ABSTRACT. The report treats a project on Innovative material solutions for Transport, Energy and Biomedical (TEB) sectors by strengthening integration and enhancing research dynamics of KMM-VIN” (INNVIN) concluded with the European Union. Its scope is to practically implement the results found within the framework of KMM-VIN (European Virtual Institute of Knowledge –Based Multifunctional Materials AISBL). The INNVIN targets are transport, energy and biomedical sectors of industry. Detailed study of the actual needs of a number of related small and medium enterprises (SME) have been performed, and KMM-VIN expertise has been offered. The project is open for further collaboration with the contacted companies, as well as for the incorporation of new interested parties.

KEY WORDS: KMM-VIN, INNVIN, transport, energy, biomedical

1. The KMM-VIN Grouping Agreement

The European Virtual Institute on Knowledge-based Multifunctional Materials AISBL (KMM-VIN) has been founded under the auspices of the European Commission to offer integrated basic and applied commercial research, educational and innovation activities in the field of knowledge-based structural and multifunctional materials [1]. The KMM-VIN is an international, non-profit association (AISBL) with head-quarters in Brussels and incorporated under Belgian law (No d'entreprise 889 462 185). The aim of KMM-VIN is to foster the creation of a powerful platform for research and development and industrial application of advanced materials in order that Europe may become a global power in this field, thus contributing to enhancing the quality of life of the European society. Hence, a grant agreement between the European Union represented by the European Commission of the one part and the European Virtual Institute of Knowledge –Based Multifunctional Materials AISBL (KMM-VIN) of the other part was concluded ensuring accession to the agreement of other beneficiaries as well. The core KMM-VIN members formed a Consortium with a task to focus skill and knowledge on the development of a project “Innovative material solutions for Transport, Energy and
Biomedical (TEB) sectors by strengthening integration and enhancing research dynamics of KMM-VIN” (INNVIN), and the basic idea behind INNVIN was to transform the KMM-VIN into a unit with a substantial share of contracts from the industry, [1], [2].

2. The KMM-VIN genesis
The KMM-VIN emerged from a project of the European Commission’s 6th Framework Program Network of Excellence entitled “Knowledge-based Multicomponent Materials for Durable and Safe Performance” (KMM-NoE), devoted to the study, understanding, design and development of new advanced materials (ceramic, metallic, metal-ceramic, intermetallic, or functionally graded). The idea was to enhance material functional properties and characteristics by: reducing bulk density, improving performance under high temperature exposure, providing the materials with greater toughness, reducing fatigue during material service life, increasing resistance to wear, corrosion and oxidation, furnishing the materials with biocompatibility thus suiting them for medical applications etc.

2.1. The KMM-VIN virtual institute
KMM-VIN is a single legal entity with a supranational character gathering research institutes, universities as well as companies and offering integrated basic and applied commercial research, educational and innovation activities in the field of knowledge-based structural and multifunctional materials. At present KMM-VIN partnership consists of 40 core and 26 associate members, and it is constantly growing. The mission of KMM-VIN is to develop a new European model of integration (virtual institute) 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, small and medium enterprises (SME) and academia via R&D projects, testing, analysis and consultancy services

2.2. The KMM-VIN members
Note that KMM-VIN is a grouping as outlined above and according to the definition under the 7-th Framework Program (FP7). As seen in what follows, it has generated the INNVIN project, including in it itself and a number of other KMM-VIN members:

a) Core Members
1. Austria - Graz University of Technology, Vienna University of Technology, Werkstoff-Kompetenzzentrum-Leoben Forschungsgesellschaft m.b.H. (Materials Centre Leoben);
2. Bulgaria- Institute of Mechanics, Bulgarian Academy of Sciences (IMBAS);
3. Czech Republic- Institute of Physics of Materials;
4. France- Office National d'Etudes et de Recherches Aérospatiales;
5. Germany- Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.; Steinbeis Advanced Risk Technologies GmbH; Technische Universität Darmstadt;
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6. **Italy**- Politecnico di Milano, Politecnico di Torino, Università degli Studi di Padova, Università Politecnica delle Marche, Centro Internazionale di Scienze Meccaniche CISM Lab

7. **Poland**- AGH University of Science and Technology, Cracow University of Technology, Foundry Research Institute, Institute of Electronic Materials Technology, Institute for Ferrous Metallurgy, Institute of Fundamental Technological Research, Polish Academy of Sciences, Institute of Metallurgy and Materials Science, Polish Academy of Science, Instytut Spawalnictwa - Polish Welding Centre of Excellence, Warsaw University of Technology;

8. **Serbia**- Bioengineering Research and Developing Centre;

9. **Slovakia**- Institute of Materials Research of Slovak Academy of Sciences;

10. **Spain**- AITEX, Fundacion CIDETEC, Fundación TECNALIAInstituto de Tecnología Cerámica – AICE, Universidad Politécnica de Madrid

11. **UK**- Doosan Power Systems Ltd, eminate Ltd, Materials Engineering Research Laboratory Ltd, University of Hertfordshire

**b) Associate Members**

1. **Austria**- Böhler Edelstahl GmbH & Co KG, Böhler Schweißtechnik Austria GmbH, voestalpine Giesserei Linz GmbH;

2. **Czech Republic**- SVÚM a.s., Výzkumný a zkušební ústav Plzeň s.r.o.;

3. **Finland**- Teknologian tutkimuskeskus VTT


5. **Italy**- Centro Ricerche FIAT, Centro Sviluppo Materiali S.p.A.;

6. **Lithuania**- Vilnius Gediminas Technical University;

7. **Netherlands**- KEMA Nederland BV;

8. **Sweden**- Siemens Industrial Turbomachinery AB;

9. **Switzerland**- EMPA - Materials Science and Technology;

10. **UK**- Alstom Power Ltd., E.ON New Build & Technology Ltd., Loughborough University, NPL Management Limited;

2.3. **The KMM-VIN working groups**

The current thematic scope of KMM-VIN is arranged within four Working Groups focused on Materials for Transport (WG1), Materials for Energy (WG2), BioMaterials (WG3), Modeling (WG4). The KMM-VIN membership includes research groups with expertise in material processing technologies, characterization of material microstructure, mechanical and physical properties, modeling (analytical and numerical) of material behavior under design and in-service conditions. The continuously growing number of researchers within the KMM-VIN comprise specialists in materials science, physics, chemical engineering, mechanical engineering, and numerical methods, who are capable of forming problem-oriented consortia to provide comprehensive and verifiable solutions in the KMM area.
KMM-VIN addresses research primarily to transport, aerospace and aeronautics, energy, health and electronics, offering services such as research, development and innovation, education and training, integrated post-graduate school.

2.4. KMM-VIN materials

The materials investigated within the KMM-VIN framework are designed for enhanced performance under thermo-mechanical and impact loading, high strain rates and temperature regimes, aggressive chemical environment, and combinations thereof. Such regimes are typical of applications in aerospace and automotive transport, energy, turbo-machinery industry, tribology, chemical industry, electronic devices and microsensors. These materials comprise ceramics, metal-ceramic composites, functionally graded materials, intermetallics, shape memory alloys, coatings, high temperature steels and biomaterials.

2.5. KMM-VIN structure

The KMM-VIN structure is as shown in Fig. 1.

<table>
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<tr>
<th>European Commission</th>
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<tr>
<td>↓ Grouping Agreement “Virtual Institute on Knowledge-based Multifunctional Materials”</td>
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<tr>
<td>Abbreviation – KMM-VIN Grouping Agreement</td>
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<td>Project Coordinator</td>
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<td>↓ Project “Innovative materials solutions for Transport, Energy and Biomedical sectors of the KMM-VIN”</td>
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<td>Abbreviation – INNVIN Project</td>
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<td>Project Title</td>
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Fig. 1. KMM-VIN structure

3. The INNVIN project

INNVIN is the abbreviation of “Innovative materials solutions for Transport, Energy and Biomedical sectors of the KMM-VIN”, as shown in Fig. 1. The basic idea of the project within the KMM-VIN framework is to engage the large transnational partnership of KMM-VIN in transforming the KMM-VIN into an organization with increasing share of contracts from industry, [3]. The strategy to be pursued is to prepare the KMM-VIN for contracts, testing, analysis, consultancy and other activities from industrial clients that can be provided by the KMM-VIN members individually or collectively.

The primary objective of the INNVIN project 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. It will primarily focus on Transport, Energy and Biomedical sectors as these are the ones where KMM-VIN’s expertise has
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reached a critical mass. A set of measures is proposed to reach this objective: Survey of technology needs in Transport, Energy and Biomedical sectors, Update of contents and enhancement of functionalities of KMM expertise and equipment database, Dissemination campaign of KMM-VIN research, infrastructure and training potential, Recruitment of new KMM members from industry. An important by-product of this strategic plan is the satisfaction of the economic criteria of SMEs as this status can be beneficial for KMM-VIN financial stability in the long term. Below is specified the list of work packages pursuant to the Grant Agreement.

3.1. List of Work Packages (WP)

WP1. Survey of technological needs in Transport, Energy and Biomedical (TEB) sectors.
A thorough survey of the technological needs of the above sectors is (will be) crucial for any INNVIN action. Subsequently, the INNVIN partners have some experience in these activities gained from the KMM-NoE project, and their expertise will be made use of.

WP2. Update of contents and enhancement of functionalities of KMM-VIN equipment/expertise database.
The main task here is to create a detailed database which is a valuable tool in meeting the needs of SEM-s in the TEB sectors.

WP3. Strategy of training activities for industry and specialized courses.
The work package is focused on training activities for industry and preparatory work for KMM-VIN specialized courses.

WP4. Preparation for expansion towards the industry.
This is a crucial package for reaching the INNVIN primary objectives. It is thus expected that the KMM-VIN will gain more visibility in transport, energy and biomedical sectors in Europe.

WP5. Project management.

4. Involvement of the IMech in the INNVIN

The Institute of Mechanics, BAS, is involved in the INNVIN as follows:

WP1 - Task 1-1. “Survey of technological needs in KMM field in companies and SMEs for TEB sectors;
Task 1-2 “Analysis of research agendas for the European and national technology platforms and market studies in TEB sectors”;

WP2 - Task 2-3 “Update and extension of KMM materials toolkit”;

WP3 - Task 3-2 “KMM-VIN strategy for specialized courses”

WP4 - Task 4-2 “Dissemination of information on KMM-VIN activities for industry via conventional and electronic means and at conferences and fairs”;

5. Results and discussion

5.1. WP1/Task1-1
The IMech contacted the following companies in Bulgaria for collaboration within the INNVIN framework, pursuant to the above WP:
5.1.1. Transport sector
Contacted company- TRANSWAGON LTD, Burgas, Bulgaria.
Contact- Mr. Vassil Danev, Executive Director

The company specializes in railway wagon repair, reconstruction, and modernization. It meets the requirements of DB for maintenance of wagons, having trained staff, facilities, and necessary equipment.

**IMech competence** - aiding the company in assessing and avoiding wheel/rail material damage.

5.1.2. Energy sector
a) Contacted company – DIAVACH LTD, Sofia, Bulgaria
   Contact- Mr. Vasko Velkov
   Web link - http://www.diavach-bg.com/

Fig.2. Illustration of TRANSWAGON LTD activities

Fig.3. Products of DIAVACH LTD
Since 1991 DIAVANCH designs and manufactures various items: - heaters using renewable energy sources-biomass (fir, pellets and briquettes); facilities and installations for the fabrication of briquettes and pellets from wastewood; transport bands, fabricated on rubber/textile/plastic basis; non-standard spareparts.

IMech competence - assessment and eventual control of the efficiency of combustion in a specific heating device, assessment and control of fuel consumption; specification of eventual means for fuel spare.

b) Contacted company- MEGAGROUP S.A., Varna, Bulgaria
Contact- Mr. Rumen Dimitrov, Managing Director
Web link - http://www.megagroup.bg/bg/Projects-Future.html

![Fig. 4. MEGAGROUP S.A view](image)

The company manages a plant for the utilization of oil waste to be used as fuel for a 150 MW electric generator.

IMech competence - assessment and eventual control of the efficiency of combustion; specification of eventual means for fuel spare.

5.1.3. Biomedical sector
a) Contacted company- NATIONAL CLINIC OF CARDIO-SURGERY AND ANGIOLOGY, Sofia, Bulgaria
Contact- Assoc. Prof. Dr. Mario Stankev
Web link - http://www.hearthospital.bg/node/49

IMech competence- blood flow modeling and assessment, identification of human blood characteristics

b) Contacted company- SHUMEL-M SA, Shumen, Bulgaria
Contact- Mr. Jordan Jordanov, Managing Director

IMech competence- blood flow modeling and assessment, identification of human blood characteristics

SHOUMEL-M AD is designing and manufacturing two main groups of items: medical equipment and electronic devices. The medical equipment is intended
for physiotherapy, cosmetic treatment, electro-surgery, ECG monitoring, etc. With a task to perform healing and cosmetic procedures applying low-frequency, diadynamic, low- and high-frequency currents, ozoned steam, iontophoresis, brush-massage, vacuum massage, oxygen, high-frequency electrocoagulation, and others.

**IMech competence** – aid in device design

5.2. WP4/Task 4-2

Pursuant to the above WP, some INNVIN activities performed by the IMech were reported at the “International Conference on Mechanics- MECH2012”, Sofia, 2012.

Report title: **The KMM-VIN Project-Objectives and Perspectives**
Authors: V. Kavardjikov, R. Kazandjiev, B. Dishev

**IMPORTANT NOTE:**

The companies, listed above within the scope of WP1/Task1-1, are the main ones that the IMech is in contact with under the INNVIN project, and there are some more SMEs which the IMech proceeds talks with.

5.3. IMech activities within the KMM-VIN Working Groups

In view of the outlined INNVIN work packages and the related KMM-VIN working groups, the IMech was also active in preparing the following projects within the working group scope:

5.3.1. WG3. Materials design by modeling: Atomistic modeling and \textit{ab initio} methods – phase diagrams, mechanical properties (elastic constants, stacking faults, dislocation interactions), thermodynamic properties, surface and interface properties, electric properties

**Project title** *Genesis of a new high-nitrogen high-strength corrosion resistant austenitic economic steel for medical implants*

**Project leaders** Assist. Prof. Pavel Venkov Bogoev, C. Eng.
Prof. D.Sc. Tsolo Rashev

**Objectives:** Study of the possibilities of replacing some steels and alloys for medical implants, based on expensive alloying elements (Ni, Ti, Co etc.) with a new high-nitrogen stainless steel and unique qualities–several times stronger, harder and cheaper as compared to the widely used stainless nickel steel 316L. The steel is biological-friendly and has a stimulating local bio-effect.

5.3.2. WG4 Micromechanical and multiscale modeling of materials

Modelling crack driving forces in graded materials and composites

**Project title** *Multiscale modelling of knowledge-based materials subjected to environmental effects*

**Project leaders** Prof. Dr. Petia Dineva

**Objectives:** Assessment of material response to various environmental effects accounting for the material structure changes. Graded and
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Composite materials subjected to various environmental effects, such as hydro, piezo, thermo, chemical, seismic etc. effects, will be taken into consideration. The phenomena will be studied on multiscale level (nano, micro, meso and macro level). Subsequent problems will be formulated, mechano-mathematical modelling of the phenomena will be performed and analytical and numerical solutions will be found. Experimental data for some of the modelled materials will be collected. Change of material structure and properties will be theoretically and experimentally assessed. Modelling plausibility will be estimated comparing the theoretical results with experimental evidence.

REFERENCES