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:

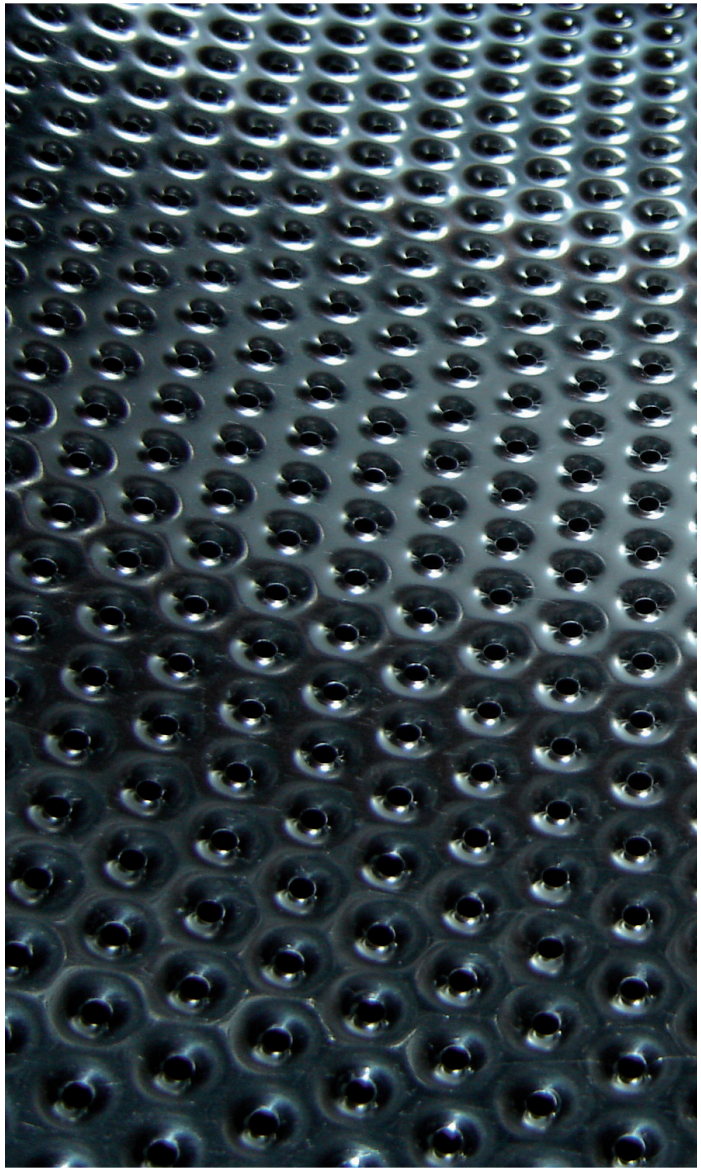
- Design of materials chemical composition, phase composition and structural models.
- Verified and optimised materials technologies.
- Complete characterisation of materials microstructure, properties and performance in service conditions.
- Materials design by modelling of materials composition, properties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

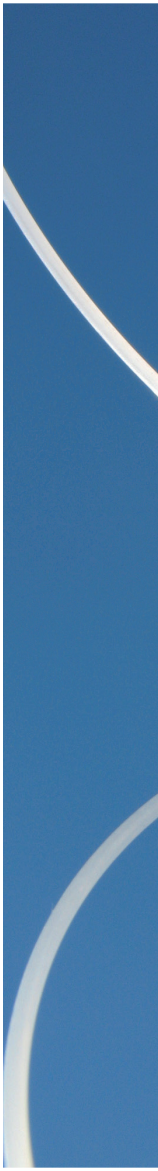
Our core competency lies in the following materials groups (abbreviated as KMM):

- 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).

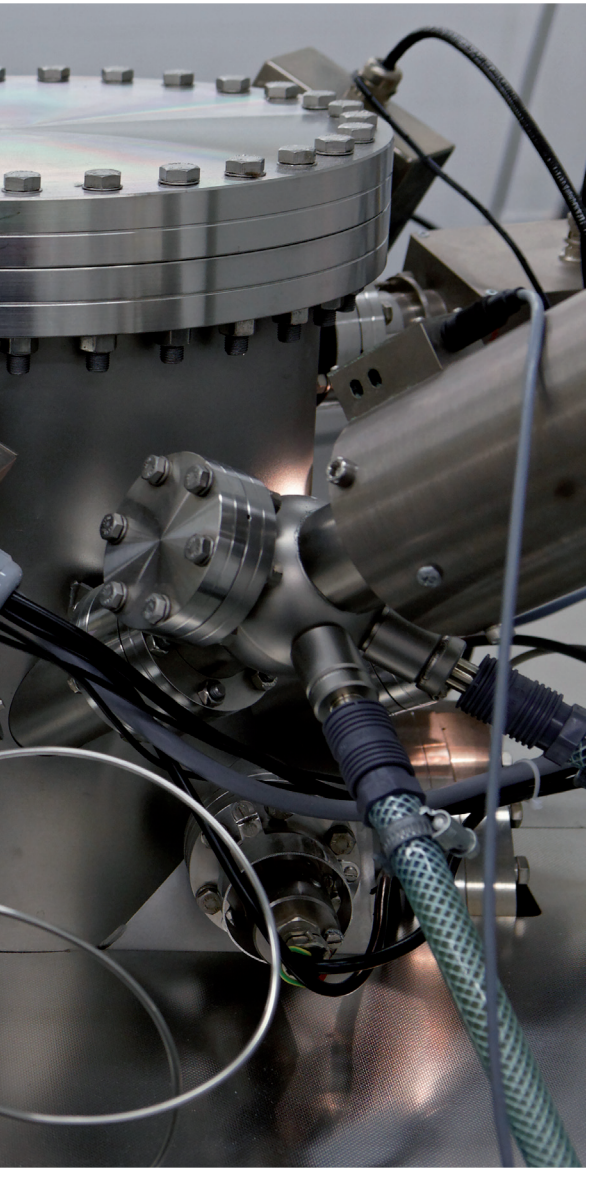
AEROSPACE and AERONAUTICS, (e.g. elements of aeroengines, turbine blades, exhaust systems).

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



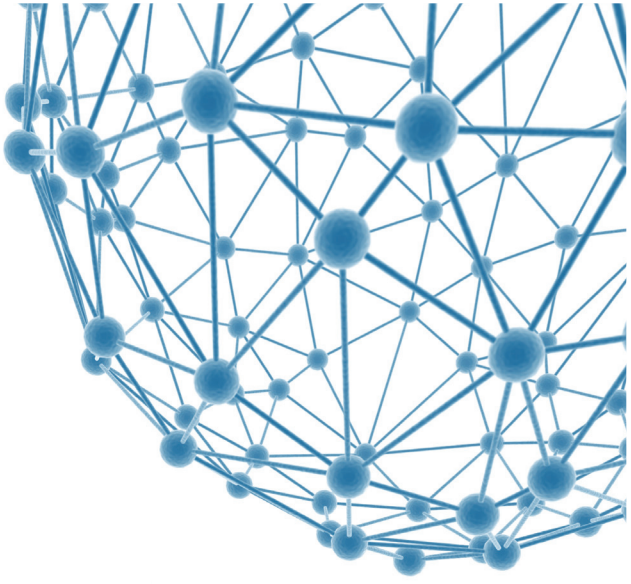
In addition to the broad spectrum of research and services, the KMM-VIN partnership offers specialised workshops, educational trainings and practical courses tailored to the needs of industry sectors, SME's and academia on interested topics from the fields of materials design, processing technologies, 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?

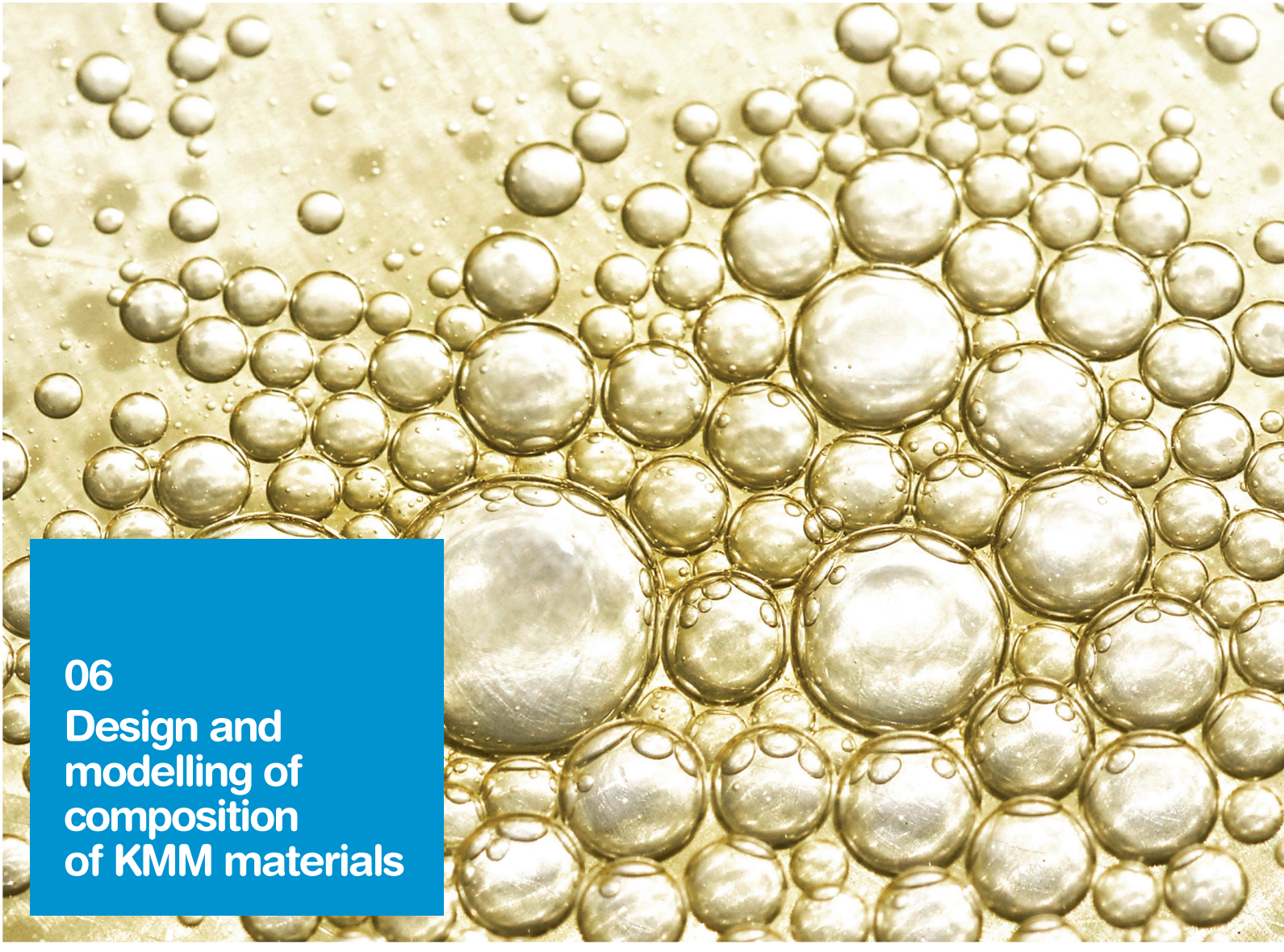
The European Virtual Institute on Knowledge-based Multifunctional Materials AISBL (KMM-VIN) is an international, non-profit organization (AISBL) head-quartered in Brussels and incorporated under Belgian law (entreprise no. 889 462 185).

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 40 core and 27 associate members and is constantly growing.

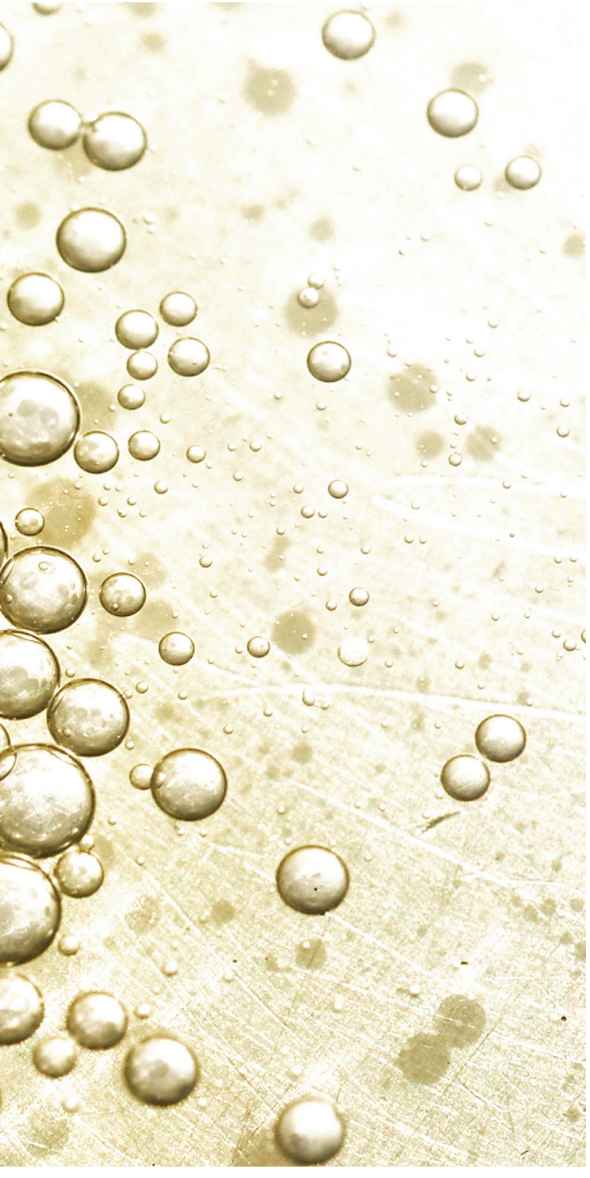
05
KMM-VIN mission



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.



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: Al_2O_3/Cr, Al_2O_3/Cr/Re, Al_2O_3/Mo, ZrO_2/Al, SiC/Cu, AlN/Cu; MMC: Cu/SiC, Al/SiC, Al/TiB_2, Al/Si_3N_4, Al/Al_2O_3, Ti/SiC; CCC: ZrO_2/Al_2O_3, SiC/C_f, SiC/C_p).
- Metal-ceramic functionally graded materials (FGM's - Al_2O_3/Cr, SiC/Cu, AlN/Cu, NiAl/Al_2O_3, FeAl/Al_2O_3, Fe_3 Al/ Al_2O_3.
- Layered materials (ZrO_2/Al_2O_3, Al/TiB_2).
- Coatings (Al/TiB_2, Ti/SiC, WC/Co, Si_3N_4, 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.

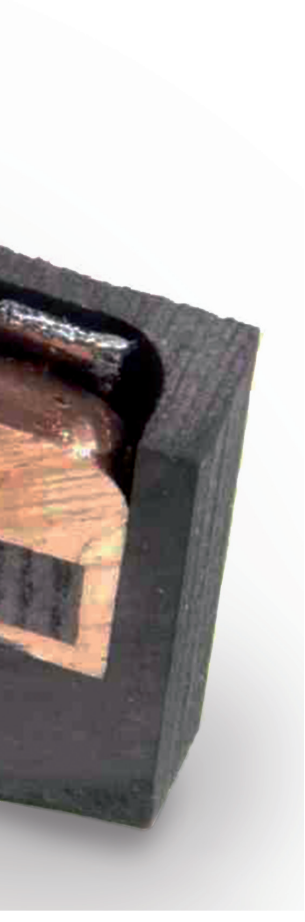
The end products comprise e.g. models of advanced bulk composites or FGMs with specified volume fractions of the constituent phases, the shape, the size and the distribution of the reinforcing phase which may be particles, fibers or interpenetrating networks. For functionally graded composites the respective 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 (Ti_6Al_4V…) 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.**

08
Joining of KMM materials using different bonding techniques

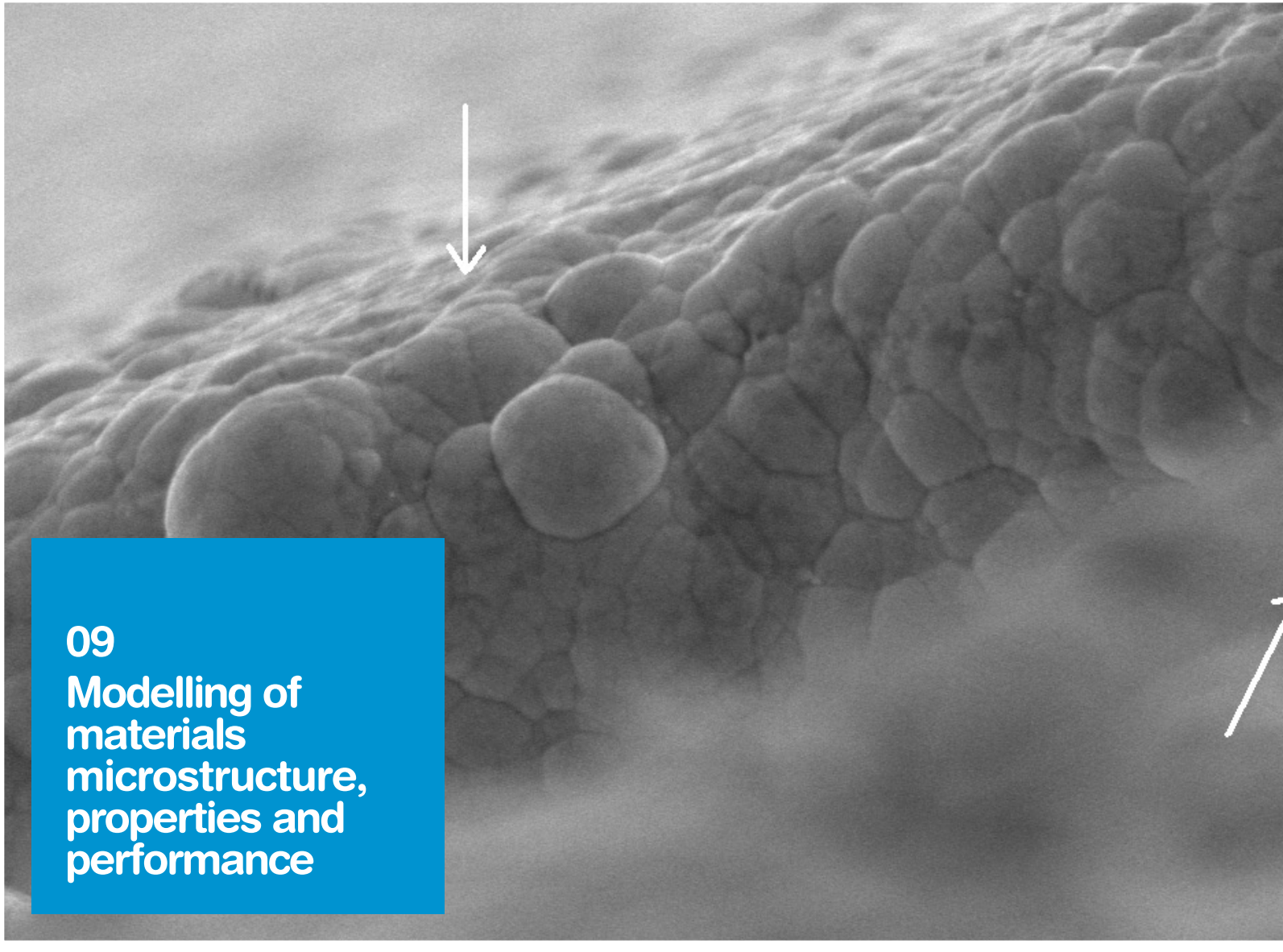


We offer the joining technology for, e.g.:

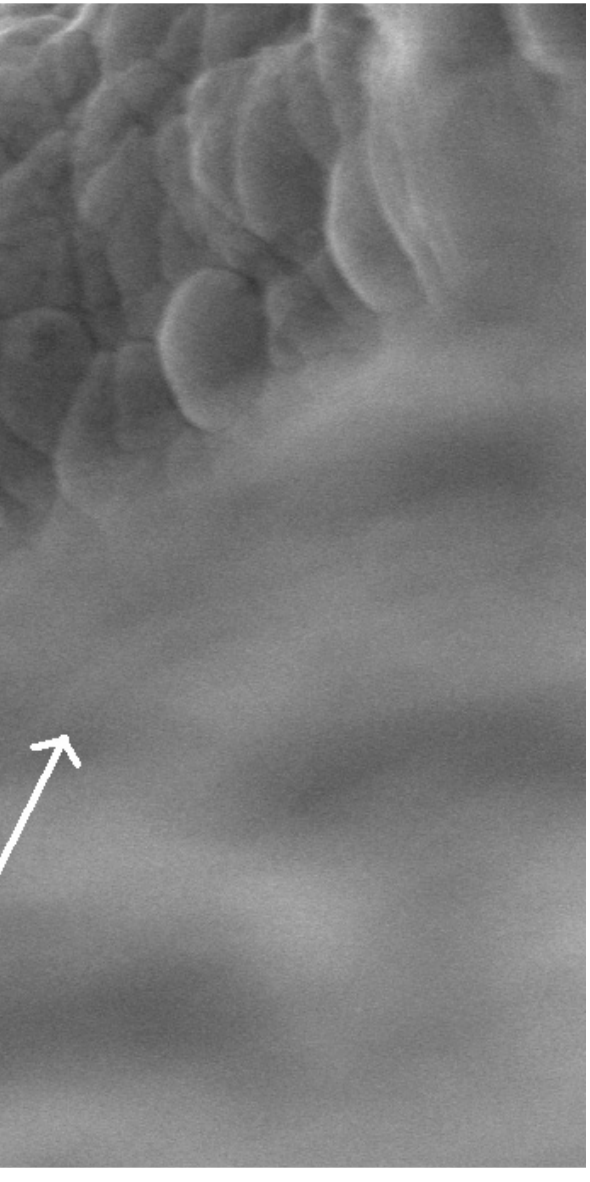
- High temperature steels
- Ti, Zr and their alloys.
- Refractory metals (W, Re-W, Mo, Ti-Zr-Mo (TZM), Nb).
- Intermetallics (Ni-Al, Fe-Al, Mo-Si, Ti-B).
- Oxide ceramics (Al_2O_3, ZrO_2).
- Nitride ceramics (AlN, BN, Si_3N_4).
- Carbide (SiC, B_4C, ZrC, WC).
- Graphite.
- Glass (borosilicate, silica).
- Composites (SiC-Cu, C-C, Al_2O_3-Al, Al_2O_3-Cr, Al_2O_3-Cu, Al_2O_3-Mo, Al_2O_3-ZrO_2, Ni/Al-Al_2O_3, Fe/Al-Al_2O_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

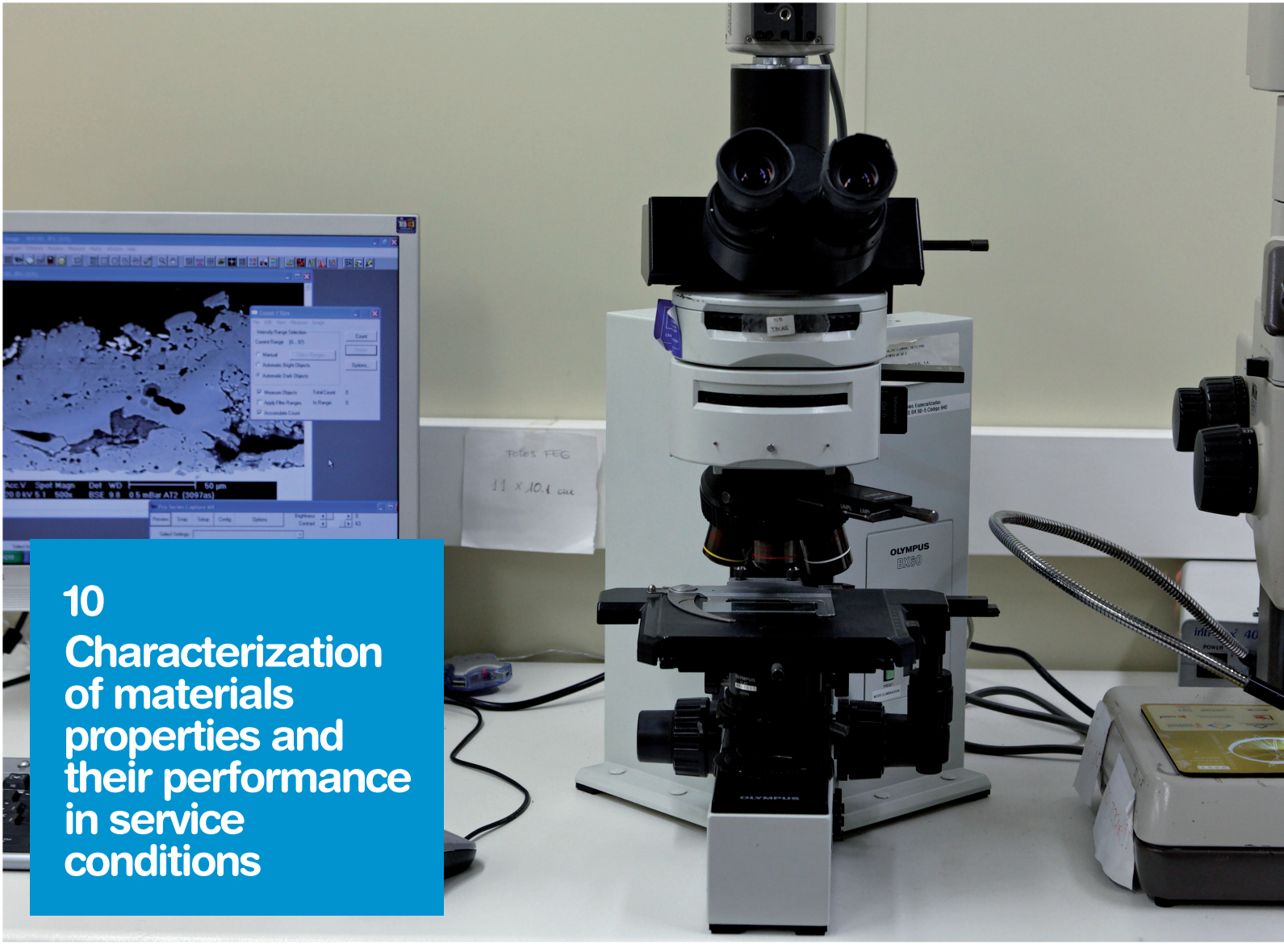


KMM-VIN members have considerable expertise in modelling of:

- 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/field 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 computer 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.

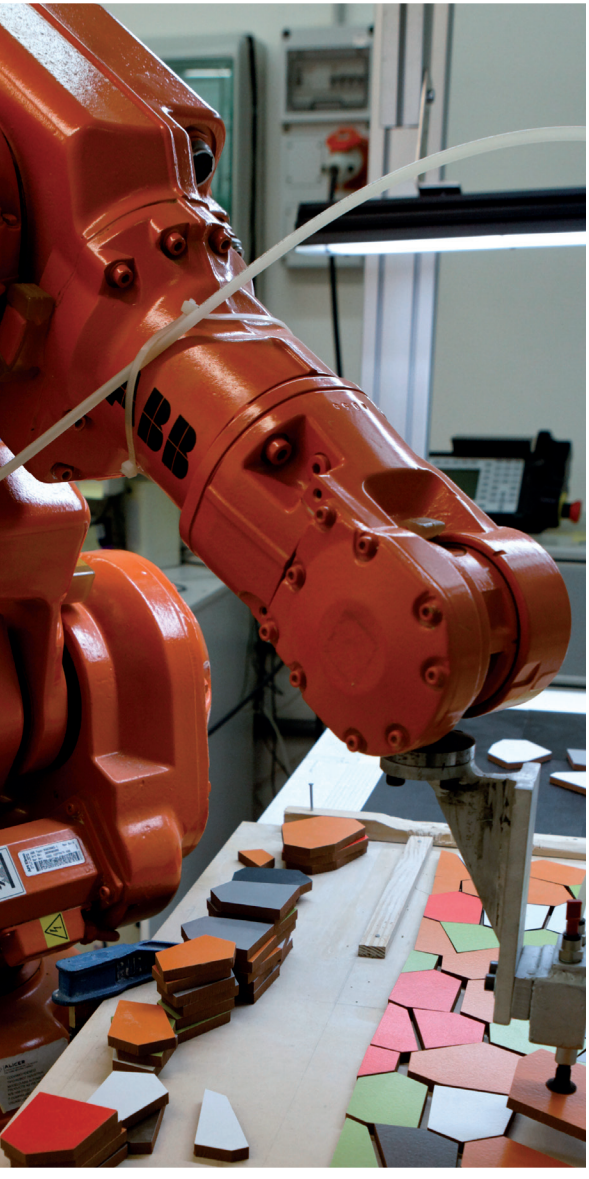
KMM-VIN offers analysis of multiple aspects of risks, risk engineering and risk management appearing in:

- 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.

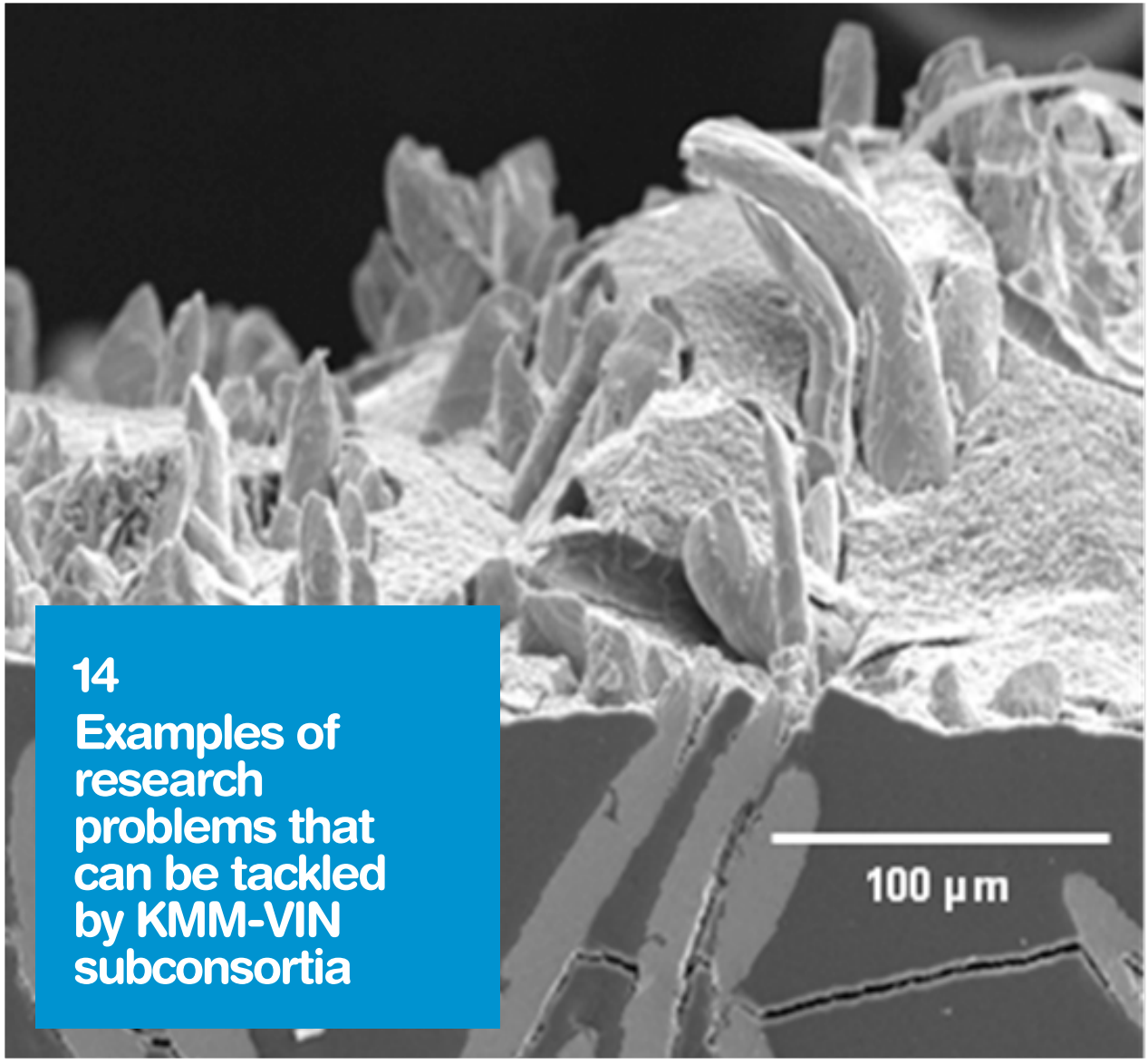
12
Access to KMM-VIN infrastructure and equipment



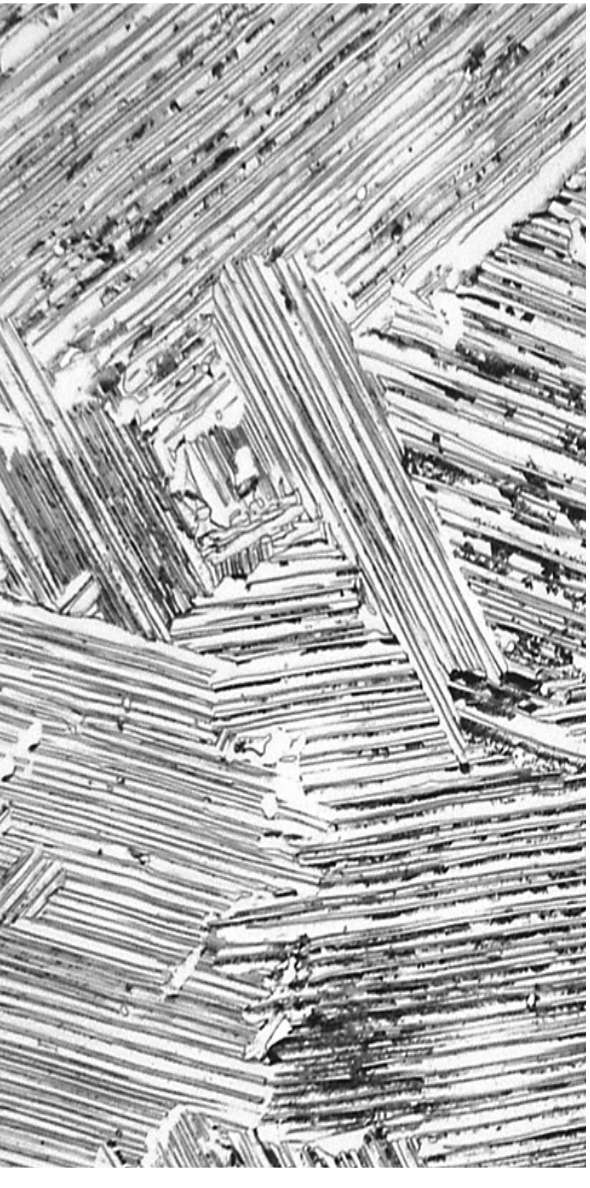
We offer for external clients from industry, SMEs and academia a transnational access to specialized research infrastructure owned by KMM-VIN members. The access can be made available to external clients either in person (“hands on”) or through remote services by KMM-VIN members. If you need to conduct specialized tests on your own 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.

13
Ask KMM-VIN service

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 subconsortia



- 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.

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 (superalloys).

16
KMM-VIN's involvement in R&D projects (EU)

KMM-VIN is active in inspiring, writing, participating and coordinating research projects in the EU 7th Framework Programme. 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.

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?

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 multitiude of technology, equipment, know-how throughout Europe. KMM-VIN can form research sub-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 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	AGH University of Science and Technology, Cracow, Poland
AITEX	Textile Research Institute, Alcoy-Alicante, Spain
BioIRC	Bioengineering Research and Developing Centre, Kragujevac, Serbia
CIDETEC	Fundación CIDETEC (Centre for Electrochemical Technologies), Donostia/San Sebastián, Spain
CISM-Lab	Centro Internazionale di Scienze Meccaniche Spin-off, Udine, Italy
CUT	Cracow University of Technology, Cracow Poland
DPS	Doosan Power Systems Ltd, Crawley, UK
EMINATE	Eminate Ltd, Nottingham, UK
FGH	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V:
FGH-IFAM	Fraunhofer Institute for Manufacturing and Advanced Materials, Bremen, Germany
FGH-IFAM-DD	Fraunhofer Institute for Manufacturing and Advanced Materials, Dresden, Germany
FGH-IWM	Fraunhofer Institute for Mechanics of Materials, Freiburg, Germany
IMBAS	Institute of Mechanics, Bulgarian Academy of Sciences, Sofia, Bulgaria
IMIM	Institute of Metallurgy and Materials Science, Polish Academy of Sciences, Cracow, Poland
IMRSAS	Institute of Materials Research, Slovak Academy of Sciences, Kosice, Slovakia
IMZ	Institute for Ferrous Metallurgy, Gliwice, Poland
INTA	Instituto Nacional de Técnica Aeroespacial, Torrejón de Ardoz, Spain
IOD	Foundry Research Institute, Cracow, Poland
IPM	Institute of Physics of Materials, Brno, Czech Republic
IPPT	Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Poland
IS	Instytut Spawalnictwa, Gliwice, Poland
ITC	Instituto de Tecnología Cerámica – AICE, Castellón, Spain
ITME	Institute of Electronic Materials Technology, Warsaw, Poland
MCL	Materials Centre Leoben, Austria
MERL	Materials Engineering Research Laboratory Ltd, Hitchin, Hertfordshire, UK
ONERA	Office National d'Etudes et de Recherches Aérospatiales, Châtillon, France
POLIMI	Politecnico di Milano, Italy
POLITO	Politecnico di Torino, Italy
RTECH	Steinbeis Advanced Risk Technologies GmbH, Stuttgart, Germany
TECNALIA	Fundación TECNALIA, Donostia-San Sebastian, Spain
TUD	Darmstadt University of Technology, Germany
TUG	Graz University of Technology, Graz, Austria
TUW	Vienna University of Technology, Vienna, Austria
UH	University of Hertfordshire Higher Education Corporation, Hatfield, Herts, UK
UNIPAD	Università degli Studi di Padova, Italy
UNIVPM	Università Politecnica delle Marche, Ancona, Italy
UPM	Universidad Politécnica de Madrid, Madrid, Spain
WRUT	Wroclaw University of Technology, Wroclaw, Poland
WUT	Warsaw University of Technology, Poland

AGH

aitex
textile
research
institute

BioIRC

CiDETEC
lk4 research alliance

CISMLab

PK

DOOSAN

eminate
Innovative solutions for health

Fraunhofer

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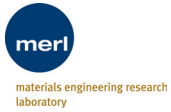
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materials engineering research
laboratory

ONERA
THE FRENCH AEROSPACE LAB

POLITECNICO
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R-Tech

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Inspiring
Business

TECHNISCHE
UNIVERSITÄT
DARMSTADT

CHEMNITZ UNIVERSITY
OF TECHNOLOGY

TU
WIEN
TECHNISCHE
UNIVERSITÄT
WIEN
Vienna University of Technology

UH
University of
Hertfordshire

Università
degli Studi
di Padova

Università Politecnica
delle Marche

Universidad Politécnica
Madrid

19 KMM-VIN Partnership ASSOCIATE MEMBERS

ALSTOM	Alstom Power Ltd., Rugby, UK
BEG	Böhler Edelstahl GmbH & Co KG, Kapfenberg, Austria
BSGA	Böhler Schweißtechnik Austria GmbH, Kapfenberg, Austria
BUDERUS	Buderus Edelstahl GmbH, Wetzlar, Germany
CRF	Centro Ricerche FIAT, Orbassano, Italy
CSM	Centro Sviluppo Materiali S.p.A., Rome, Italy
E.ON	E.ON New Build & Technology Ltd., Coventry , UK
EMPA	Empa, Swiss Federal Laboratories for Materials Testing and Research, Duebendorf, Switzerland
ETE	Energietechnik Essen GmbH, Essen, Germany
EU-VRi	EU-VRi, European Virtual Institute for Integrated Risk Management, Stuttgart, Germany
FAU	Friedrich-Alexander Universität Erlangen-Nürnberg, Erlangen-Nürnberg, Germany
KEMA	KEMA Nederland BV, Arnhem, Netherlands
LU	Loughborough University, Loughborough, UK
MPA	Materialprüfungsanstalt Universität Stuttgart, Stuttgart, Germany
NPLML	NPL Management Limited, Teddington, UK
SiemensTurbo	Siemens Industrial Turbomachinery AB, Finspong, Sweden
SIEMENS	Siemens AG, Energy Sector, Fossil Power Generation Division, Products Dept. Materials, Mülheim, Germany
SSF	Saarschmiede GmbH Freiformschmiede, Völklingen, Germany
SVUM	SVÚM a.s., Prague, Czech Republic
SWG	Schmiedewerke Gröditz GmbH, Gröditz, Germany
SZMF	Salzgitter Mannesmann Forschung GmbH, Duisburg, Germany
TUC	Chemnitz University of Technology, Chemnitz, Germany
V&MD	Vallourec & Mannesmann Tubes, V&M Deutschland GmbH, Düsseldorf, Germany
VAGL	Voestalpine Giesserei Linz GmbH, Linz, Austria
VGTU	Vilnius Gediminas Technical University, Vilnius, Lithuania
VTT	VTT Technical Research Centre of Finland, Espoo, Finland
VZU	Výzkumný a zkušební ústav Plzen s.r.o., Czech Republic

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