KMM.VIN

European Virtual Institute on Knowledge-based Multifunctional Materials AISBL

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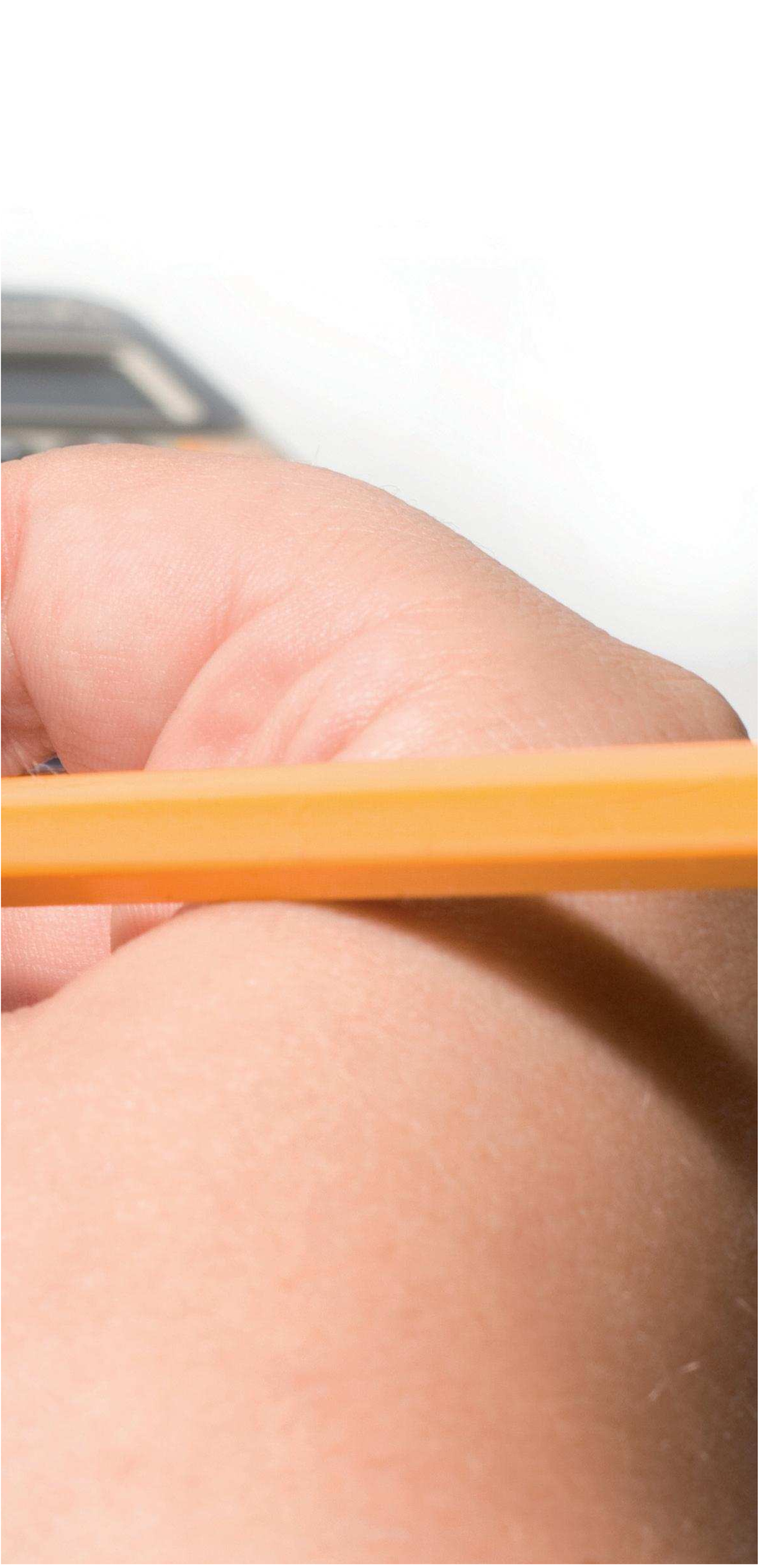
01
What can KMM-VIN offer to industrial customers?



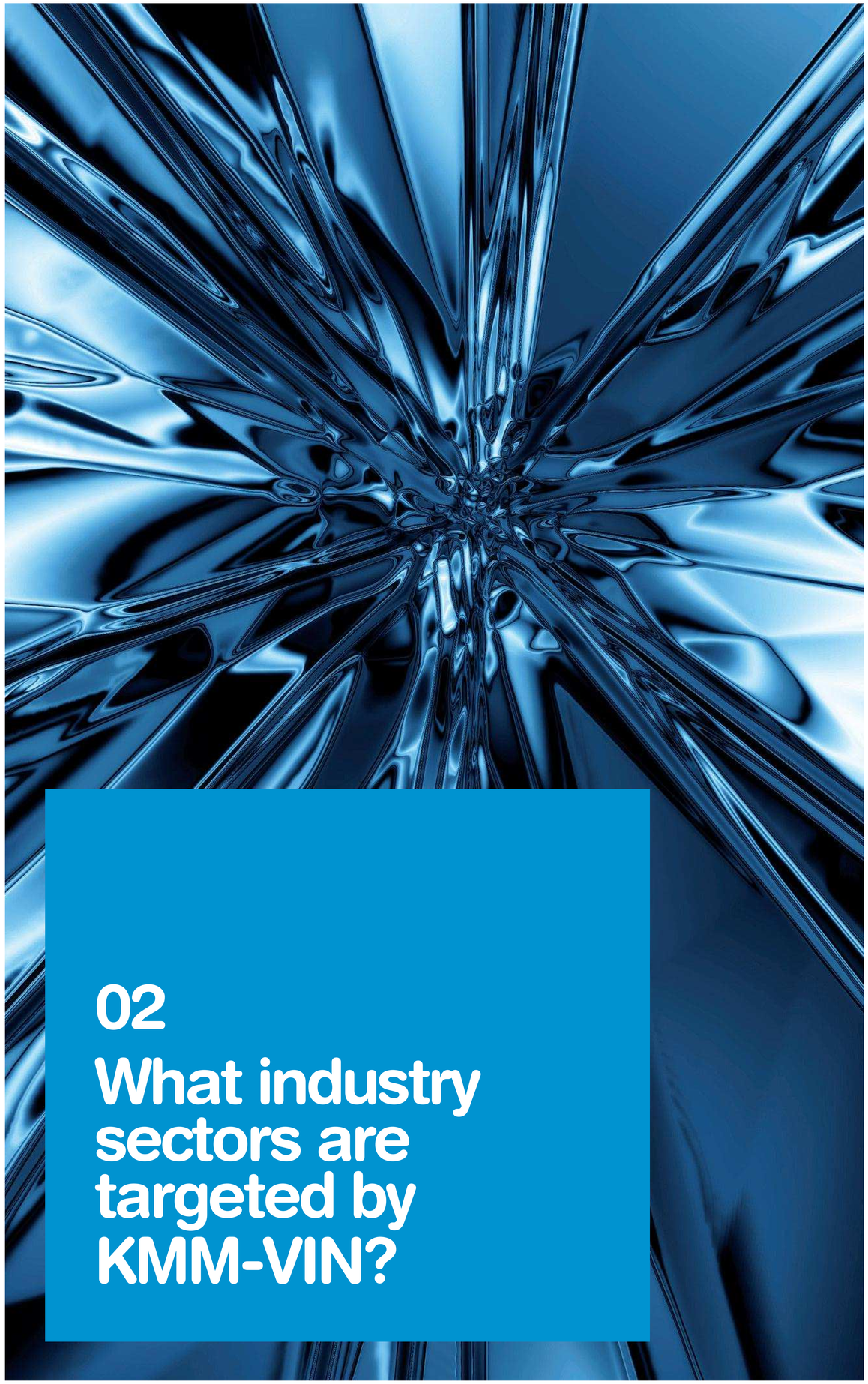
Operating with the most appropriate technology is crucial for every industry sector, and that is especially true for the increasingly sophisticated, knowledge-based engineering materials.

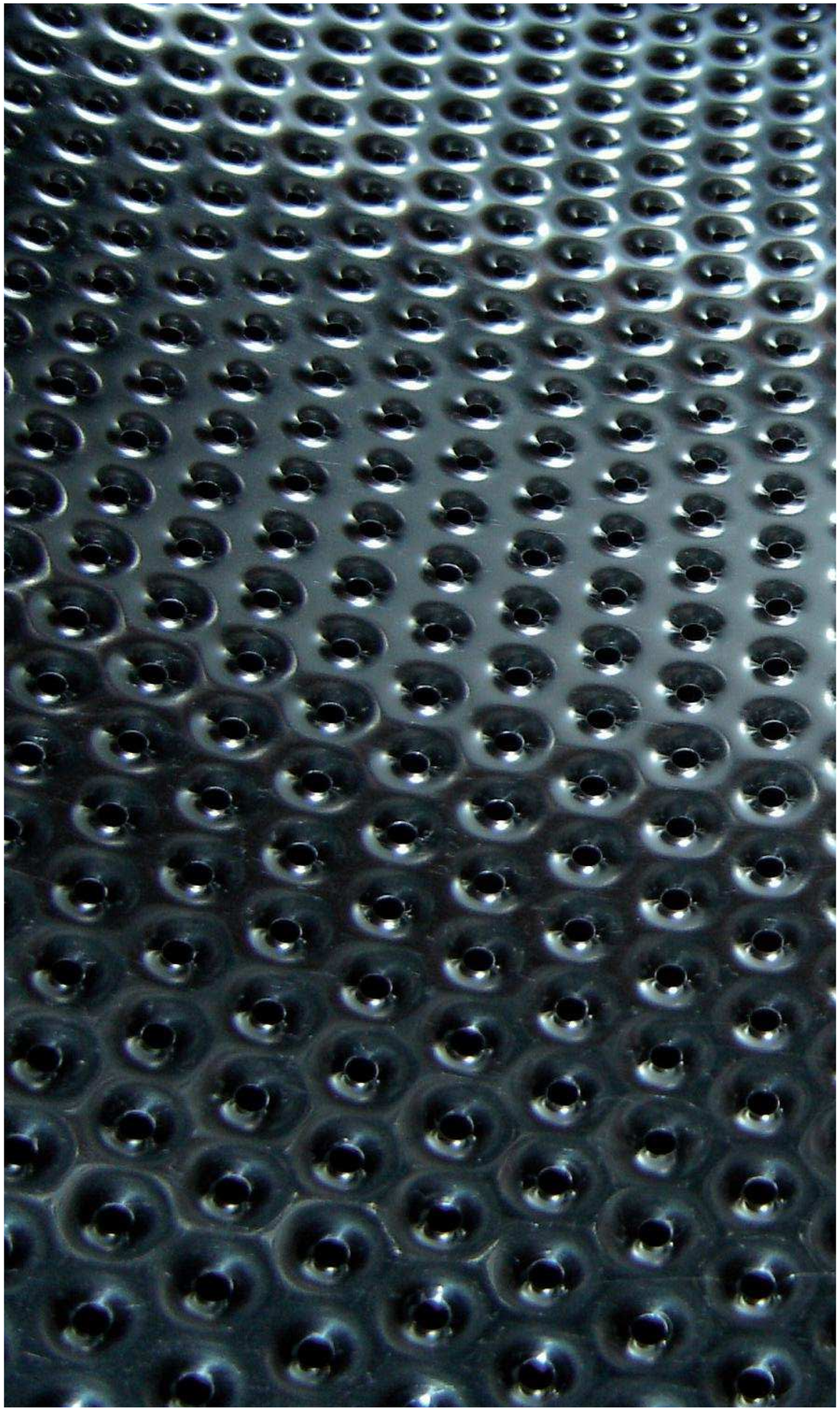
KMM-VIN partnership offers integrated solutions ("from idea to ready product") of new structural and functional materials processed via cutting edge technologies. Our novel integrated solutions comprise:

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.
Modelling of materials properties and behaviour under complex thermomechanical loading conditions and harsh environments.

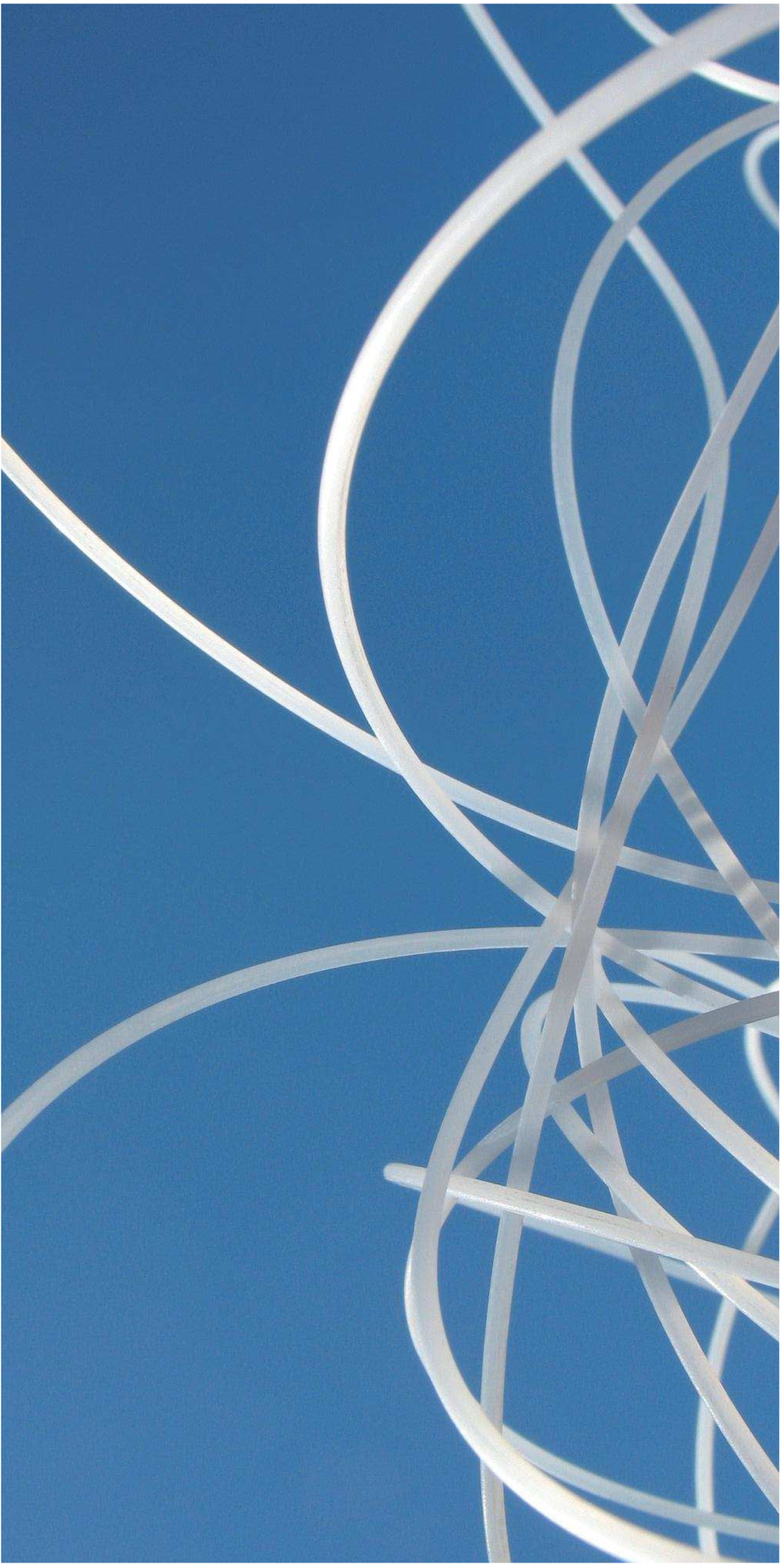
Our core competency lies in the following materials groups (abbreviated as KMM):

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.
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).

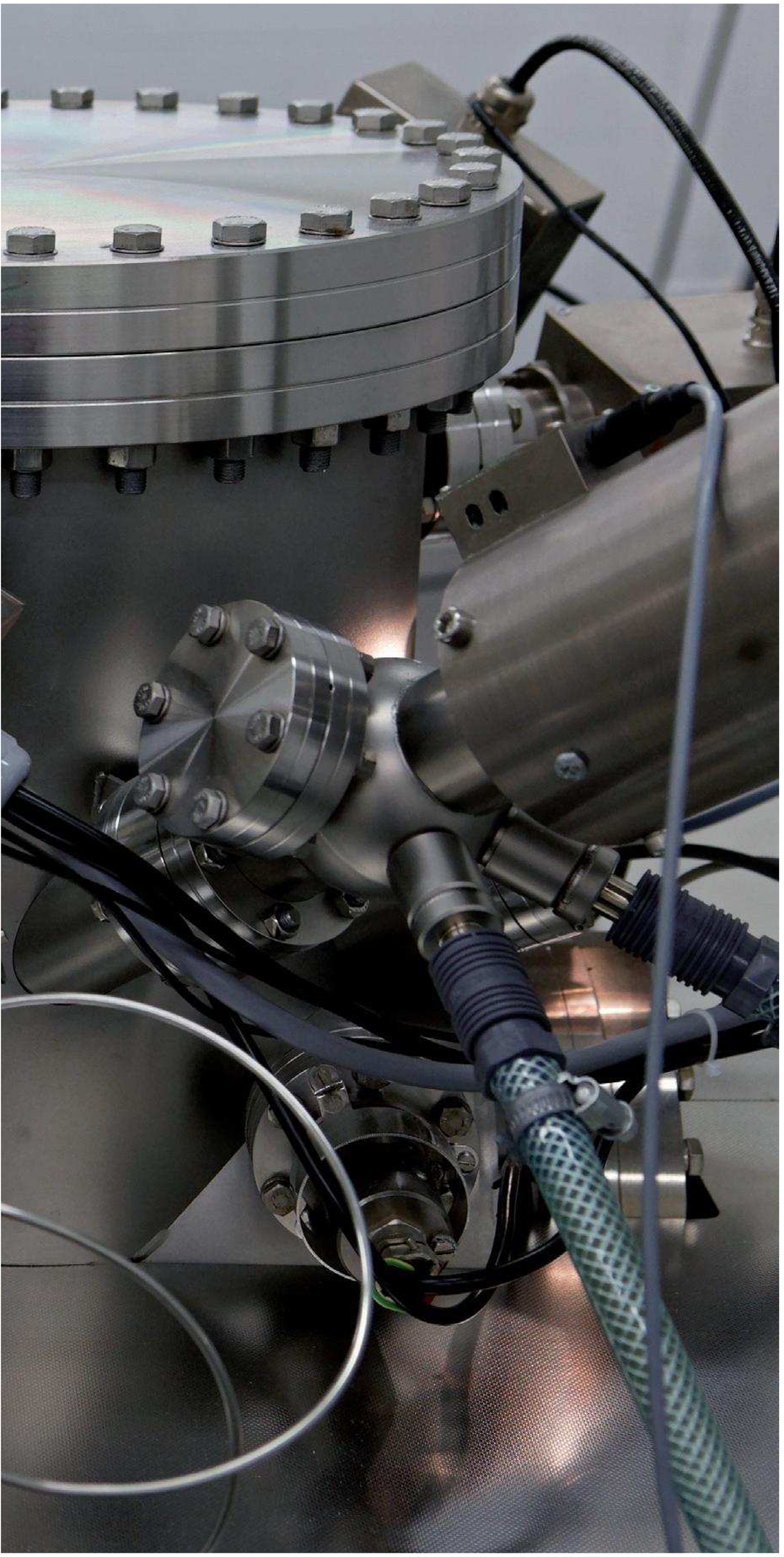
AEROSPACE and AERONAUTICS, (e.g. elements of aeroengines, turbine blades, exhaust systems).

ENERGY, conventional and renewable (e.g. 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



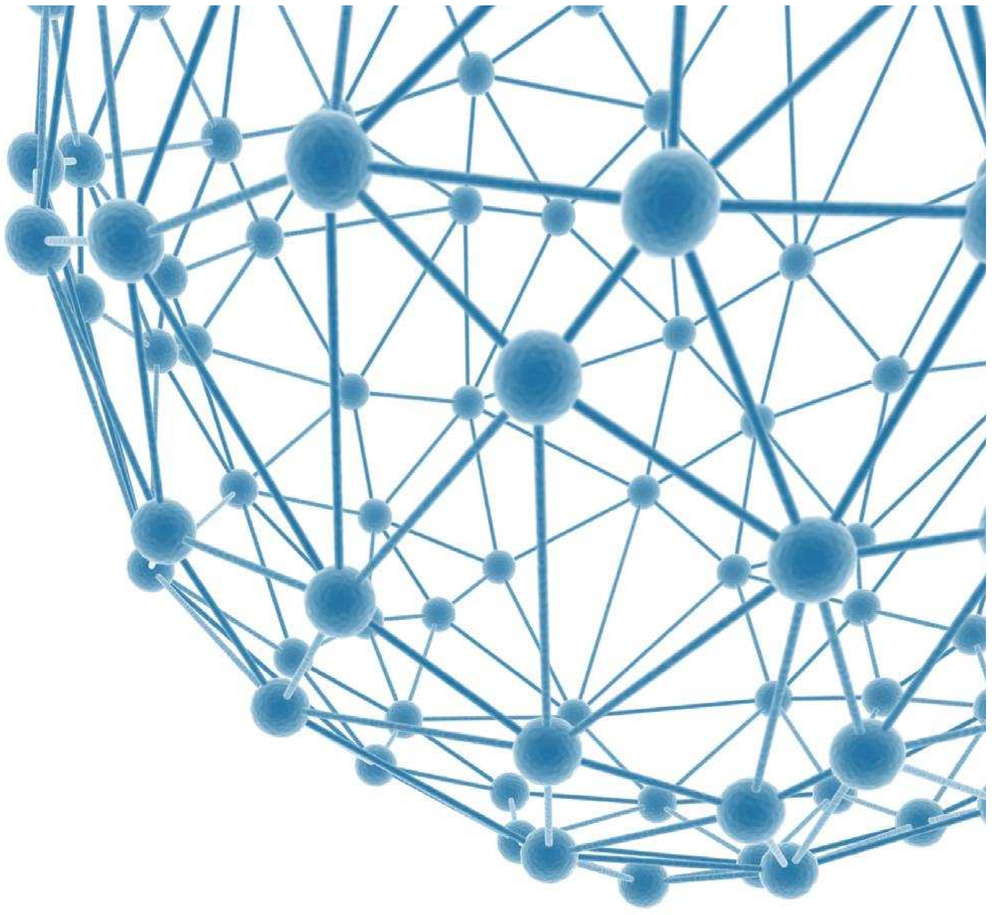
In addition to the broad spectrum of research and services, the KMM-VIN partnership offers specialised workshops, educational trainings and practical courses tailored to the needs of industry sectors, SME's and academia on interested topics from the fields of materials design, processing technologies,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

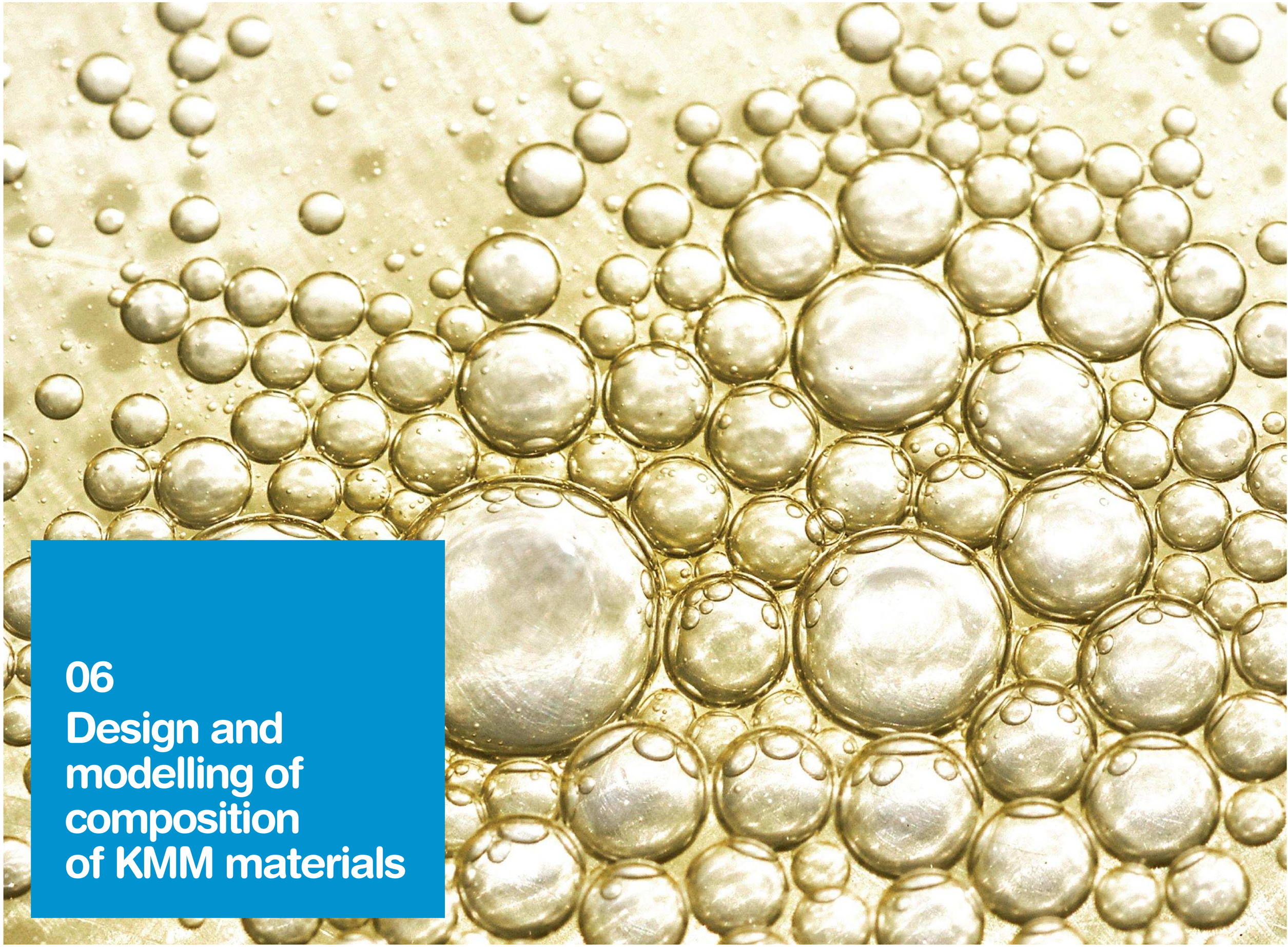
The European Virtual Institute on Knowledge-based Multifunctional Materials AISBL (KMM-VIN) is an international, non-profit organization (AISBL) head-quartered in Brussels and incorporated under Belgian law (entreprise no. 889 462 185).

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.

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

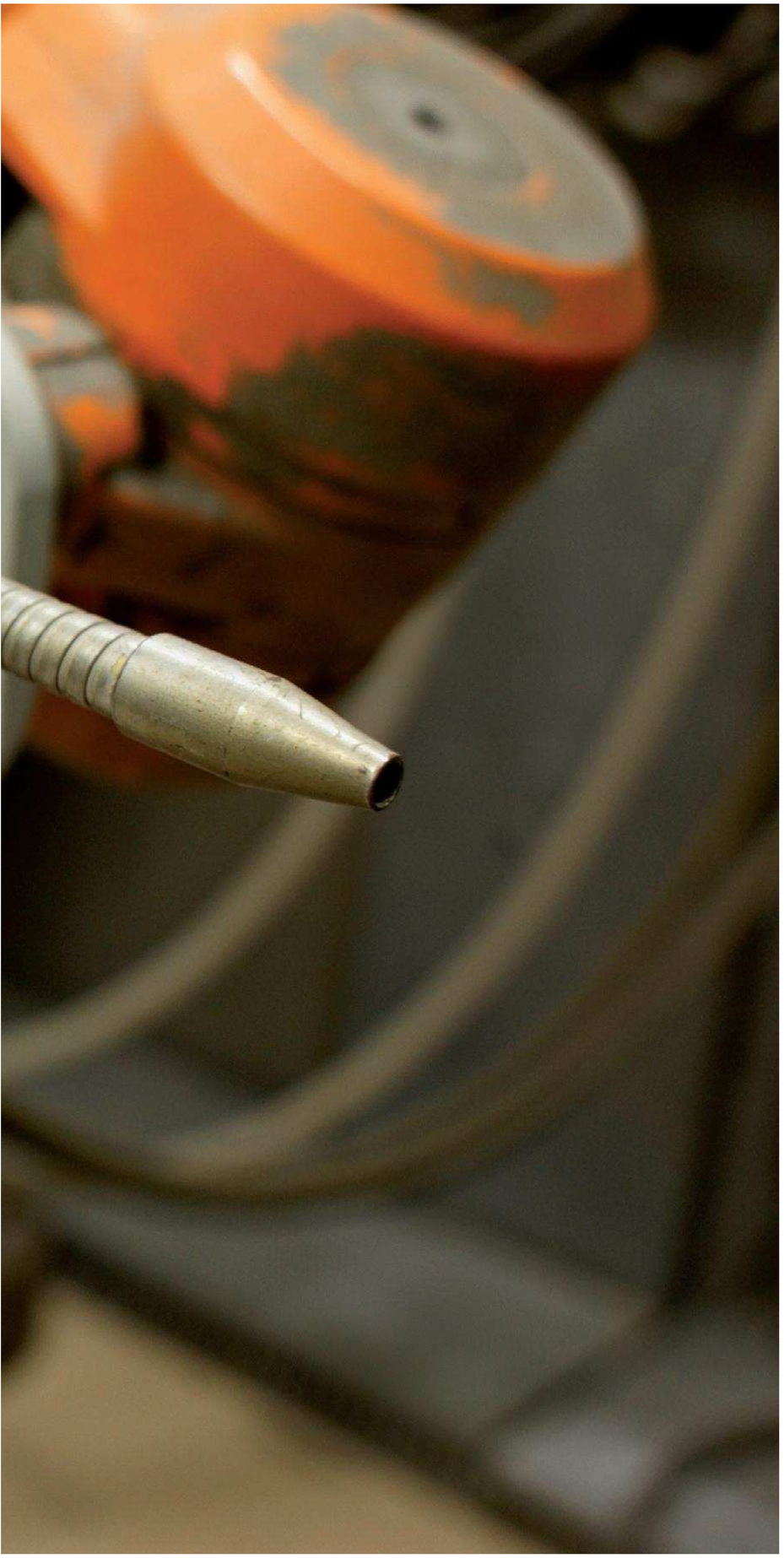
Materials that can be processed by KMM-VIN members include, e.g.:

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/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).
Layered materials (ZrO_2/Al_2O_3, Al/TiB_2).
Coatings (Al/TiB_2, Ti/SiC, WC/Co, Si_3N_4, AlN).
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,...
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 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+...).

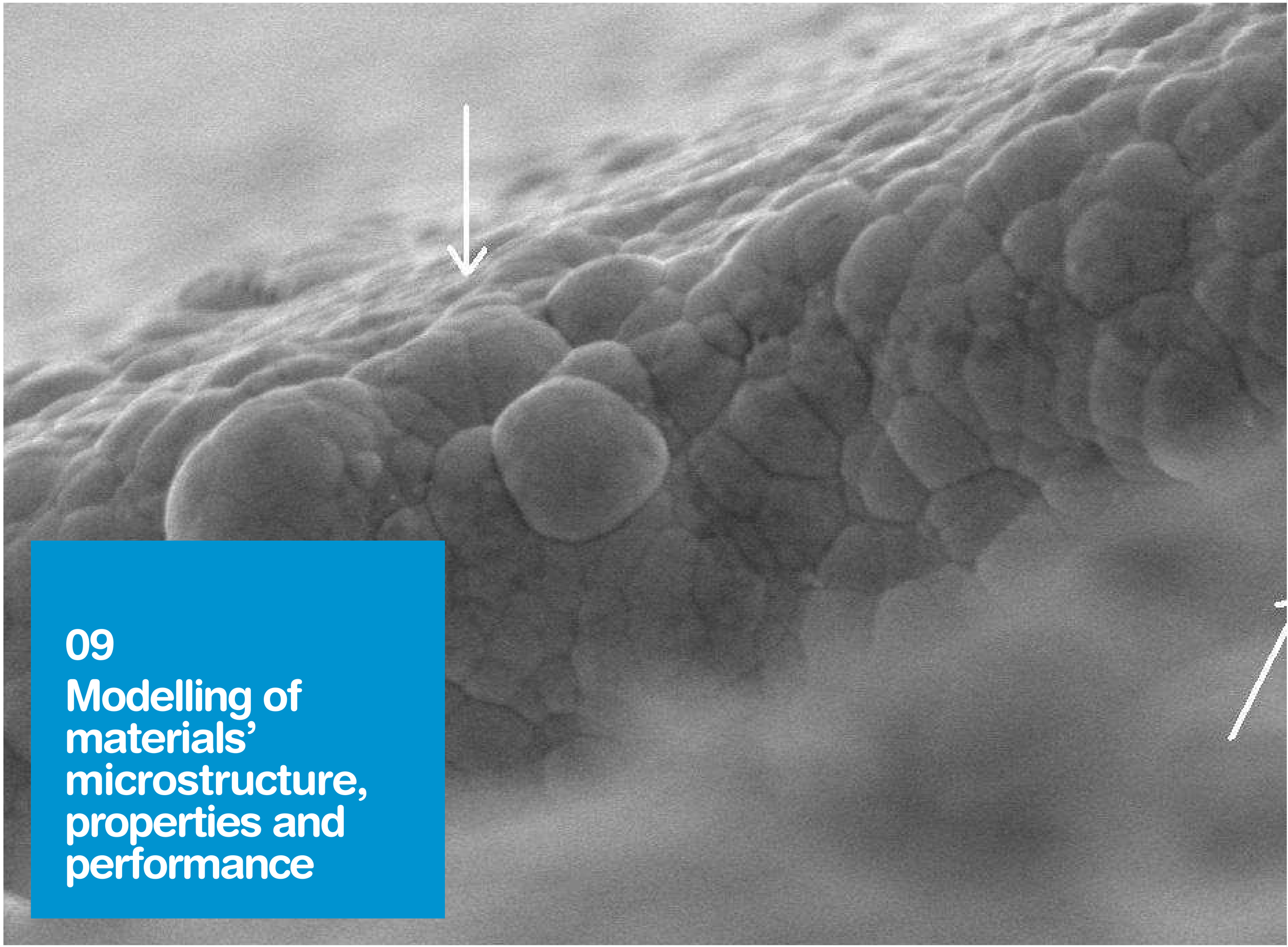
08
Joining of KMM materials using different bonding techniques

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

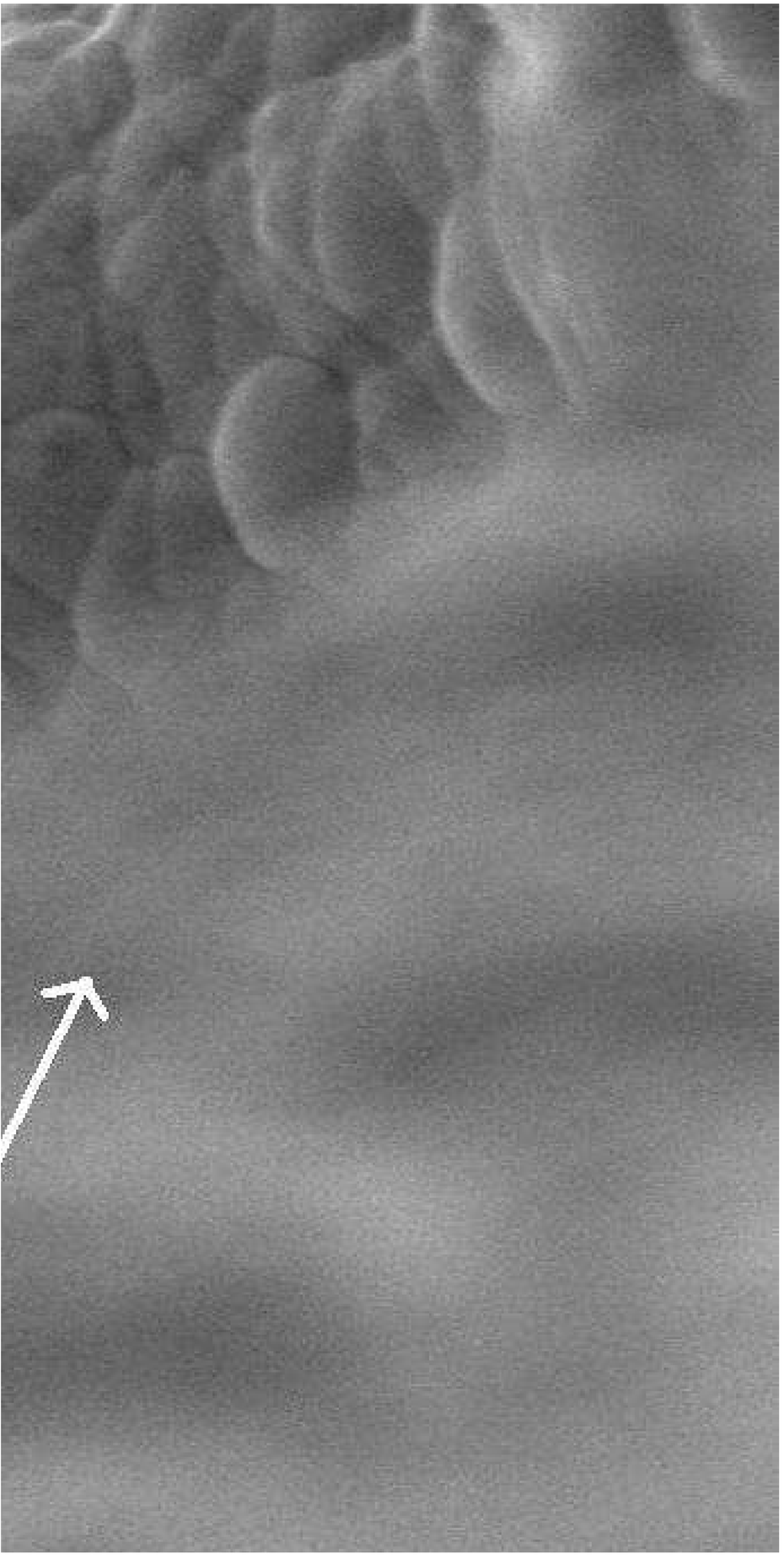
Ti, Zr and their alloys.
Refractory metals (W, Re-W, Mo, Ti-Zr-Mo (TZM), Nb).
Intermetallics (Ni-Al, Fe-Al, Mo-Si, Ti-B).
Oxide ceramics (Al_2O_3, ZrO_2).
Nitride ceramics (AlN, BN, Si_3N_4).
Carbide (SiC, B_4C, ZrC, WC).
Graphite.
Glass (borosilicate, silica).
Composites (SiC-Cu, C-C, Al_2O_3-Al, Al_2O_3-Cr,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



09
Modelling of materials' microstructure, properties and performance

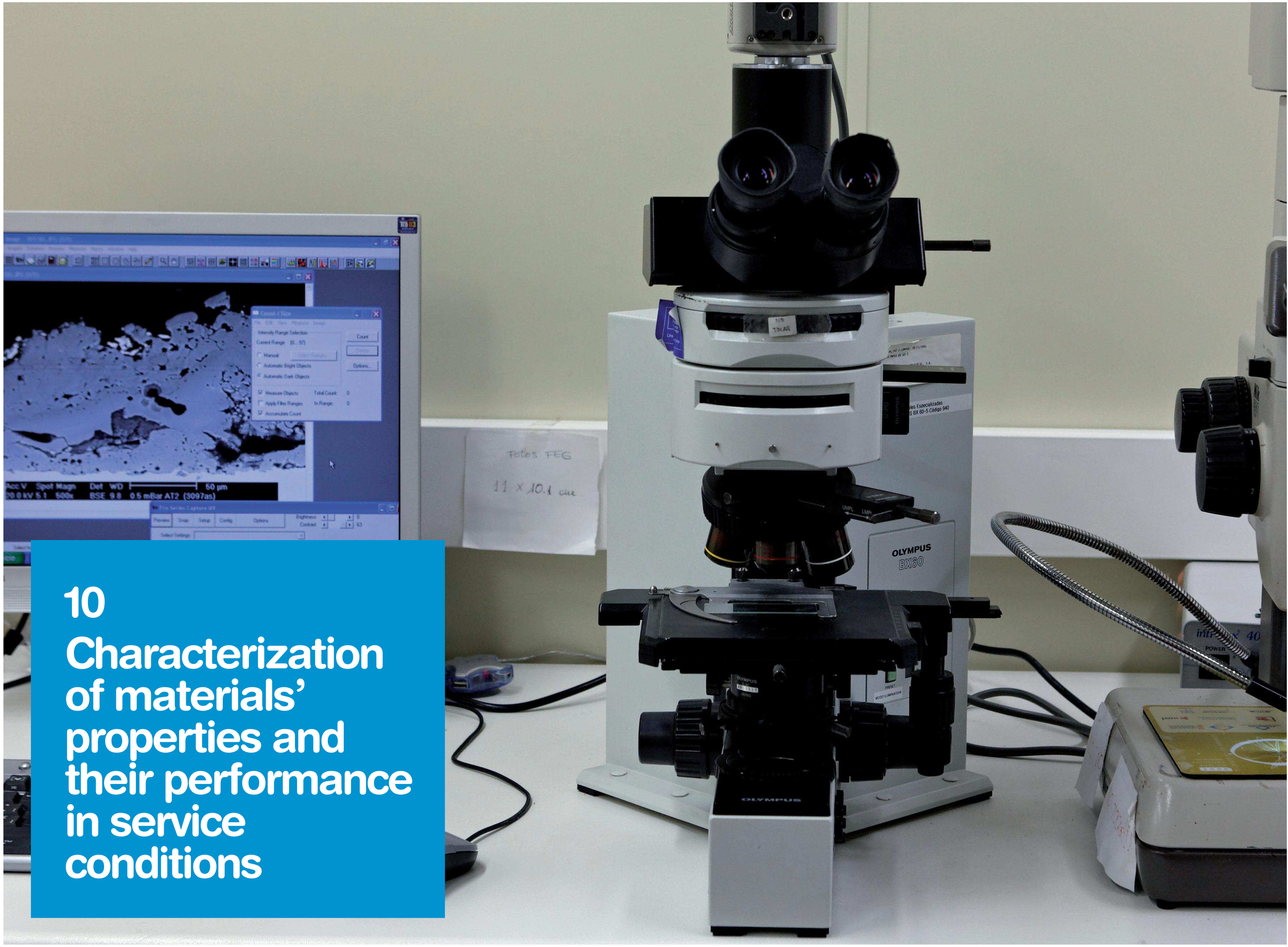


KMM-VIN members have considerable expertise in modelling of:

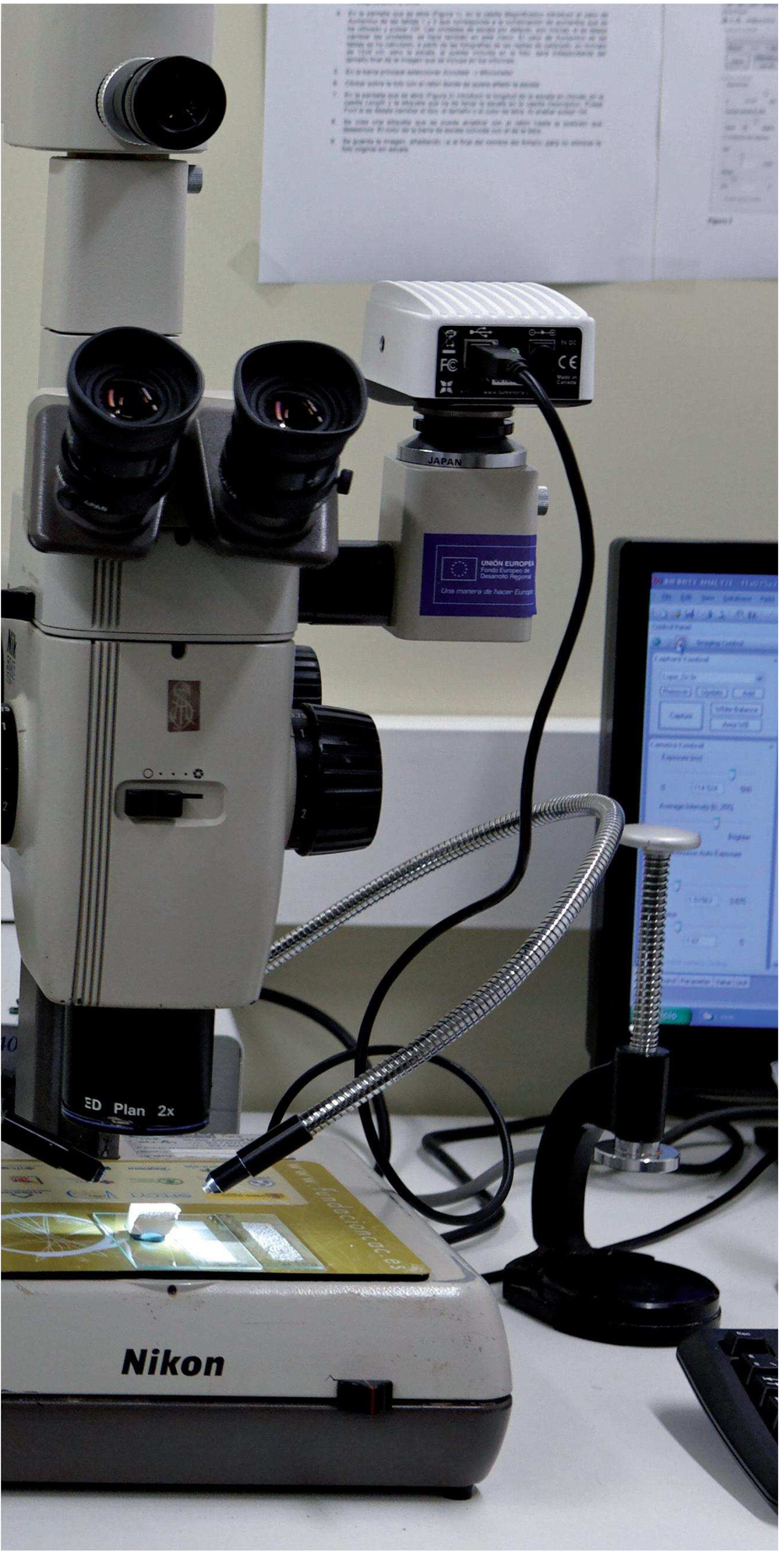
Microstructure by optimisation methods to arrive at required material properties.
Effective thermoelastic and transport properties of complex materials using effective continua/field methods and multiscale approaches with advanced numerical simulations.
Microcracking during processing (e.g. due to cooling 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:

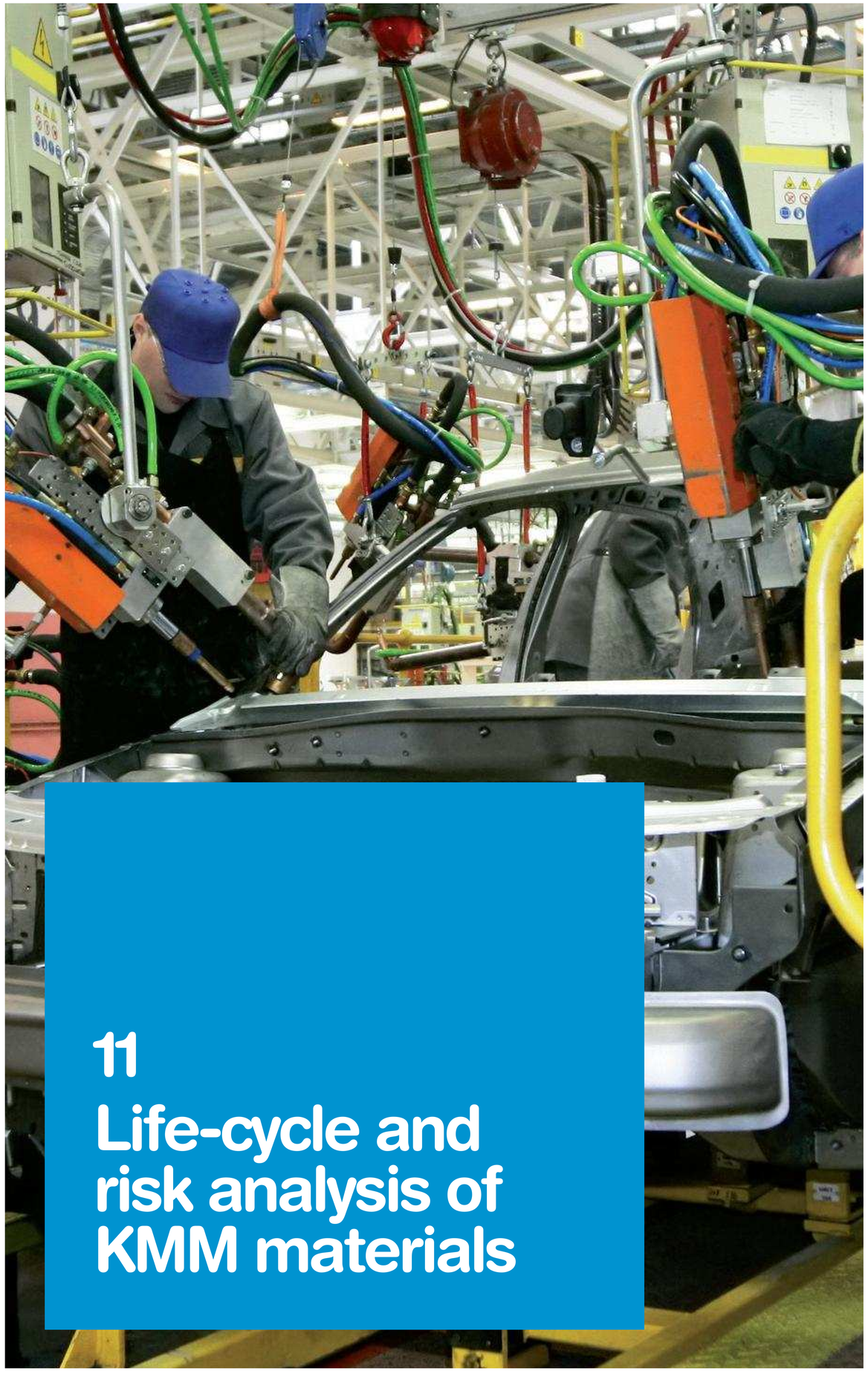
Materials macro-, micro- and nanostructure:
SEM, TEM, EDS, XRD, EDAX; measurements of zeta potential of the submicrometer and nanometer powder particles in water suspensions; viscosity; pore size distribution in powder compacts.
Materials physical and mechanical properties, e.g.:
Density, thermal expansion, conductivity.
Internal friction, interfacial shear strength (push in and pull out tests).
Elastic module, micro- and nanohardness.
Tensile-, impact- and bending strength.
Fracture toughness and other fracture parameters.

We also offer advanced testing of materials resistance to:

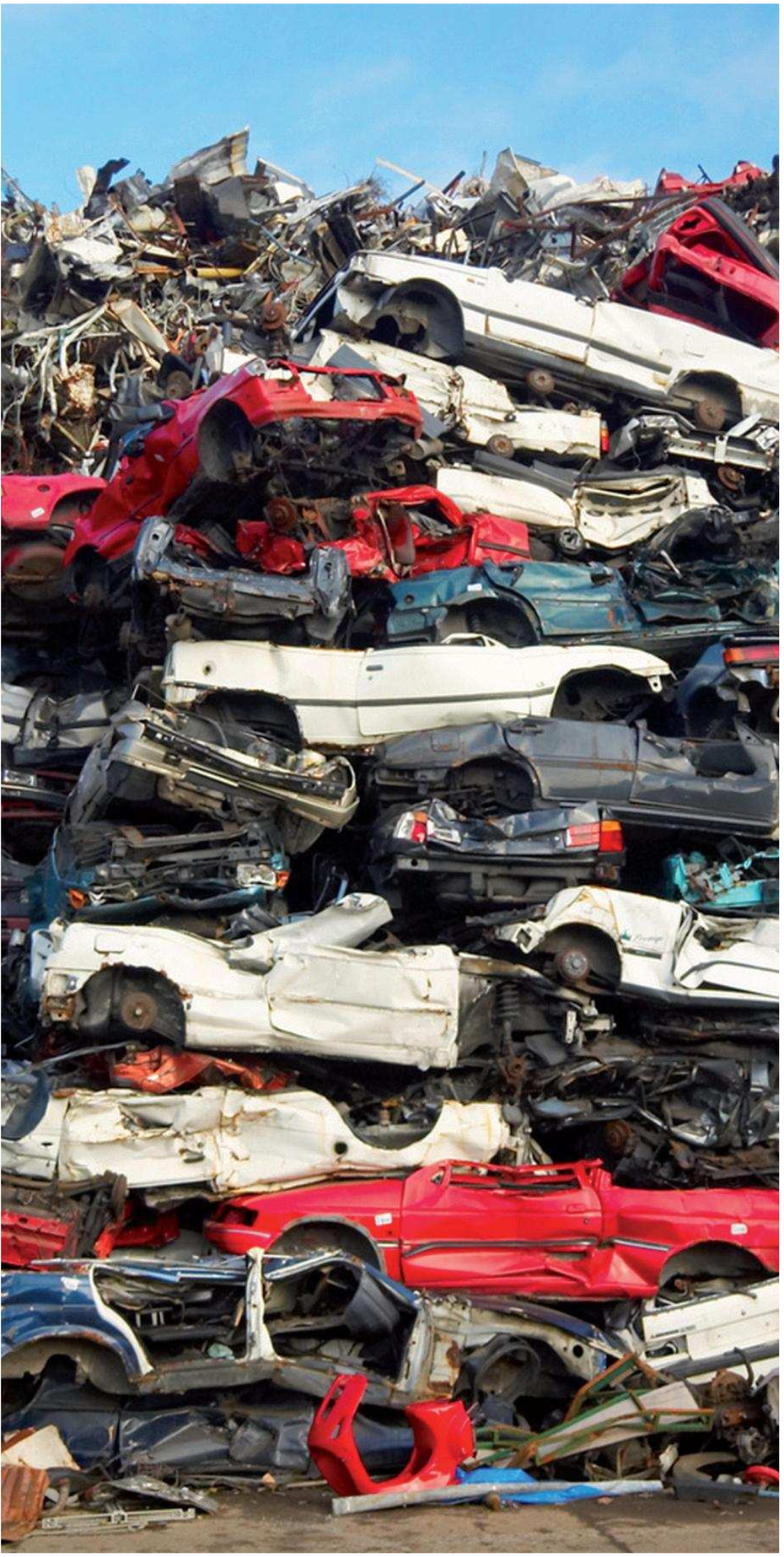
Aggressive environment.
Wear.
High temperatures and thermal shocks.
Corrosion.
Oxidation.

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:

Defining the goal and scope of the study.

Making a model of the product life cycle with all the environmental inflows and outflows (life cycle inventory, LCI stage).

Understanding the environmental relevance of all the inflows and outflows (life cycle impact assessment, LCIA stage).

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).

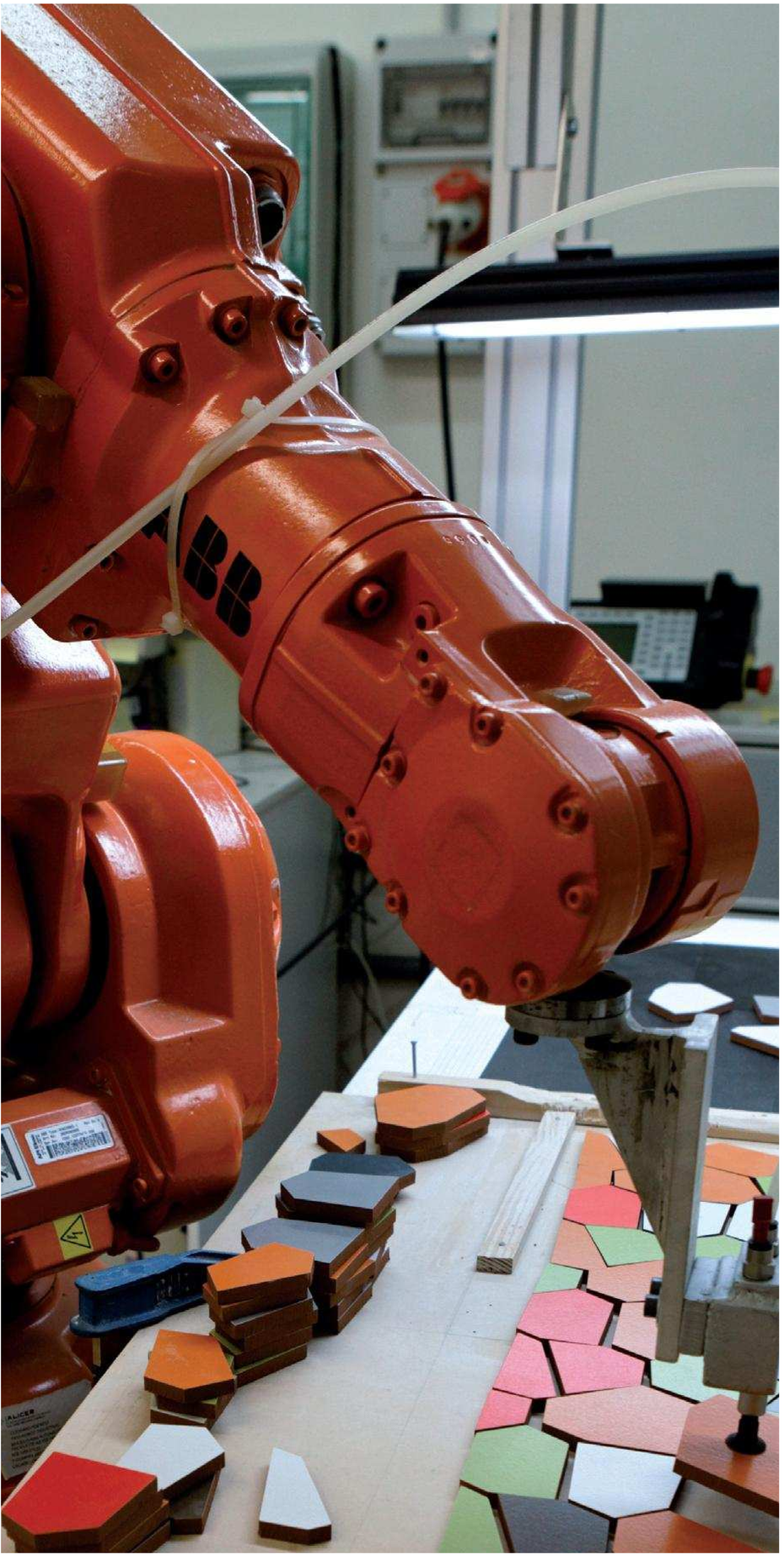
Risk of non-performance or performance below expectations (e.g. risks of system or component failures).

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.

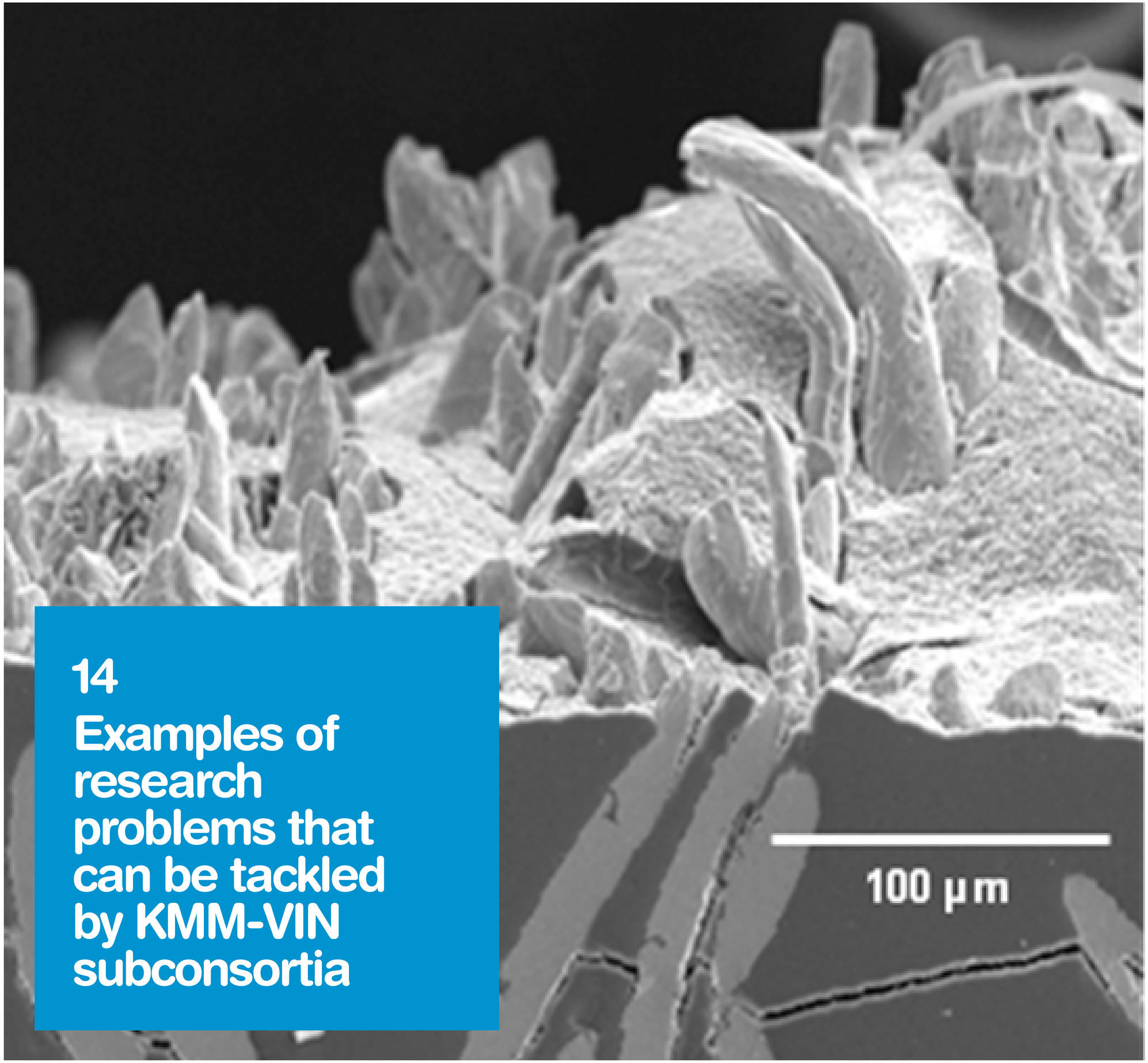
12
Access to KMM-VIN infrastructure and equipment



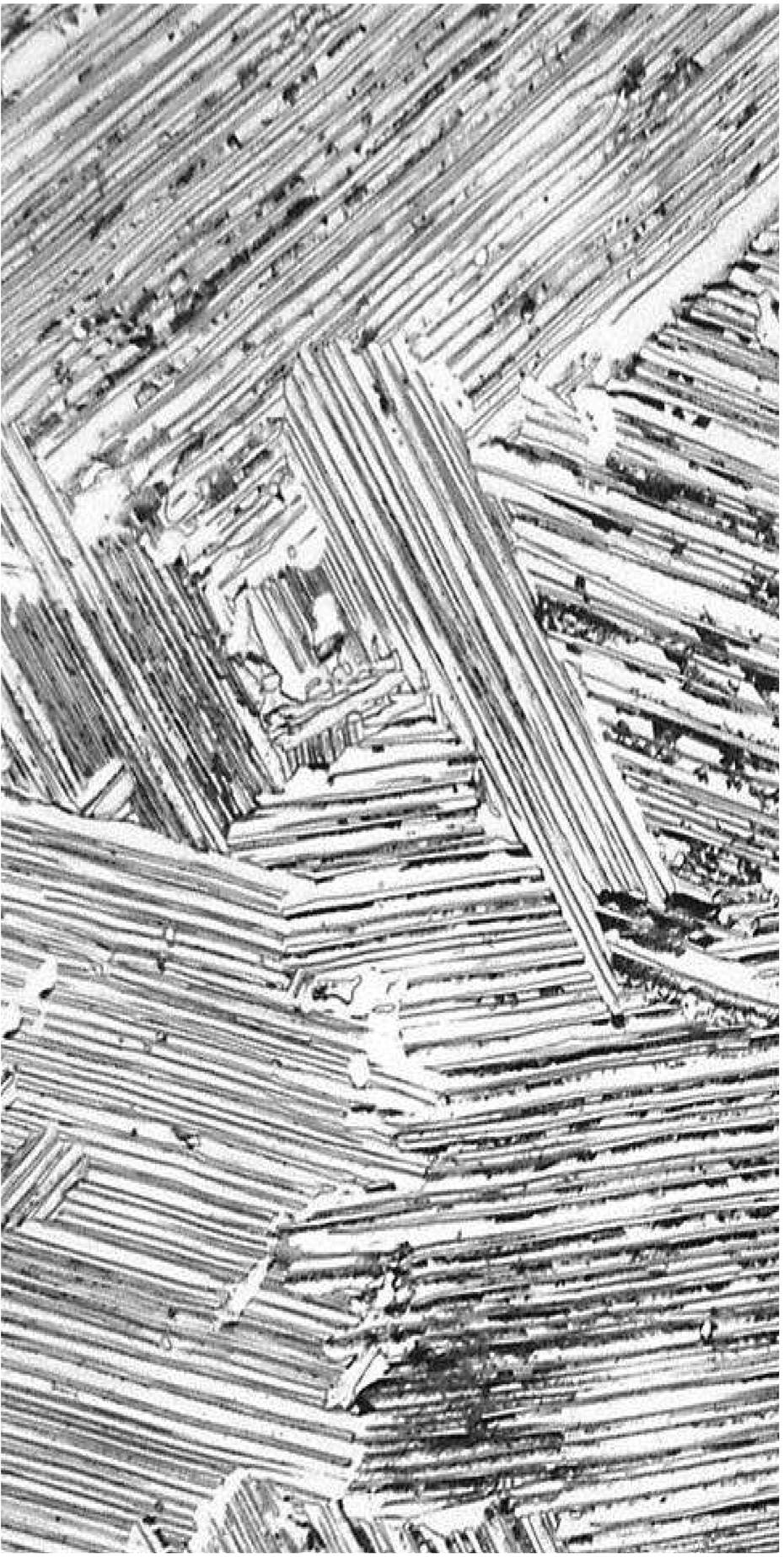
We offer for external clients from industry, SMEs and academia a transnational access to specialized research infrastructure owned by KMM-VIN members. The access can be made available to external clients either in person (“hands on”) or through remote services by KMM-VIN members. If you need to conduct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

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.

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.
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.
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.

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 and projects from the EU Structural Funds. Some recent examples include:

MATRANS (FP7) "Micro and Nanocrystalline Functionally Graded Materials for Transport Applications" (2010-2013), project will started 1 Feb. 2010, coordinated by KMM-VIN, consortium: 16 partners, EC funding 3.6 M€ (www.kmm-vi.eu/Projects/Matrans).

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).

BIO-CT-EXPLOIT (FP7) "Innovative Simulation Tool for Bone and Bone Biomaterials based on Enhanced CT-data Exploitation". Project started 1 Dec. 2009, EC funding 900 K€. This project will enhance the competitiveness of SMEs active in the markets of biomedical engineering and biomaterials design. The consortium includes three KMM-VIN core members: TUV (project coordinator), WUT, UNIVPM (www.bio-ct-exploit.imws.tuwien.ac.at).

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).

KomCerMet (EU Structural Funds) "Metal-Ceramic Composites and Nanocomposites for Aerospace and Automotive Industry" One of the so-called Polish key projects supported by the EU Structural Funds. Started 1 October 2008, duration 4 years. Coordinated by IPPT (KMM-VIN core member), consortium of 12 partners including 5 KMM-VIN members (IPPT, ITME, IMIM, WUT, AGH). The total project budget is 6.3 M€ (http://www.komcermet.ippt.gov.pl)

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. The clients can access the Catalogue of Expertise and Equipment, www.kmm-vin.eu, which is an inventory of services, scientific and technical infrastructure and other resources available at the KMM-VIN partnership. 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
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Fax : +32 2 79 155 36
E-mail : office@kmm-vin.eu

KMM-VIN Remote Office c/o IPPT PAN
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02-106 Warsaw, Poland
Phone: +48 22 826 2522
Fax: +48 22 826 2522
E-mail: office@kmm-vin.eu

18 KMM-VIN Partnership CORE MEMBERS

AGH	University of Science and Technology, Cracow, Poland
AITEX	Textile Research Institute, Alcoy-Alicante, Spain
BioIRC	Bioengineering Research and Developing Centre, Kragujevac, Serbia
CIDETEC	Fundacion 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, Poland
CUTL	Cyprus University of Technology, Limassol, Cyprus
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
IOD	Foundry Research Institute, Cracow, Poland
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
INASMET	Fundación Inasmet, Donostia-San Sebastian, Spain
IPPT	Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Poland
IPSUA	Institute for Problems of Strength, National Academy of Sciences, Kiev, Ukraine
ITC	Instituto de Tecnología Cerámica – AICE, Castellón, Spain
IPM	Institute of Physics of Materials, Brno, Czech Republic
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
R-Tech	Steinbeis Advanced Risk Technologies GmbH, Stuttgart, Germany
TUD	Technische Universität Darmstadt, Germany
TUV	Vienna University of Technology, Austria
UH	University of Hertfordshire, Hatfield, Herts, UK
UNIPAD	Università degli Studi di Padova, Italy
UNIVPM	Università Politecnica delle Marche, Ancona, Italy
WUT	Warsaw University of Technology, Poland

AGH

aitex
textile research institute

CIDETEC
ik4 research alliance

CISMLab

PK

CYPRUS UNIVERSITY OF TECHNOLOGY 2004

eminate
Innovative solutions for health

Fraunhofer

MZ

inasmet tecnalia

IPPT PAN

UM

Instituto de Tecnología Cerámica jtc

ipm

ITME

MCL MATERIALS CENTER LEOBEN

merl
materials engineering research laboratory

ONERA
THE FRENCH AEROSPACE LAB

POLITECNICO DI MILANO

POLITECNICO DI TORINO

Steinbeis Advanced Risk Technologies

TECHNISCHE UNIVERSITÄT DARMSTADT

TU WIEN
TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

UH University of Hertfordshire

UNIVERSITÀ DEGLI STUDI DI PADOVA

UNIVERSITÀ POLITECNICA DELLE MARCHE

19 KMM-VIN Partnership ASSOCIATE MEMBERS

EU-VRi	European Virtual Institute for Integrated Risk Management, Stuttgart, Germany
Saar-Uni	Saarland University, Saarbrücken, Germany
ALENIA	Alenia Aeronautica S.P.A., Italy
CRF	Centro Ricerche FIAT, Orbassano, Italy
VGTU	Vilnius Gediminas Technical University, Lithuania
EMPA	Materials Science and Technology, Duebendorf, Switzerland
UEN	Friedrich-Alexander Universität Erlangen-Nürnberg, Germany