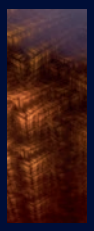
.institute IMdea

madrid institute
for advanced studies



institute IMdea materials

encompassing research of excellence and technology transfer

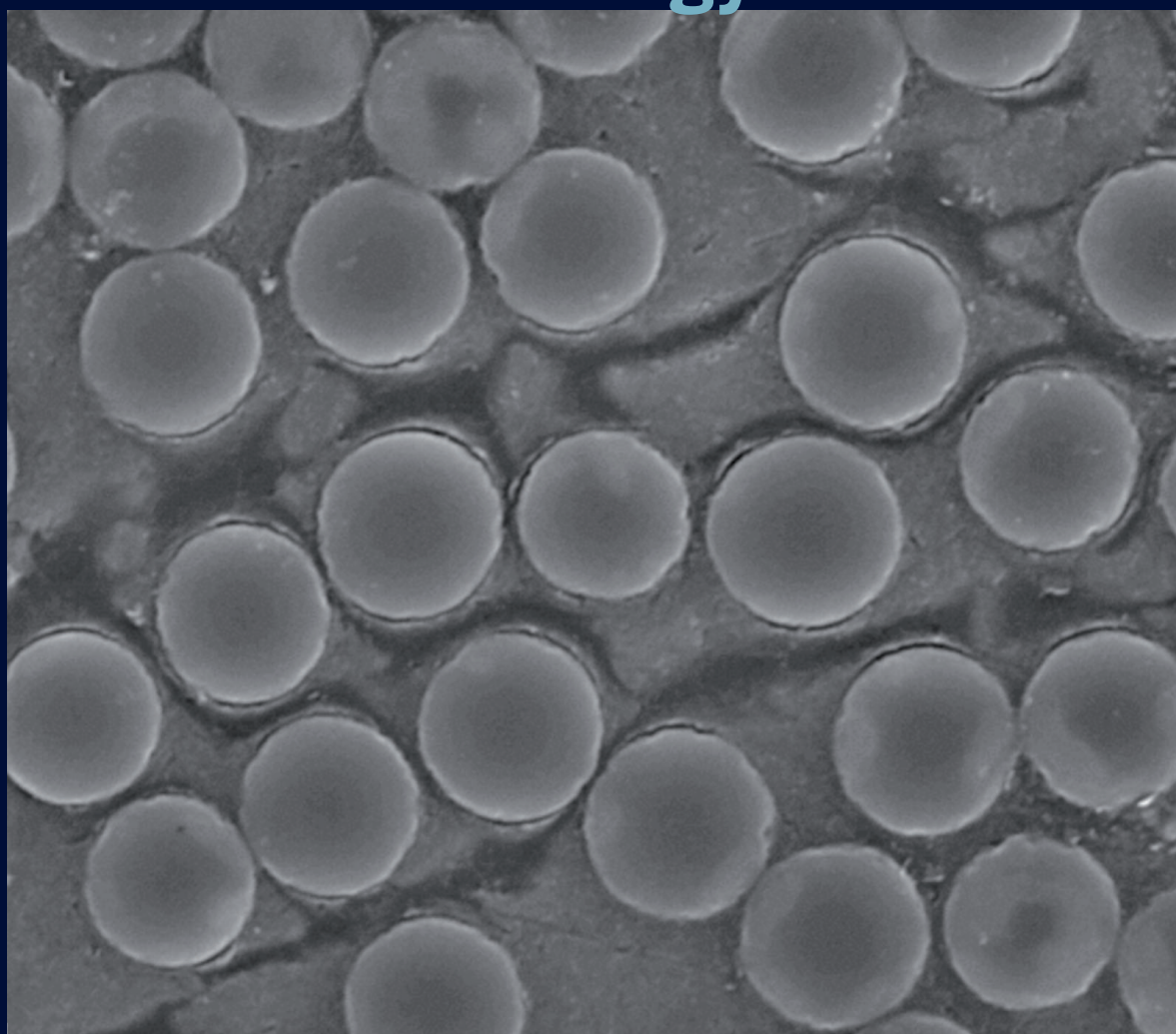
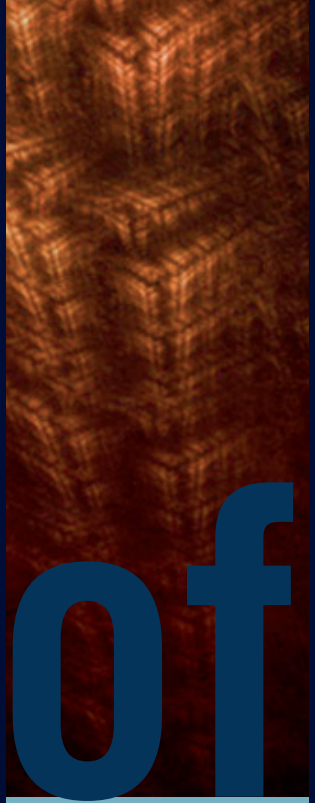


table of contents



contents

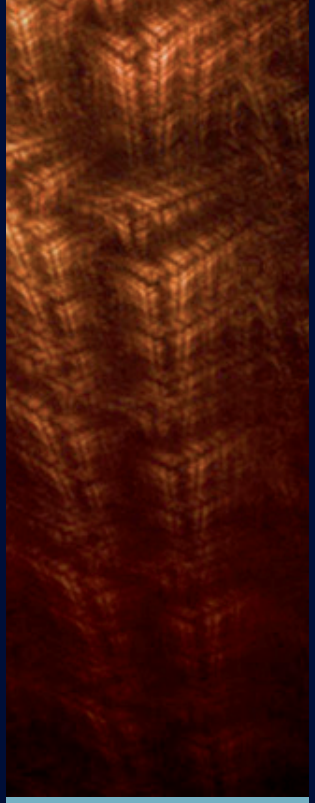
encompassing research of excellence and technology transfer

institute IMDEA materials

1

institute profile

研究所简介



IMDEA Materials Institute (Madrid Institute for Advanced Studies of Materials) is a non-profit independent research institute promoted by the Madrid regional government to perform research in Materials Science and Engineering. IMDEA Materials Institute belongs to the Madrid Institute for Advanced Studies network, a new institutional framework created to foster social and economic growth in the region of Madrid by promoting research of excellence and technology transfer in a number of strategic areas (water, food, social sciences, energy, materials, nanoscience, networks, software).

1.1. Objectives

IMDEA Materials is committed to three main objectives:

- Excellence in Materials Science and Engineering research.
- Technology transfer to the industrial sector in order to increase competitiveness.
- Attract talented researchers from all over the world to Madrid to work in a truly international and interdisciplinary environment.

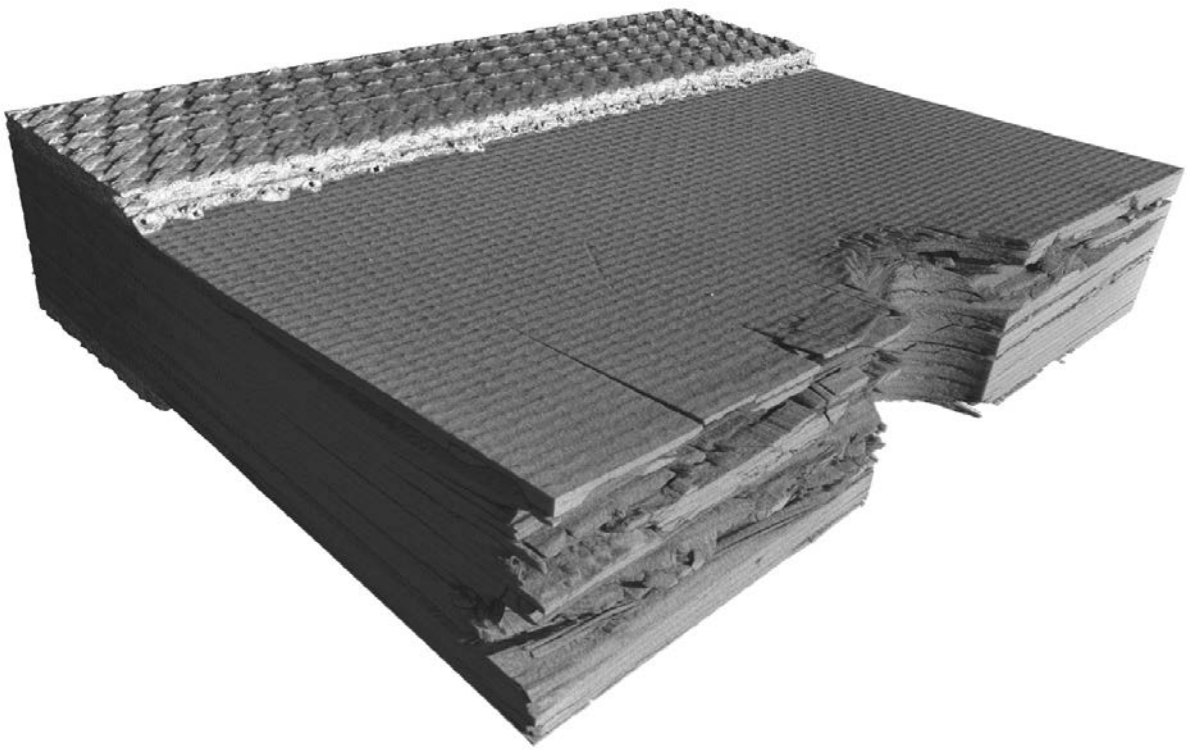
Figure 1. IMDEA Materials Institute

1.2. Location

The headquarters of IMDEA Materials Institute is located at the Scientific and Technological Park of the Polytechnic University of Madrid in Tecnogetafe. The Institute has a total floor area of 9,000 m^2 devoted to offices for researchers and staff, seven main laboratories (processing of nanocomposites, processing of advanced structural materials, chemical and microstructural characterization, thermo-mechanical characterization, nanomechanics and computational materials science), as well as a conference area to host scientific workshops.

1.3. Researchers

IMDEA Materials Institute research staff encompasses approximately 100 people, including 16 Staff Researchers, 2 Visiting Scientists, 20 Postdoctoral Research Associates, 40 PhD students and 20 master students from 16 different nationalities. Approximately 50% of the researchers have been born abroad while 60% of the PhDs were granted by foreign universities from the five continents, including Cambridge University, Max Plank for Iron Research, Delft University of Technology, University of California Berkeley, Dayton University, India Institute of Technology, China Central South University, Sichuan University, etc. This ability to attract talent from everywhere is rapidly contributing to establish IMDEA Materials Institute as an international reference in the materials science and engineering field.



1.4. R&D activities

The Institute is currently involved in the development of approximately 60 research projects funded by industry (Airbus, Gamesa, Global Foundries, ITP, Fokker, Hexcel, Abengoa, Boeing, BE Aerospace, Tolsa, etc.), the European Union, the Spanish Ministry of Economy and Competitiveness, the Spanish Center for Technological and Industrial Development, and the Regional government of Madrid. In addition, the institute has carried out several research projects funded by international funding agencies such as the Materials World Network within the framework of the research agreements between the Spanish and US National Science Foundations, the Russian Federation and CAPES Foundation of Brasil. As a result of these research activities, the Institute researchers have registered ten patents and published over 480 papers in international peer-reviewed journals (including Scientific American, Advanced Materials, Physical Review Letters, Acta Materialia, Journal of the Mechanics and Physics of Solids, Annual Review of Materials Science, Macromolecules, Composites Science and Technology, Langmuir, etc.) during the last eight years.

Figure 2. Research Programmes of IMDEA Materials Institute

These programmes are focused on the development of advanced materials mainly in the sectors of transport, energy, information technology and manufacturing as well as on the exploration of emerging materials and processes for sustainable development.

Each research programme combines the expertise of different research groups (processing, characterization and simulation) leading to a multidisciplinary effort to achieve results beyond the state-of-the-art.

Driven by the talent of the researchers, research programmes combine cutting-edge fundamental oriented research in topics at the frontiers of knowledge with applied research encompassing the midterm interest of our industrial partners to provide long-term technological leadership.

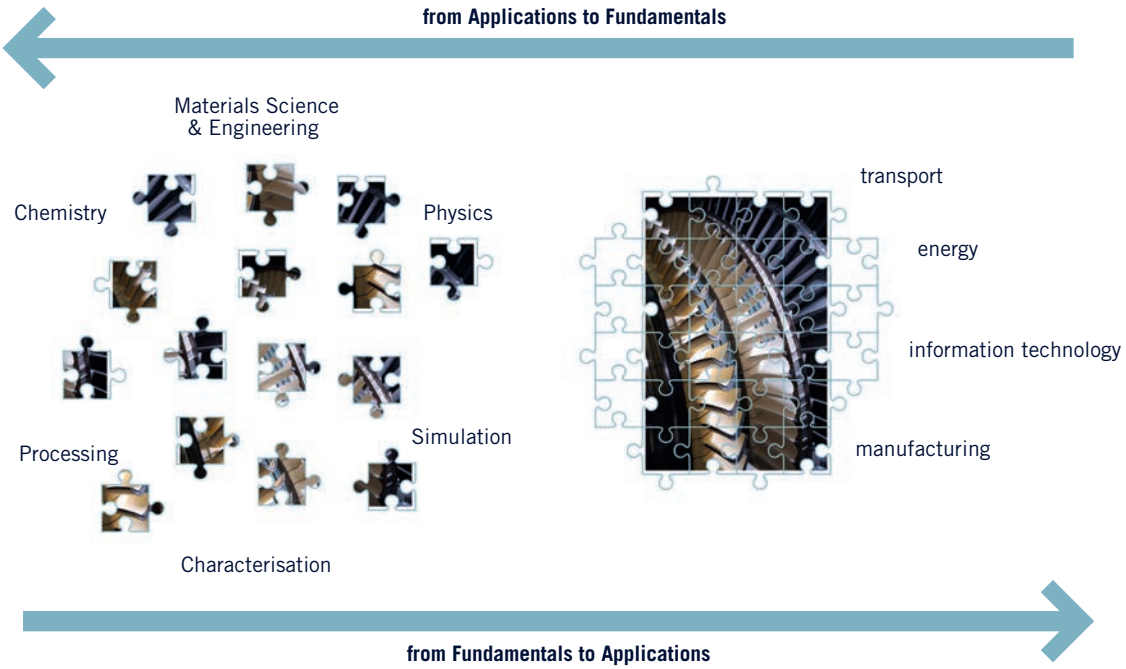
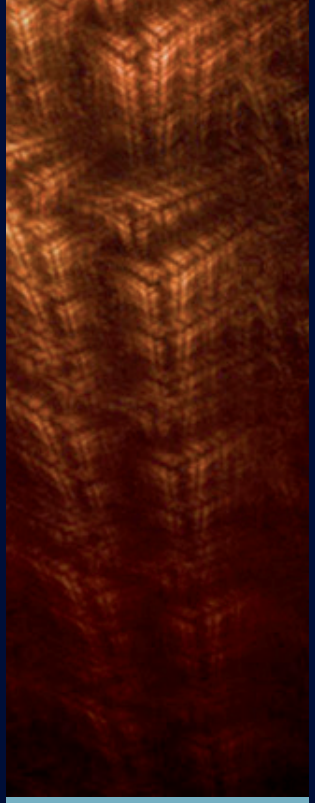


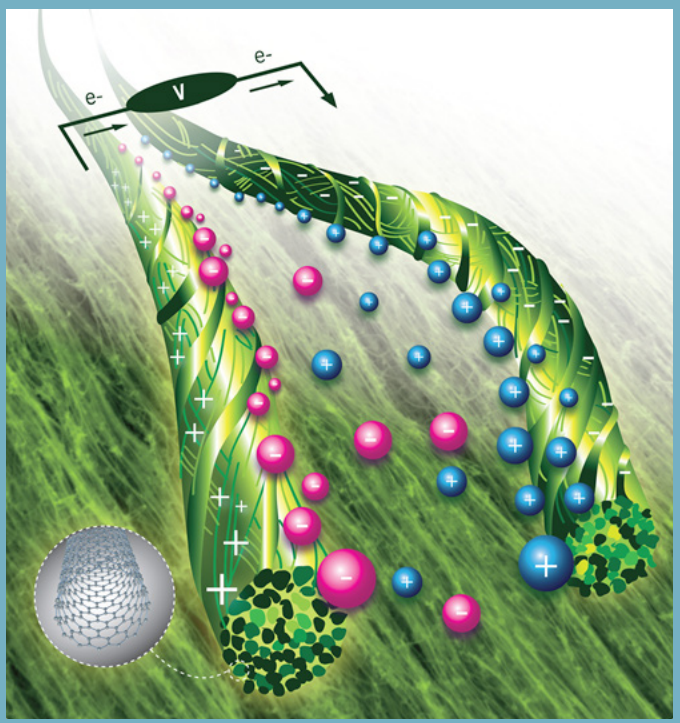
Figure 3. Bottom-up (fundamentals to applications) and top-down (applications to fundmentals) research approaches of IMDEA Materials Institute.



2 research programmes
研究课题

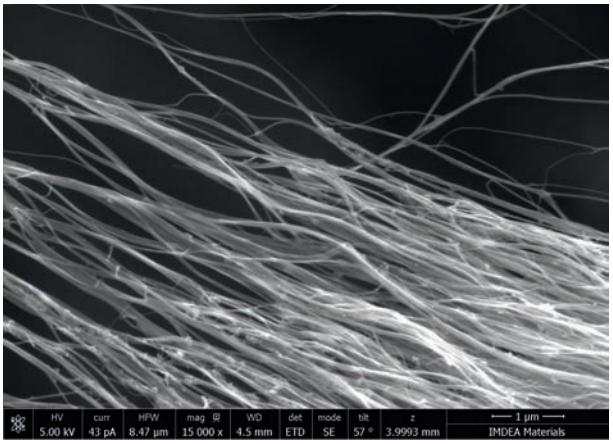
Nanomaterials for Multifunctional Applications

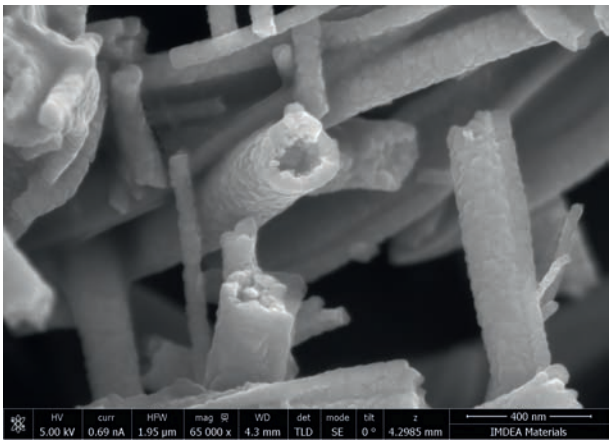
- Synthesis, emerging technologies and integration of carbon-based nanomaterials (graphene, nanotubes, nanofibers and hybrids). Nanomaterials for energy generation and storage, Sensors, Hierarchical materials, Size effects in the mechanical behaviour of multifunctional materials.
- Design and development of new capacitor and battery systems
- Synthesis and properties of polymer-based multifunctional nanocomposites. Sustainable materials, Fire retardant materials through nanodesign.
- Design of nanoscale multilayers for extreme environments: high temperature coatings, radiation resistant applications, etc
- Computational and data-driven Materials Discovery. Discovery of porous materials for energy applications, Design of ionic liquids, Characterization of nanoparticles and others.



multifunctional

applications





encompassing research of excellence and technology transfer

The Next Generation of Composite Materials

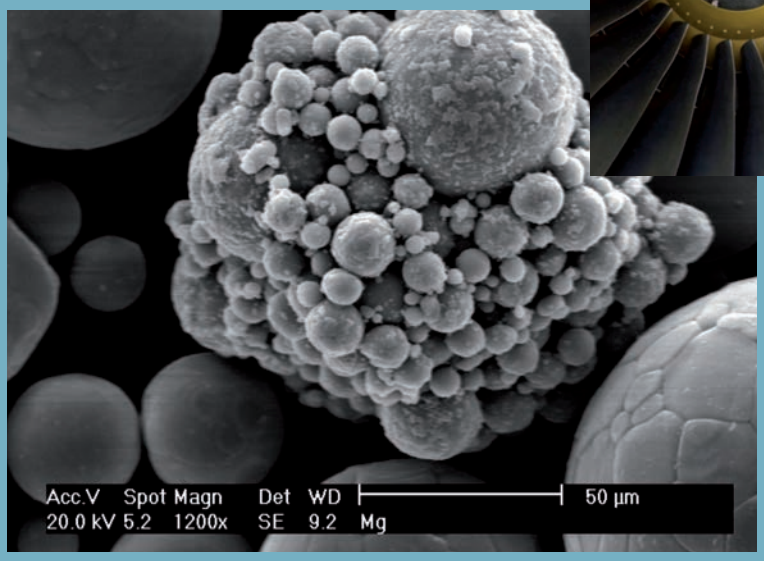
- Processing of high performance composites. Optimization of out-of-autoclave curing, hot-forming, non-conventional curing strategies, optimization of manufacturing strategies.
- Recycling and repair of structural composites. Green (recyclable) epoxies, electric current-assisted curing for bondings and repairs, effect of ageing on composite performance.
- New frontiers of structural performance. High temperature, impact, self-healing, smart materials, self-sensing, toughened composites, non-conventional lay-up configuration, green composites, etc.
- Composites with multifunctional capabilities. Fire resistance, electrical and thermal conductivity, energy managements, barrier properties, non-destructive evaluation and health monitoring, etc.
- Micromechanics of composites.
- Virtual processing and testing of composites.

# of composite materials

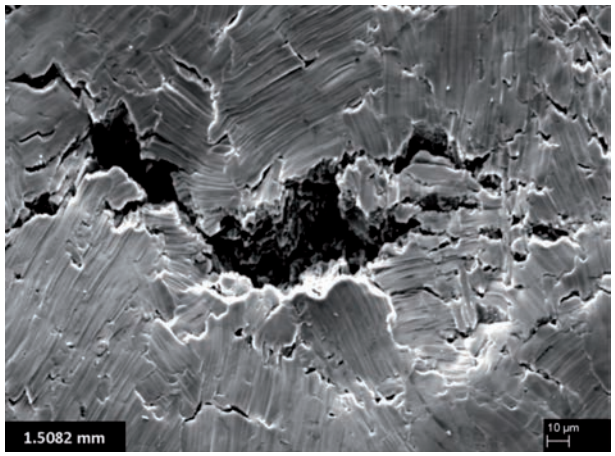
alloy design, processing

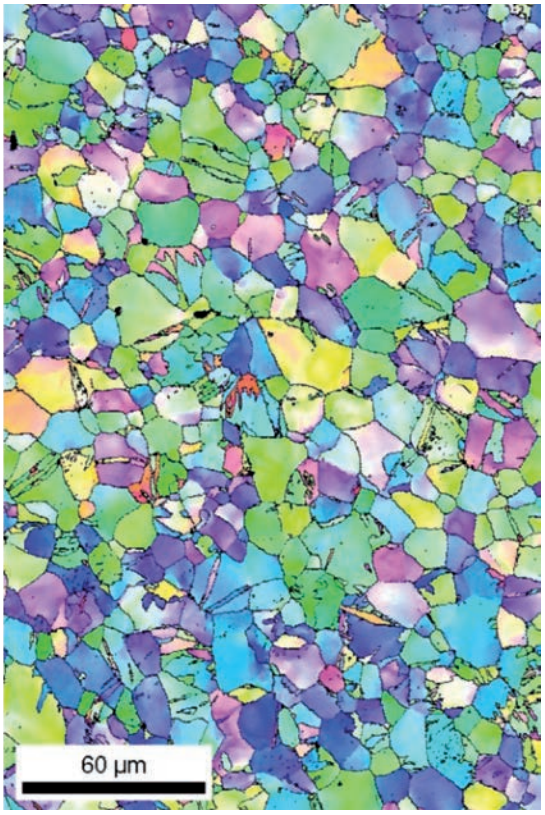
Alloy Design, Processing and Development

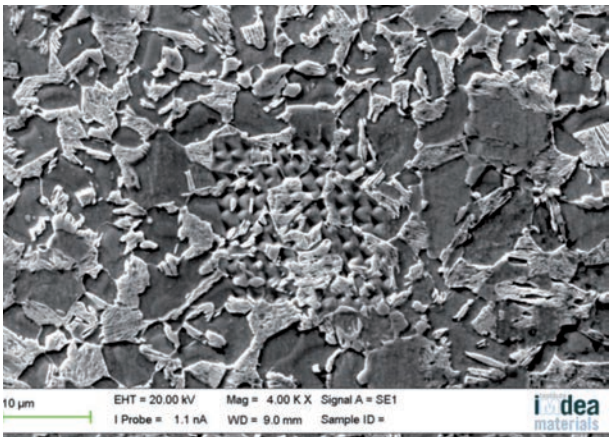
- Metallic alloys for high temperature structural applications. Ni/Co-based superalloys, NiAl and TiAl based alloys and FeAl alloys.
- Lightweight (Mg, Al, Ti) alloys and their composites. Development of advanced medical implants from pure Ti and the next generation electrical conductors from Al alloys. Light Mg alloys and nanocomposites for green transport.
- Solidification and Casting. Optimization of casting processes and solidification-microstructure relationships using traditional and advanced techniques.
- High strength steels. Quenched and partitioned steels, welding, etc.
- Physical simulation of metallurgical processes. Development of novel thermo-mechanical processing routes for the fabrication of metallic materials with superior properties; design and optimization of metallurgical processes (rolling, forging, extrusion, welding, casting, etc.).
- High throughput screening of materials.
- Model-based materials design.
- Simulation of the mechanical behaviour.
- Solid state processing.
- Metals additive manufacturing.

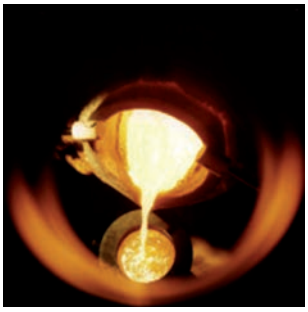


and development







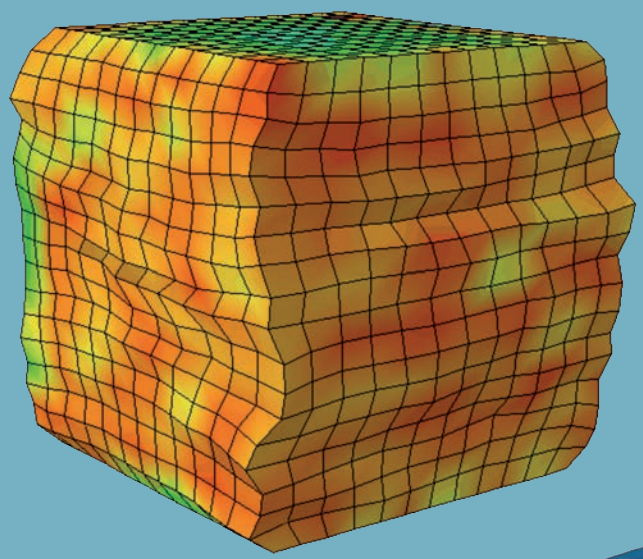


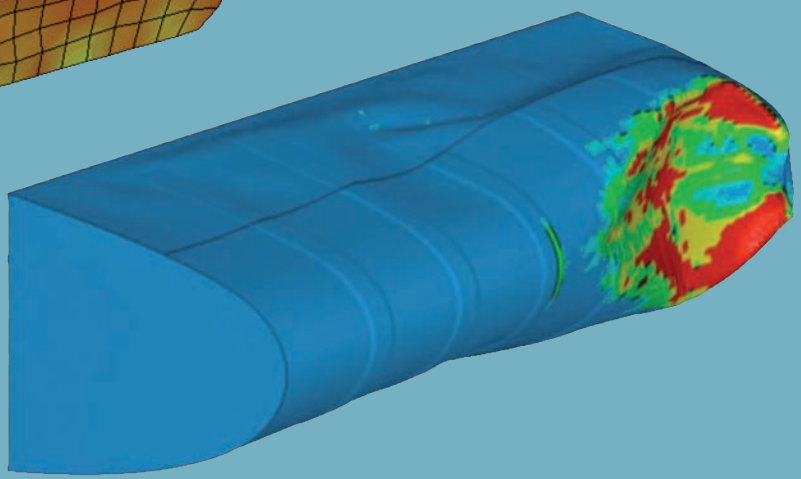
encompassing research of excellence and technology transfer

integrated computational

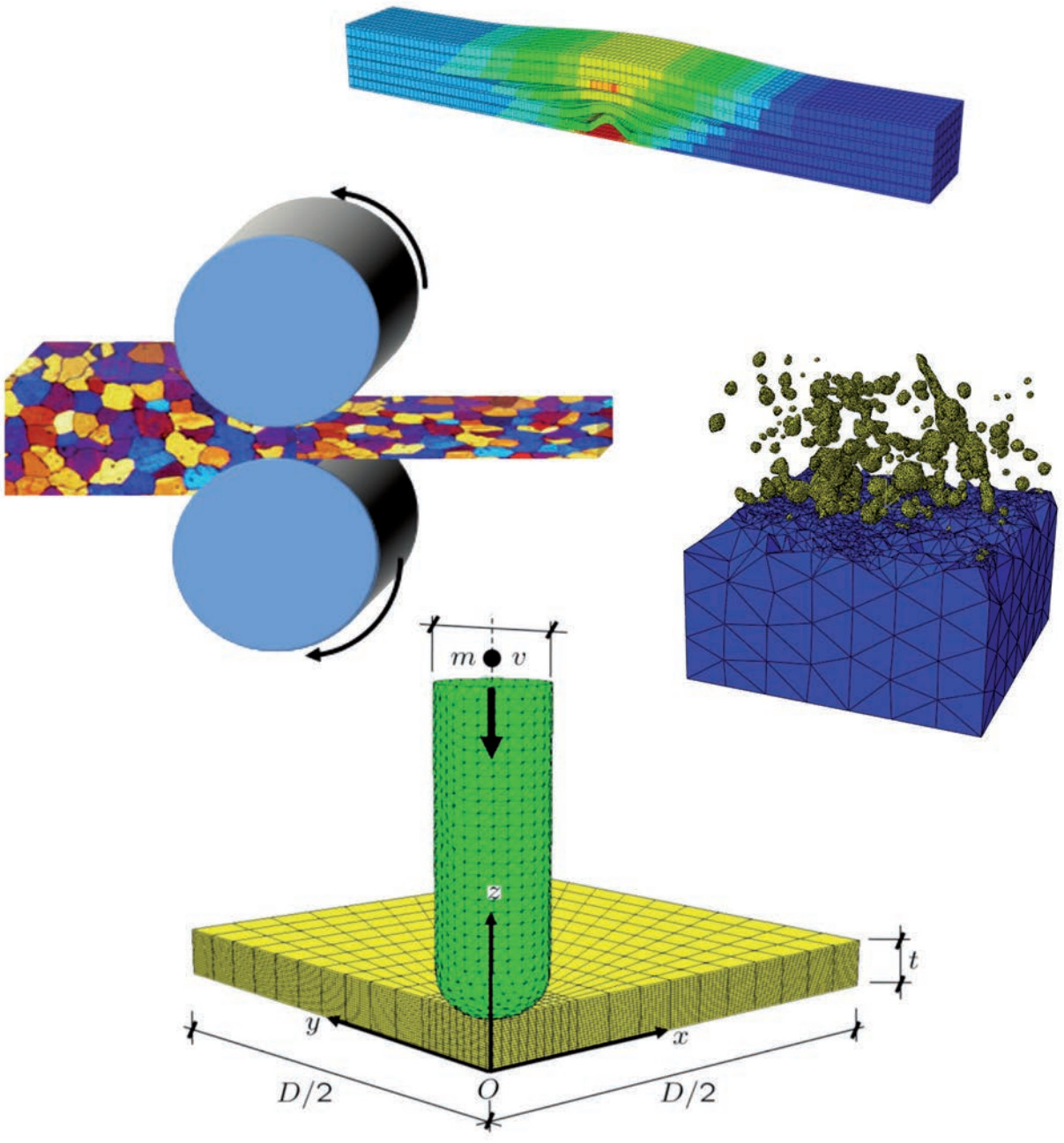
Integrated Computational Materials Engineering

- Development of multiscale modelling strategies to carry out virtual design, virtual processing, and virtual testing of metallic and composite materials (ab initio, molecular mechanics, computational thermodynamics, kinetic Monte Carlo, phase-field modelling, computational fluid dynamics, dislocation dynamics, finite elements, homogenization, etc.).
- Integrated computational materials engineering.
- Numerical simulation of damage and failure of composite and metallic materials and
- structures; impact and damage tolerance analysis.



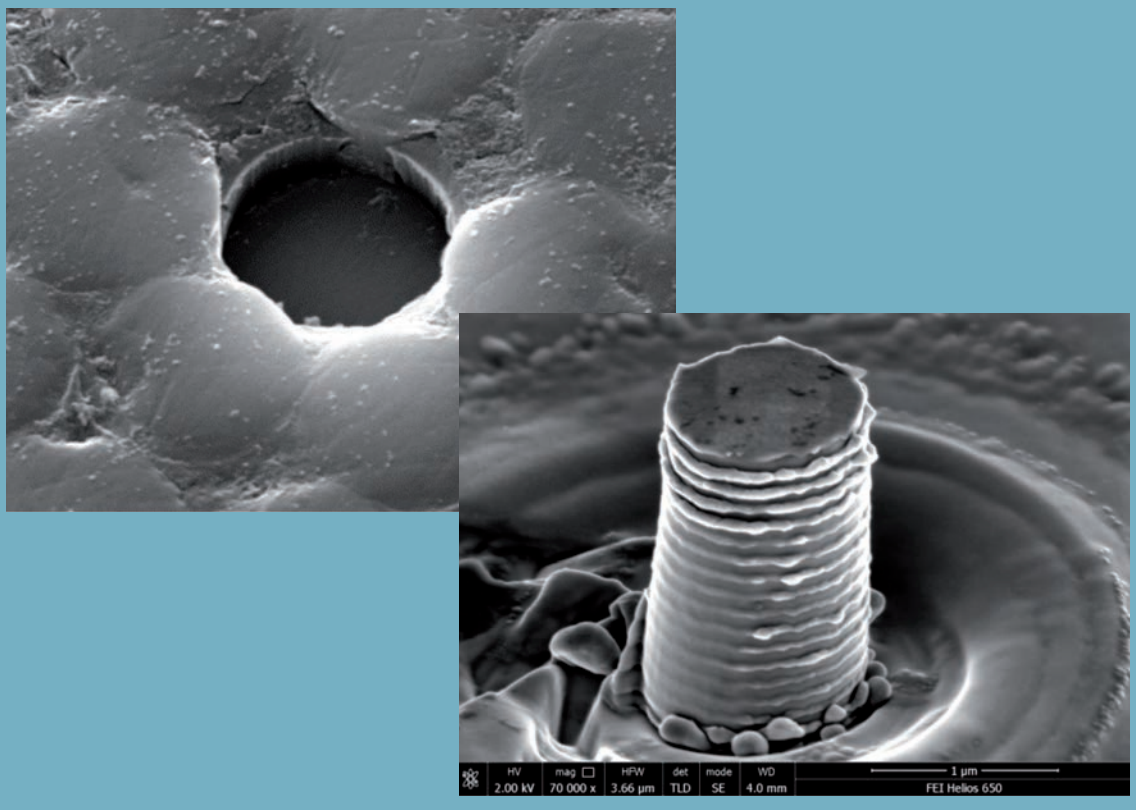


materials engineering

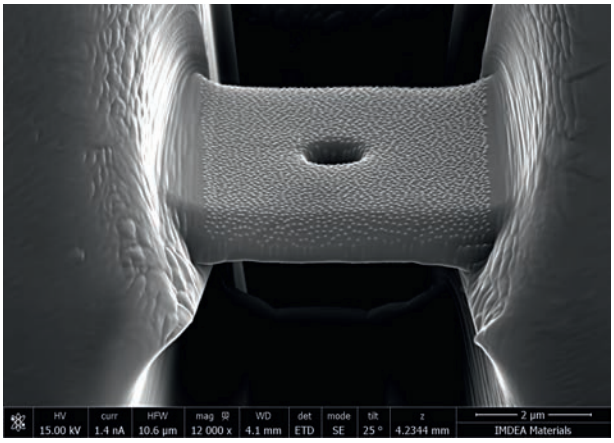


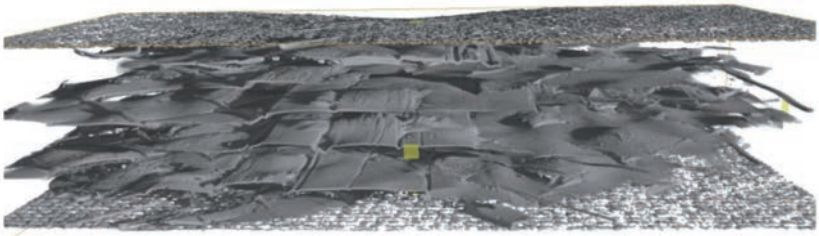
Multiscale Characterization of Materials and Processes

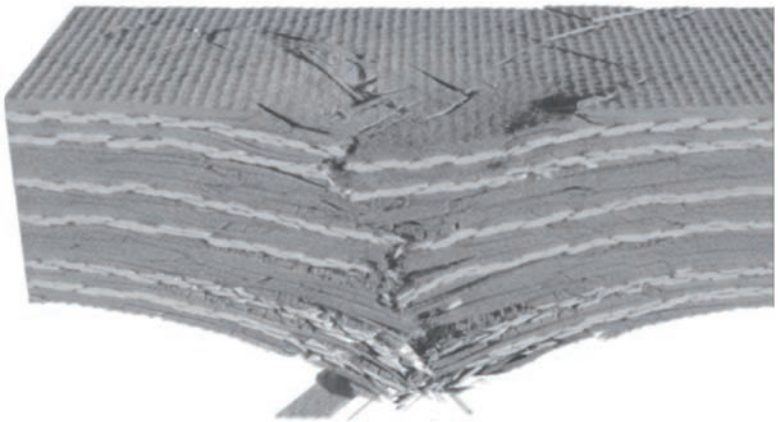
- 3D Characterization of materials, including microstructural, chemical and crystallographic information across several scales and using different techniques. X-Ray Tomography (XCT) and Diffraction (XRD); FIB-FEGSEM, including 3D-SEM, 3D-EDS and 3D-EBSD; TEM, including 3D-STEM and 3D-EDS; Multiscale correlative tomography studies, i.e. tomography across multiple scales & combining insights from different techniques.
- In-situ characterization of processes across multiple scales (4D characterization). Mechanical testing across several length scales; 4D characterization of forming processes by XCT (Infiltration and resin flow studies in composites and Solidification studies).
- Cross-correlation between experiments and multiscale simulations (molecular dynamics, dislocation dynamics, crystal plasticity, finite elements, ...).



# of materials and processes





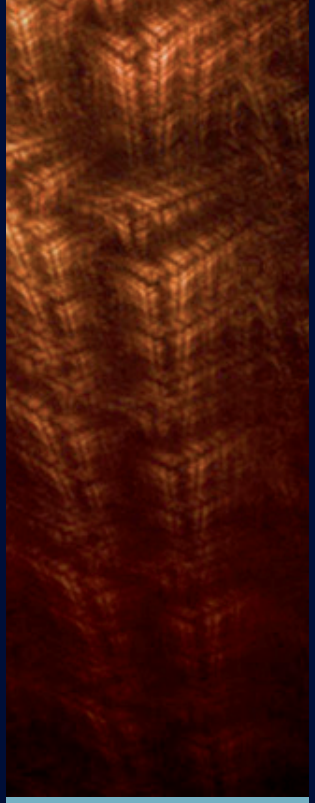


encompassing research of excellence and technology transfer

3

graduate study and life in madrid

研究生学习以及马德里生活介绍



3.1. Why Madrid

- Madrid is the capital of Spain.
- 6.5 million inhabitants in its Metropolitan Area and 3.3 million in the Capital. It is the third most populous city in the European Union.
- Capital of Spanish language and culture.
- Europe's third largest metropolitan area after Paris and London.
- Fourth richest city in Europe.
- Home to the 'Cortes Generales'- the Spanish Houses of Parliament - the Government of Spain, and the home of the Spanish Royal Family
- Average height above sea level: 667 m.
- Average temperature: 12 °C.
- Area: 605.77 km^2.
- Income per capita in Madrid is $40,000 and contributes 18% of the total national GDP.
- Barajas Airport, with annual passenger traffic of 50 millions,it is the fourth largest in Europe and tenth in the world. It is connected by metro and bus to the centre of the city.
- The Madrid metro is the second largest underground network in the world.
- There are five transport interchanges that connect the city bus network to the metro and railways.
- Madrid is linked by high-speed trains to the main Spanish cities.

Madrid is not just any city; it is a place full of energy and passion with a flavor of its own, rich in heritage to explore, full of spice and yet focused and highly sophisticated. In Madrid international students soon find themselves integrated into a multicultural environment to enjoy a city packed with creativity and fun where learning comes easy.

As the financial, political and cultural centre of Spain, Madrid is a modern, cosmopolitan city with a strong economy and a vibrant life. In recent years the growth and development of Madrid have placed it firmly within the network of global cities as the third great European metropolis and as the economic and cultural capital of the Spanish Speaking World.

The City of Madrid has a population of nearly three million people and is also the capital of the Madrid Region (Comunidad Autonoma de Madrid). This region is the economic powerhouse of Spain and also of Southern Europe; its six million inhabitants and their readiness to succeed make it possible every day... and night.

As a large metropolitan area, Madrid is tirelessly striving to attract productive investment, new technology businesses, scientific capability, creative talent, international institutions, a steady flow of tourists, and the staging of important events. Indeed, Madrid now stands out in many of these aspects over other major cities.

3.2. Resource directory

MADRID

Strategy and International Action Office Madrid Global
http://www.munimadrid.es/madridglobal

Madrid City Council Official websites
Resources for Culture and Leisure, Economy, Education, Environment, Immigration, Housing, Research, Sports and Youth
http://www.munimadrid.es/

Entertainment and tourism
http://www.esmadrid.com/en

Madrid Regional Government Official Website for Higher Education Information on Madrid Higher Education
http://www.emes.es/

Madrid Regional Government Official Website for R&D Madri+d
http://www.madrimasd.org/empleo/default.asp

The European Space for Higher Education
European policy for Higher Education with Bologna process
http://www.eees.es/

Chinese Students Association in Madrid
www.cn-es.org

UNIVERSITIES

Universidad Politécnica
www.upm.es

Introduction (English)
www.dit.upm.es/aalvarez/UPM.Introduction.pdf

Introduction (Chinese)
www.dit.upm.es/aalvarez/MadeliGong.pdf

Practical Information for Students
http://www.upm.es/internacional/Students/

Universidad Autónoma
www.uam.es

Orientation, Information and Employment
http://www.uam.es/estudiantes/coie.html

Graduate Studies and Continuing Education
http://www.uam.es/estudios/doctorado/presentacion.html

Scholarships
http://www.uam.es/estudiantes/becas.html

Orientation and Student Support
http://www.uam.es/estudiantes/acceso/

Universidad Carlos III
www.uc3m.es
English version:
http://www.uc3m.es/portal/page/portal/home

Masters and PhD
http://www.uc3m.es/portal/page/portal/postgraduate_studies

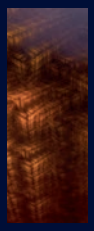
Living and Studying in Madrid
http://www.uc3m.es/portal/page/portal/get_know_us/living_studying_mad

www.materials.imdea.org

Comunidad de Madrid

EUROPEAN UNION
STRUCTURAL FUNDS

madrid institute
for advanced studies



institute
imdea
materials

www.materials.imdea.org

Contact
contact.materials@imdea.org
tel. +34 91 549 34 22
fax +34 91 550 30 47

c/ Eric Kandel, 2
E-28906 Getafe, Madrid · Spain