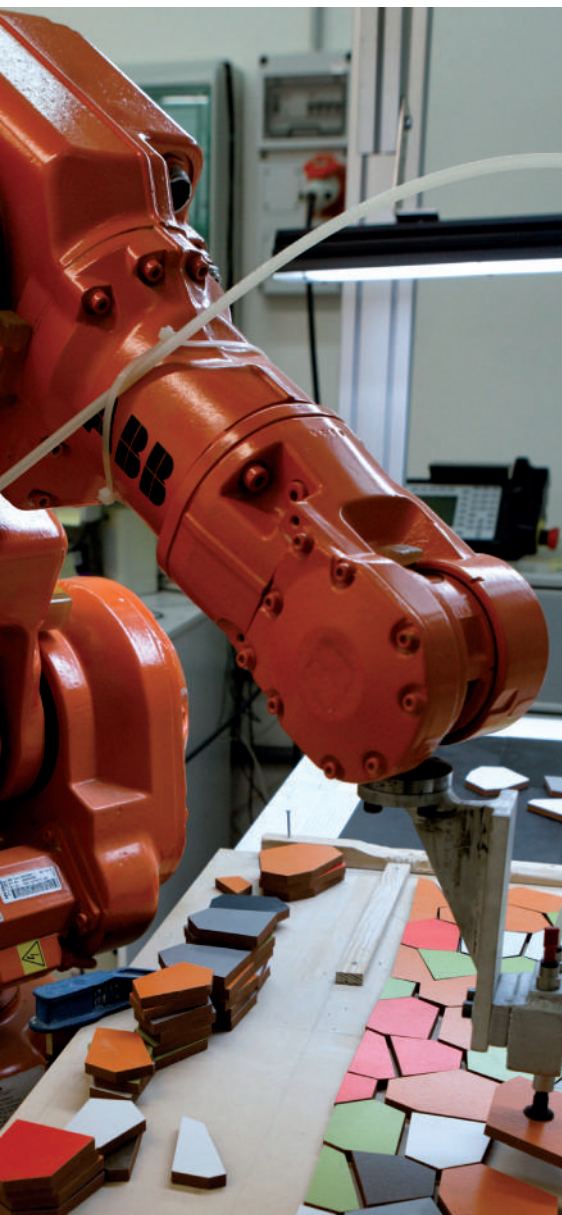
KMM-VIN offers analysis of multiple aspects of risks, risk engineering and risk management appearing in:

- › Structural and advanced materials technologies.
- › Power plants and energy supply.
- › Petro-chemical and process plants.

Main aspects of risks dealt with are:

- › Risks in/of innovation (e.g. risks of unexpected side-effects).
- › Risk of non-performance or performance below expectations (e.g. risks of system or component failures).
- › Risk of adverse/unexpected effects and impacts (e.g. on public health and/or environment).
- › Risks over the life-cycle of products and technologies (e.g. unexpected problems in decommissioning or recycling phase).
- › Project risks, especially in innovation, R&D and new technologies oriented projects.





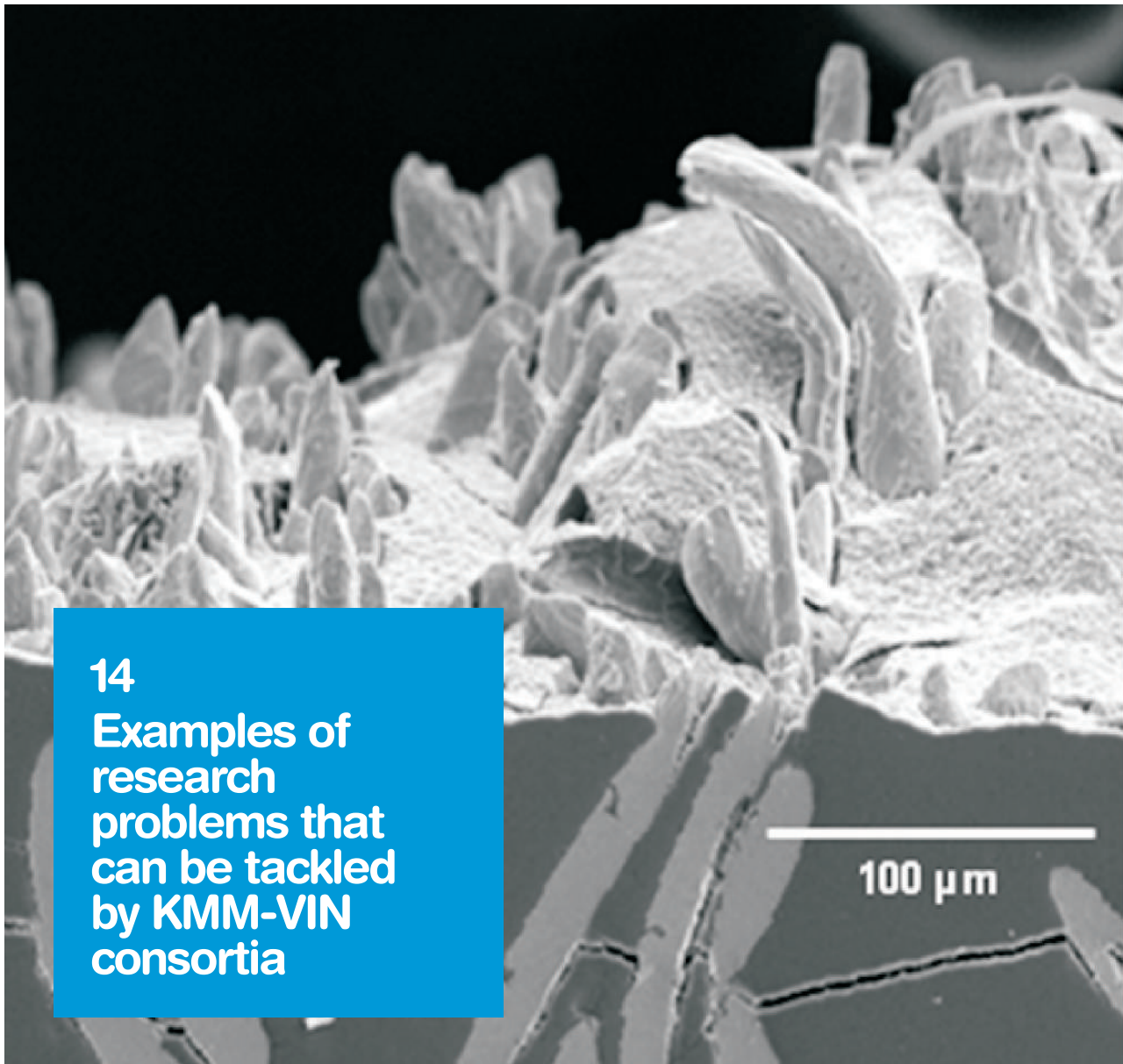
We offer for external clients from industry, SMEs and academia a transnational access to specialized research infrastructure owned by KMM-VIN members. The access can be made available to external clients either in person (“hands on”) or through remote services by KMM-VIN members. If you need to conduct specialized tests on your material samples or specific processing methods to obtain laboratory samples of an advanced structural or functional material, the office@kmm-vin.eu is the right address to use. The terms and conditions of an access to the relevant infrastructure will be determined via KMM-VIN office with the KMM-VIN member who owns the infrastructure.

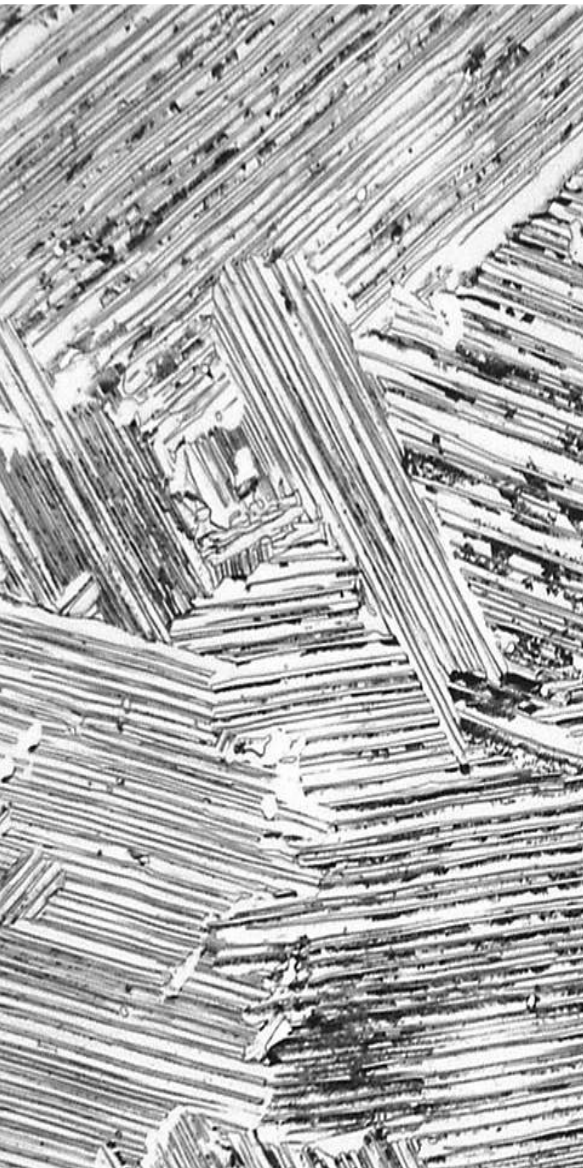




We offer the so-called “Ask KMM-VIN” service which is a direct line to expert help from KMM-VIN members on specific technical questions. This service is a one-stop-shop for any of the technology required to meet an R&D need in the KMM area. Simply submit your enquiry, in confidence, using a box on www.kmm-vin.eu and we will direct it to relevant KMM-VIN experts, resources and facilities.

14
Examples of
research
problems that
can be tackled
by KMM-VIN
consortia





- › Development of **low cost** metal-matrix composites and production routes.
- › Development of new reliable metal-matrix and ceramic-matrix composites with **high ductility**, toughness and corrosion resistance.
- › Modelling of **sintering** / microstructure development.
- › Development of intermetallic materials for high speed vehicles engines through **weight reduction**.
- › Development of nano/micro-structured biomaterials through integrated closed-loop '**processing-characterization-modelling**'.
- › Development of composites and FGMs with **intermetallics as matrix** materials.
- › Development of composites involving **phase change materials** for latent heat storage.
- › Development of **multilayer technology** for new **piezoceramics** for high temperature applications.
- › Development of **reliable characterisation methods** for advanced composite materials and FGMs.
- › Development of innovative **ferritic-martensitic steels** for steam power plants.

A woman with long brown hair and glasses, wearing a green sleeveless dress, is standing in a library. She is holding an open book and looking down at it. The library has dark wooden shelves filled with many books. The books are of various colors and sizes, some standing upright and some lying flat. The woman is positioned in the center-right of the frame, and the shelves extend into the background on both sides of her.

15
Examples of
KMM-VIN
educational offer:
Workshops,
courses and
practical trainings



- › Metals, intermetallics, ceramics and glasses.
- › Advanced metal-ceramic composites (bulk or with gradient of chemical composition).
- › Ceramic composite coatings by thermal spraying.
- › Natural fibre composites.
- › Biomaterials.
- › Organic-inorganic hybrid coatings and their applications.
- › Polymer engineering.
- › Non-metallic sealings.
- › Rubber in engineering.
- › Structural adhesives.
- › Joining of materials and coatings.
- › Powder metallurgy.
- › Metal injection moulding.
- › Micro manufacturing.
- › Electrophoretic deposition.
- › Tissue engineering.
- › Mechanical characterization of materials based on non-standard testing/inverse analysis.
- › Residual stress evaluation techniques for metal and ceramic industrial components.
- › Advanced microstructure diagnostics by transmission electron microscopy (TEM) and residual stress measurement.
- › Testing and fracture of composites, fatigue and fracture of elastomers.
- › Fatigue life prediction of critical turboengine components.
- › Inelastic constitutive behavior of metallic materials and structures.
- › Creep-fatigue-oxidation damage and crack propagation of metallic materials.

16 KMM-VIN's involvement in EU projects

KMM-VIN is active in inspiring, writing, participating and coordinating research projects in the EU Framework Programmes. Some recent examples include:

MATRANS (FP7) “Micro and Nanocrystalline Functionally Graded Materials for Transport Applications” (2010-2013), coordinated by KMM-VIN, consortium: 16 partners, EC funding 3.6 M€ (www.kmm-vi.eu/Projects/Matrans).

INNVIN (FP7) “Innovative materials solutions for Transport, Energy and Biomedical sectors by strengthening integration and enhancing research dynamics of KMM-VIN”. A three year CSA project coordinated by KMM-VIN and involving 21 of KMM-VIN members as third parties. The primary objective of INNVIN is to engage the large transnational partnership of KMM-VIN in the process of transforming it into an organization with a more effective strategy towards the industry, which should enhance KMM-VIN's financial viability. KMM-VIN will primarily focus on Transport, Energy and Biomedical sectors as these are the ones where KMM-VIN's expertise has reached a critical mass. This orientation is already reflected in the new structure of KMM-VIN Working Groups.

MatVal (FP7) “Alliance for Materials - A Value Chain Approach to Materials Research and Innovation”, a CSA project involving six European Technology Platforms, large European Materials Societies EMRS and FEMS and KMM-VIN. MatVal is supporting the Alliance for Materials (A4M) in its efforts to create partnership in materials research and innovation along the value chain concept.

INTeg-Risk (FP7) “Early Recognition, Monitoring and Integrated Management of Emerging, New Technologies Related, Risks.” A large 4.5 year project (2008-2013), coordinated by the European Virtual Institute for Integrated Risk Management, KMM-VIN grouping comprising itself and IPPT, IMRSAS, IMIM, MCL is a project partner (<http://integrisk.eu-vri.eu>).

MUST (FP7) „Multi Level Protection of Materials for Vehicles by Smart Nanocontainers”, a large cooperative R&D project (2008-2012) coordinated by EADS Germany, consortium of 20 partners including KMM-VIN itself and its core member BioIRC (<http://www.sintef.no/Projectweb/MUST>).

17

Interested in KMM-VIN offerings or membership?

The KMM-VIN's offer to industry and public sector is a one-stop-shop for any of the technology they may require to meet and R&D need in the KMM area. By coming to KMM Office the clients will find a multitude of technology, equipment, know-how throughout Europe. KMM-VIN can form research consortia of complementary expertise to solve in an comprehensive manner the technical problems appearing in industrial applications.

For any questions or placing research/ service order or becoming a member of KMM-VIN please contact KMM-VIN staff in any of the two offices:

KMM-VIN Main Office
rue du Trône 98
1050 Brussels, Belgium
Phone: +32 2 21 341 60
Fax : +32 2 79 155 36
E-mail : office@kmm-vin.eu

KMM-VIN Remote Office c/o IPPT PAN
Pawinskiego 5 B
02-106 Warsaw, Poland
Phone: +48 22 826 2522
Fax: +32 2 79 155 36
E-mail: office@kmm-vin.eu

18 KMM-VIN Partnership CORE MEMBERS

AGH-UST
AITEX
BioIRC
CIDETEC

CISM-Lab
CUT
DPS
EMINATE
FRAUNHOFER

IFAM
IFAM-DD
IWM
IMBAS
IMIM
IMRSAS
IMZ
INTA
IOD
IPM
IPPT

IS
ITC
ITME
MCL
ONERA
POLIMI
POLITO
RITECH
TECNALIA
TUD
TUG
TUW
UH
UNIPAD
UNIVPM
UPM
WRUT
WUT

AGH University of Science and Technology, Cracow, Poland
Textile Research Institute, Alcoy-Alicante, Spain
Bioengineering Research and Developing Centre, Kragujevac, Serbia
Fundación CIDETEC (Centre for Electrochemical Technologies),
Donostia/San Sebastián, Spain
Centro Internazionale di Scienze Meccaniche Spin-off, Udine, Italy
Cracow University of Technology, Poland
Doosan Power Systems Ltd, Crawley, UK
Eminate Ltd, Nottingham, UK
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V:
Fraunhofer Institute for Manufacturing and Advanced Materials, Bremen, Germany
Fraunhofer Institute for Manufacturing and Advanced Materials, Dresden, Germany
Fraunhofer Institute for Mechanics of Materials, Freiburg, Germany
Institute of Mechanics, Bulgarian Academy of Sciences, Sofia, Bulgaria
Institute of Metallurgy and Materials Science, Polish Academy of Sciences, Cracow, Poland
Institute of Materials Research, Slovak Academy of Sciences, Kosice, Slovakia
Institute for Ferrous Metallurgy, Gliwice, Poland
Instituto Nacional de Técnica Aeroespacial, Torrejón de Ardoz, Spain
Foundry Research Institute, Cracow, Poland
Institute of Physics of Materials, Brno, Czech Republic
Institute of Fundamental Technological Research, Polish Academy of Sciences,
Warsaw, Poland
Instytut Spawalnictwa, Gliwice, Poland
Instituto de Tecnología Cerámica – AICE, Castellón, Spain
Institute of Electronic Materials Technology, Warsaw, Poland
Materials Centre Leoben, Austria
Office National d'Etudes et de Recherches Aérospatiales, Châtillon, France
Politecnico di Milano, Italy
Politecnico di Torino, Italy
Steinbeis Advanced Risk Technologies GmbH, Stuttgart, Germany
Fundación TECNALIA, Donostia-San Sebastian, Spain
Darmstadt University of Technology, Germany
Graz University of Technology, Austria
Vienna University of Technology, Austria
University of Hertfordshire Higher Education Corporation, Hatfield, Herts, UK
Università degli Studi di Padova, Italy
Università Politecnica delle Marche, Ancona, Italy
Universidad Politécnica de Madrid, Spain
Wroclaw University of Technology, Poland
Warsaw University of Technology, Poland



19

KMM-VIN

Partnership

ASSOCIATE

MEMBERS

ALSTOM
BEG
BSGA
BUDERUS
CRF
CSM
E.ON
ELEMENT
EMPA

ETE
EU-VRI

FAU
GSC
KEMA
LU
MPA
NPLML
SiemensTurbo
SIEMENS
SUT
SSF
SVUM
SWG
SZMF
TUC
TUDD
UCM
V&MD
VAGL
VG TU
VSB
VTT
VZU

Alstom Power Ltd., Rugby, UK
 Böhler Edelstahl GmbH & Co KG, Kapfenberg, Austria
 Böhler Schweißtechnik Austria GmbH, Kapfenberg, Austria
 Buderus Edelstahl GmbH, Wetzlar, Germany
 Centro Ricerche FIAT, Orbassano, Italy
 Centro Sviluppo Materiali S.p.A., Rome, Italy
 E.ON New Build & Technology Ltd., Coventry, UK
 Element Materials Technology Hitchin Ltd, Hertfordshire, UK
 Empa, Swiss Federal Laboratories for Materials Testing and Research, Duebendorf, Switzerland
 Energietechnik Essen GmbH, Essen, Germany
 EU-VRI, European Virtual Institute for Integrated Risk Management, Stuttgart, Germany
 Friedrich-Alexander Universität Erlangen-Nürnberg, Germany
 Goodwin Steel Casting Limited, Hanley, UK
 KEMA Nederland BV, Arnhem, Netherlands
 Loughborough University, UK
 Materialprüfungsanstalt Universität Stuttgart, Germany
 NPL Management Limited, Teddington, UK
 Siemens Industrial Turbomachinery AB, Finspong, Sweden
 Siemens AG, Energy Sector, Mülheim, Germany
 Slovak University of Technology, Trnava, Slovakia
 Saarschmiede GmbH Freiformschmiede, Völklingen, Germany
 SVÚM a.s., Prague, Czech Republic
 Schmiedewerke Gröditz GmbH, Germany
 Salzgitter Mannesmann Forschung GmbH, Duisburg, Germany
 Chemnitz University of Technology, Germany
 Dresden University of Technology, Germany
 Universidad Complutense de Madrid, Spain
 Vallourec & Mannesmann Tubes, V&M Deutschland GmbH, Paris, France
 Voestalpine Giesserei Linz GmbH, Austria
 Vilnius Gediminas Technical University, Lithuania
 Technical University of Ostrava, Czech Republic
 VTT Technical Research Centre of Finland, Espoo, Finland
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