

## **R&D COLLABORATIVE PROPOSAL /** **COMPANY PARTNER SEARCH**

The information you are about to provide in this form will be distributed among Spanish companies matching your company profile and that might be interested in the proposal of collaborative R&D project that you will be describing in this form. (Please use English language for filling in the document)

In the case that your company will establish a R&D project in collaboration with a Spanish company, you could present a Joint Project Proposal to the CHINEKA Program.

### **YOUR ENTITY PROFILE**

**Name:** IMDEA Materials Institute

**Number of employees:** 120

**Annual turnover:**

**Balance Total:**

**Year of latest financial report:** 2019

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**Contact:** Dr. De-Yi Wang

**Position:** Head of the High Performance Polymer Nanocomposites Group

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## COLLABORATIVE R&D PROJECT PROPOSAL

(Describe as precisely as possible the technology cooperation proposal.  
Describe what you have to offer and what you expect from your potential partner) Include: Sector Group; Abstract of Project; Innovations Offered; and Current State of Development

<b>Title</b>	Bio-based fire safety phase-change materials for thermal energy storage <b>(BIOPEs)</b>		
<b>Duration (YM- YM)</b>	09/2021-09/2024		
<b>Budget(1,000 Euro)</b>	SPAIN	CHINA	TOTAL
<b>Technology Field</b> (Click a box)	<input type="checkbox"/> Smart Cities <input checked="" type="checkbox"/> Production Technologies, <input type="checkbox"/> Biomedicine and Technologies for Health, <input checked="" type="checkbox"/> Environment technologies <input checked="" type="checkbox"/> Clean Technologies <input type="checkbox"/> Modern Agriculture <input checked="" type="checkbox"/> Advanced Materials. <input type="checkbox"/> Others		
<b>Summary</b>	<p>The development of thermal energy storage materials is the most attractive strategy to increase the energy utilization efficiency. Phase change materials (PCMs) have received much attention in this research field because of their large thermal energy storage density, wide temperature working range, long-term stability, and noncorrosive and low toxicity properties. However, the commonly occurring issues of organic PCMs are their intrinsic weak ability to light absorptivity, low thermal conductivity, and leakage during the solid-liquid phase-change process. As a credible alternative to solve this problem, solid-solid change materials have usually been incorporated with organic PCMs to improve their phase transition enthalpy, thermal conductivity as well as form stability.</p> <p>Recent progress has shown notable work on solid-solid phase change materials which possess unique advantages of <i>low supercooling, high form stability, high thermal stability, high latent heat, and thermal conductivity</i>. At present, the utility of eco-friendly materials is considered as a necessity imposed by nature for securing a sustainable future against problems such as depletion of petrochemical resources and white pollution. In this respect, developing <b>green energy storage systems</b> is vital for green technological innovation and efficient energy utilization. In addition, as the amount of PCMs increases, so do the safety concerns associated with their application. Thus, the development of improved safety especially the <b>fire safety</b> for advanced PCMs is imperative. IMDEA Materials Institute designed and prepared new PCMs: <b>(1)</b> <i>it can be prepared in a facile and green pathway</i>, and <b>(2)</b> <i>it has high mechanical performance, high fire safety, high form stability, high phase transition enthalpy, and high thermal conductivity</i>.</p> <p>In this project, new generation bio-based composites will be prepared by using simple and green methods. It has plenty of potentials to be used in Intelligent textile, Phase change thermoelectric heater, Battery pack manufacturer, Advanced building materials manufacturing, etc.</p> <p>Dr.De-Yi Wang who is the technical leader/coordinator in this consortium focuses on high performance eco-friendly flame retardants and polymer composites, have established widely collaborative networks in the materials industrial in the worldwide.</p> <p>In this project, the consortims will include two teams from Spain and China. In details, it is expected that: from Spanish side, one industrial parter from Spain, and one research/technology center (IMDEA Materials as technology developer) will be included; From Chinese side, one or two University (be charge of supporting some technological development to industrial partner in China) will be involved.</p>		

### SPANISH PARTNERS

(When you know a potential Spanish company, write its name and contact details in this section) Please, make a description of the desire type of Spanish Technology Partner.



#### Keywords:

Bio-based materials; Phase-change materials; Thermal energy storage; Intelligent textile; Battery packing manufacturer; Building materials; Sustainable materials; Manufacturing, etc.


-We are looking for suitable industrial partner from Spain which are interested in developing new technology, increase the value-added of the products and enlarge the international markets for some advanced application to the current products.


### YOUR ENTITY DESCRIPTION

(Entity Website, Research and development guidelines, strategic alliances, competitive position, etc)

IMDEA Materials Institute (Spain)	
<b>General description</b>   EXCELENCIA MARÍA DE MAEZTU	<p>IMDEA Materials Institute (IMDEA), one of the seven Madrid Institutes for Advanced Studies, is a public research centre founded in 2007 by Madrid's regional government. The goal of the Institute is to do research at the forefront of Material Science and Engineering, attracting talent from all around the globe, and collaborating with companies in an effort to transfer fundamental and applied knowledge into valuable technology. The IMDEA Materials Institute has a established international reputation in the areas of design, processing, characterisation, modelling and simulation of advanced materials for applications in different industrial sectors with particular emphasis in transport, energy and health.</p> <p>Since the beginning of its activities in year 2007 IMDEA has been involved in more than 190 research projects (total budget € 18 million), funded by public bodies (EU framework programmes, AFOSR, RFSC, national agencies ...) and private companies. Amongst these, 58 are currently active and 15 are directly funded by industry (total budget € 1.2 million). Toyota motor Europe, HP printing solutions, ITP Aero, Airbus, TESA, Renisaw, Talgo, BASF, ANSYS, HEXCEL composites are amongst the companies IMDEA Materials has / is collaborating with.</p> <p>Around 120 people do research at the Institute, which is currently organised into sixteen research groups. The Institute received the 'HR Excellence in research' award on October 2015 and was recognized as a 'María de Maeztu' unit of excellence in October 2019 by the Spanish Ministry of Science, Innovation and Universities.</p>

<p><b>Role of key persons</b></p>	<p><b>Prof. Dr.De-Yi Wang</b> is a Senior Researcher and Program Leader of multifunctional nanomaterials for advanced application at IMDEA Materials Institute. He leads the research group of High-Performance Polymer Nanocomposites. The research group includes 5 postdoctoral researchers, 8 PhD students and 2 technicians. His research activities focus on new generation eco-friendly fire-retardant materials, high performance polymer-based composites, multifunctional nanomaterials, etc., which are mainly application-oriented research topics. He has proven experience in developing novel flame-retardant materials and high-performance polymer-based composites as shown by his publication records (over 190 peer-reviewed international journals and 20 invention patents registered) and by the participation of over 20 research programs as PI funded by European Commission, National government, and industrial sectors in the worldwide, such as TESCO (European Commission), NEOADFOAM (Spanish Government funded), SEPIFIRE (Industrial Sector from Germany), NEWTOP (Industrial Sector from China), FRANK (Industrial Sector from Germany), FRCOAT (Industrial Sector from China), etc. In 2014, he was appointed as "IPF Fellow" in Germany. Currently, he is an PhD advisor and Adjunct Professor of Technical University of Madrid (UPM) in Spain. In 2016, he elected the Fellow of Royal Society of Chemistry (FRSC) in UK. In 2019, as one of the core proposers he established China-Spain Joint Research Center of Advance Materials (9 institutions were involved from China and Spain) and/or was appointed as the director of this joint center.</p>
<p><b>Research facilities and Equipment</b></p>	<p>IMDEA has state of the art facilities for study the fire-retardant materials and high-performance polymer-based composites. The most relevant for this project are:</p> <ul style="list-style-type: none"> <li>- Surface functionalization of fillers (e.g. minerals): high speed mixer, ball grinder, etc.</li> <li>- Polymer processing: twin-screw extruder, injection machine, inter mixer, hot press, triple roller mill, high speed mixer, 3D printer, etc.</li> <li>- Fire facilities: UL94 Horizontal/Vertical Flame Chamber, Limiting Oxygen Index, Dual Cone Calorimeter, simulated single burning item, microscale combustion calorimeter, thermal analysis coupled with FTIR and differential scanning calorimeter, etc.</li> <li>-Structural characterization: SEM, TEM, XRD, Raman, X-ray computer-assisted 3D nanotomography, FTIR, particle size analysis, GPC, etc.</li> <li>-Thermal and mechanical properties: TGA, DSC, DMA, Universal electromechanical testing machine, AFM, rheometer, impact tester, indentation, etc.</li> </ul>
<p><b>Relevant publications / patents / products</b></p>	<ol style="list-style-type: none"> <li>1. Xiao-Long Li, Fu-Hui Zhang, Rong-Kun Jian, Yuan-Fang, Jin-Lu, Guo-Jing Hui, De-Yi Wang. Influence of eco-friendly calcium gluconate on the intumescent flame-retardant epoxy resin: Flame retardancy, smoke suppression and mechanical properties. Composites Part B: Engineering, 2019, 176,107200.</li> <li>2. Pablo Acuña, Zhi Li, Mercedes Santiago-Calvo, Fernando Villafañe, Miguel Ángel Rodríguez-Perez, De-Yi Wang*. Influence of the Characteristics of Expandable Graphite on the Morphology, Thermal Properties, Fire Behaviour and Compression Performance of a Rigid Polyurethane Foam. Polymers, 2019, 11(1),</li> <li>3. . Yunxian Yang, Laia Haurie, Jianheng Wen, Shuidong Zhang, De-Yi Wang*. Effect of oxidized wood flour as functional filler on the mechanical, thermal and flame-retardant properties of polylactide biocomposites. Industrial Crops and Products, 2019, 130, 301-309.</li> <li>4. Zhi Li, Junhao Zhang, Francios Dufosse and De-Yi Wang*. Ultrafine nickel nanocatalyst-engineering organic layered double hydroxide towards super-efficiently fire-safe epoxy resin via interfacial catalysis. J. Mater. Chem. A, 2018, 6, 8488-8498.</li> <li>5.“Novel Fire Retardant Polymers and Composite Materials” Editor : De-Yi Wang. Date: 06 Sep 2016, Elsevier (Woodhead) Publishing, Print Book ISBN : 9780081009772</li> <li>6. De-Yi Wang, Nian-Jun Kang, Xiao-Min Zhao. A halogen free flame-retardant epoxy resin composition. International Patent Application, PCT 2917.3, 2013.</li> </ol>

Chinese Company 1 (China)	
<b>General description</b> 	<p>Chongqing Jiaotong University (CQJTU), as one of the higher education institutions in China, enjoys a nation-renowned reputation in transportation and civil engineering. As a key university directly under the administration of Chongqing Municipal Government, CQJTU has become a comprehensive, research/teaching-oriented and internationalized university with some 70 years' efforts.</p> <p>Up to now, CQJTU has 3 postdoctoral research stations, 4 first-level disciplines authorized to offer doctorate degree, 14 second-level disciplines authorized to offer doctorate degree, 16 first-level disciplines authorized to offer master degree, 54 second-level disciplines authorized to offer master degree and 5 disciplines authorized to offer professional master degree. CQJTU has 1 national engineering technology research centre, 1 national key laboratory, 1 national-local joint engineering laboratory, 35 provincial/ministerial key laboratories and 12 provincial/ministerial key disciplines. Currently, 32,114 students at different levels and in different fields, including 27,981 full-time students, study and search in CQJTU. At present, CQJTU has a faculty of 2,049, including 1,556 full-time teachers. Among the full-time teachers, nearly 120 people obtain provincial/ministerial (or above) professorship.</p> <p>CQJTU has established friendly, long-term cooperative relationships with more than 15 universities and scientific research institutes from United States, Russia, Canada, Germany, United Kingdom, France, Japan, Australia and Poland to carry out extensive academic exchange and research cooperation.</p> <p>CQJTU has successively undertaken multiple national and provincial/ministerial scientific research projects including the National Program for Tackling Key Problems in Science and Technology, "the State 863 Program", "the State 973 Program", the National Key Research and Development Project, projects under the National Social Science Foundation and key tackling programs in fields of philosophy and social sciences of the Ministry of Education. In 2019, the scientific research grant to the University was over CNY 252 million. Over past decade, CQJTU has won nearly 200 provincial/ministerial awards for the progress in science and technology, including the National Prize for Progress in Science and Technology (first, second and third prizes), the State Invention Award, the National Teaching Achievement Award and the China Bridge Award-the Grand Prize for Mao Yisheng Science and Technology Award.</p>
<b>Role of key persons</b>	<p>Dr. Zhi Li, Associate Professor of CQJTU, obtained the Doctoral Title (Cum Laude) concerning flame retardancy of polymer composites in Polytechnic University of Madrid (UPM). In 2019, Dr. Zhi Li joined School of Materials Science and Engineering of CQJTU and assisted establishing China-Spain Collaborative Research Centre for Advanced Materials (CSCRC). Currently, Dr. Zhi Li' research focuses in the hierarchical functionalization of nanomaterials for fire-safe polymers and energy materials.</p> <p>Up to now, Dr. Zhi Li has authored 40 SCI papers in international high-level academic journals such as <i>Journal of Materials Chemistry A</i>, <i>Polymer Chemistry</i> and <i>Chemical Engineering Journal</i>. Dr. Zhi Li patents 3 domestic and foreign inventions. Currently, Dr. Zhi Li serves as the academic editor of <i>International Journal of Polymer Science</i>. As the principle investigator, Dr. Zhi Li has been ever granted by National Natural Science Foundation of China, Chongqing Municipal Science and Technology Commission, Chongqing Municipal Education Commission as well as CQJTU.</p>
<b>Research facilities and Equipment</b>	<p>The University has state-of-the-art facilities for the proposal. The most relevant for this project are:</p> <ul style="list-style-type: none"> <li>- Extrusion machine, Injection machine, hot press</li> <li>- Scanning electron microscopy, TEM</li> <li>- X-ray diffraction, Laser Particle Size Analyzer, FTIR</li> <li>- High-energy milling machine</li> <li>- Limiting oxygen index and UL-94 chamber, TGA, DSC</li> </ul>
<b>Relevant publications / patents / products / services</b>	<ol style="list-style-type: none"> <li>1. Ultrafine Ni catalyst-Assembling Layered Double Hydroxide-derived Nanohybrid towards Super-efficiently Fire-safe Epoxy Resin, <i>Journal of Materials Chemistry A</i>, 2018; 6; 8488-8498</li> <li>2. Bio-based Layered Double Hydroxide Nanocarrier toward Fire-retardant Epoxy Resin with Efficiently Improved Smoke Suppression, <i>Chemical Engineering Journal</i>, 2019, 378: 122046</li> <li>3. Bioinspired Polydopamine Induced Assembly of Ultrafine Fe(OH)<sub>3</sub> Nanoparticles on Halloysite toward Highly Efficient Fire Retardancy of Epoxy Resin via An Action of Interfacial Catalysis. <i>Polymer Chemistry</i>, 2017; 8:3926-3936</li> <li>4. Natural Halloysite Nanotube-Based Functionalized Nanohybrid Assembled via Phosphorus-containing Slow Release Method: A Highly Efficient Way to Impart Flame Retardancy to Polylactide. <i>European Polymer Journal</i>, 2017; 93:458-470</li> <li>5. A Geometry Effect of Carbon Nanomaterials on Flame Retardancy and Mechanical Properties of Ethylene-Vinyl Acetate/Magnesium Hydroxide Composites, <i>Polymers</i>, 2018; 10: 1028.</li> </ol>

Chinese Company 2 (China)	
<p>General description</p> 	<p>Shanghai Institute of Ceramics, Chinese Academy of Science (SICCAS) founded in 1959 is a comprehensive and unique organization engaged in advanced inorganic nonmetallic materials research. It has achieved outstanding results in pioneering basic research, innovation of high-tech materials and applied research. Its main research areas include high performance ceramics and superfine microstructures, structural ceramics and composites, inorganic functional materials and devices, energy materials, inorganic coatings, artificial crystals, biomaterials and tissue engineering, environmentally friendly materials, the analysis and characterization of inorganic materials, and the technological study of industrial ceramics and ancient Chinese ceramics. SICCAS has about 1276 valid patents, ranking it among the top 10 institutes in China. In addition, the number of citations of SICCAS papers indexed by SCI places SICCAS among the top 10 institutes in China in that category. SICCAS also publishes the Journal of Inorganic Materials, which is one China's key academic periodicals and is cited by SCI. SICCAS has nurtured a large number of talented researchers, thus increasing knowledge of inorganic materials in China. SICCAS has a staff of over 700, including about 500 scientific researchers and technicians. Among this group are two CAS academicians and three academicians of the Chinese Academy of Engineering. SICCAS attaches great importance to developing the next generation of materials scientists, engineers and entrepreneurs.</p> <p>SICCAS enjoys extensive and long-term cooperative relationships with famous universities, institutes and enterprises all over the world. It has partnerships with the Max Planck Institute (Germany), the National Institute for Materials Science (Japan) and the Academy of Science and Technology (South Korea), etc. It has also set up joint labs with Sony and Corning, and has signed about more than one hundred cooperative agreements with organizations such as General Electric, CERN and Samsung, etc. In 2010, it became a member of the International Energy Association. SICCAS has hosted numerous international conferences on modern ceramic technology.</p> <p>SICCAS encourages researchers to go abroad for international exchange and study. It also welcomes foreign researchers to engage in cooperative research or give academic lectures at the institute. It has so far hosted Nobel Prize winners Samuel Chao Chung Ting, Tsung-Dao Lee and Ei-ichi Negishi as well as 30 other celebrated foreign researchers as visiting scholars.</p>
<p>Role of key persons</p>	<p>Jiacheng Wang is a Professor of SICCAS and a PI for Electrocatalytic Materials and Energy Devices Group. He was awarded Shanghai Academic Research Leader, Talent Recruitment for Overseas Distinguished Talents, Alexander von Humboldt Fellow, JSPS Postdoctoral Fellow for Foreign Researcher, and Marie Curie Intra-European Fellow. Before joining SICCAS, he worked in the University of Tokyo (Collaborator: Prof. Makoto Onaka), Dresden University of Technology (Collaborator: Prof. Stefan Kaskel), and Cardiff University (Collaborator: Prof. Graham Hutchings) for totally six years.</p> <p>Prof. Jiacheng Wang's research interests include the design and preparation of novel inorganic nanosized materials for energy conversion and storage. In combination with experimental study and theoretical calculation, he has studied the intrinsic relationship of surface/interface structure, coordination method, and electronic structures, as well as its effect on the electrocatalytic performance. He has built a new strategy of electron transfer capacity, and disclosed the mechanism of synergistically enhancing activity by both anions and cations. A theory of anion electrocatalysis has been developed in the field of electrocatalysis. Based on the research, he also proposed new mechanisms of electron reservoir, coupling of localization and non-localization, and auto-optimizing catalysis, and novel strategy of target grafting/riveting for catalytic sites. Moreover, a series of high-activity electrocatalytic materials have been prepared including nanosized ZrN, monolayer ReS<sub>2</sub>, and triazine ring. He has published over 140 papers in various international famous journals including Nature Mater., Prog. Mater. Sci., npj Comput. Mater., Angew. Chem. Int. Ed., Adv. Mater., Energy Environ. Sci., etc.</p>
<p>Research facilities and Equipment</p>	<p>Eight channel battery testing system; Button cell assemble machine; Dual channel electrochemical workstation; Electrochemical workstation;</p>

	<p>High-speed centrifuge; Freeze dryer; Atmosphere furnace; Vacuum hot pressing furnace; Tube atmosphere furnace; Ion-beam multi-target sputtering system; Inkjet delivery system; Fourier Transform Infrared Spectrometer; Fluorescence spectrometer; UV-Visible Spectrophotometer; Infrared thermal imager; High pressure gas adsorption apparatus</p>
<p><b>Relevant publications / patents / products / services</b></p>	<p>Yao Yuan (#), Jiacheng Wang (# co-first author), Samira Adimi, Hangjia Shen, Tiju Thomas, Ruguang Ma, John Paul Attfield,* and Minghui Yang,* "Zirconium Nitride Catalysts Surpass Platinum for Oxygen Reduction", Nature Mater., 2020, 19, 282-286.</p> <p>Yao Zhou (#), Erhong Song (#), Wei Chen (#), Carlo U. Segre, Jiadong Zhou, Yung-Chang Lin, Chao Zhu, Ruguang Ma, Pan Liu, Shufen Chu, Tiju Thomas, Minghui Yang, Qian Liu, Kazu Suenaga, Zheng Liu,* Jianjun Liu,* and Jiacheng Wang,* "Dual-Metal Interbonding as the Chemical Facilitator for the Single-Atom Dispersions", Adv. Mater., 2020, DOI: 10.1002/adma.202003484.</p> <p>Chun Hu (#), Jinhua Hong (#), Jian Huang,* Wei Chen, Carlo Segre, Kazu Suenaga, Wei Zhao, Fuqiang Huang,* and Jiacheng Wang,* "Surface Decoration Accelerates the Hydrogen Evolution Kinetics of a Perovskite Oxide in Alkaline Solution", Energy Environ. Sci., 2020, DOI: 10.1039/D0EE01598A.</p> <p>Qiangjian Ju, Ruguang Ma,* Yu Pei, Beibei Guo, Zichuang Li, Qian Liu, Tiju Thomas, Minghui Yang,* Graham J. Hutchings, and Jiacheng Wang,* "Ruthenium Triazine Composite: A Good Match for Increasing Hydrogen Evolution Activity through Contact Electrification", Adv. Energy Mater., 2020, 10, 2000067.</p> <p>Ruguang Ma, Yao Zhou, Hui Bi, Minghui Yang, Jiacheng Wang,* Qian Liu,* and Fuqiang Huang,* "Multidimensional Graphene Structures and Beyond: Properties, Syntheses and Applications", Prog. Mater. Sci., 2020, 113, 100665.</p> <p>Patents:</p> <p>Jiacheng Wang, Qiangjian Ju, Ruguang Ma, "Multi-channel electrochemical test apparatus and the corresponding cells", Chinese Patent, 201821942031.9</p> <p>Jiacheng Wang, Chun Hu, Qian Liu, "Ru nanoparticles supported on Fe, N-doped porous carbon electrocatalysts and the preparation method", Chinese Patent, 201810629748.6</p> <p>Qian Liu, Jiacheng Wang, Qingfeng Liu, "A kind of nitrogen-doped mesoporous aluminum phosphate molecule sieve", Chinese patent, 200610029362.9</p>

**YOUR ENTITY PRODUCTS**  
**(Technologies, applications, services, etc)**

See the previous section.