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UNIVERSIDAD DE EXTREMADURA

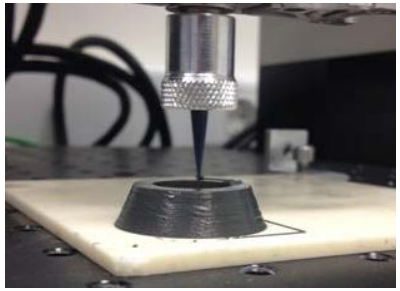
GEMA
Grupo Especializado de Materiales

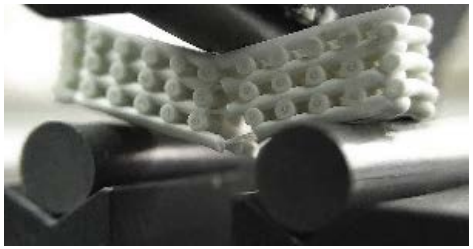
Groundbreaking Engineering Materials

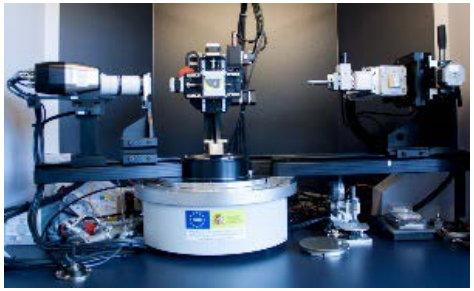
Description of the Organization

UNIVERSITY OF EXTREMADURA (UEX) is the main public research institution in Extremadura (Spain), with 4 campuses, over 24,000 students and 2,400 Researchers and Professors.

MATERIALS SCIENCE RESEARCH GROUP (GEMA) at the Dept, of Mechanical, Energy and Materials Engineering, is one of UEX top research groups in terms of scientific productivity and knowledge transfer activities. GEMA expertise lies in the field of advanced ceramics processing and additive manufacturing, together with their microstructural and mechanical characterization and modelling.

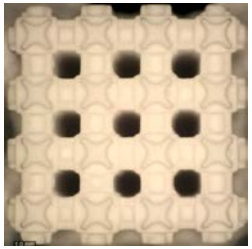


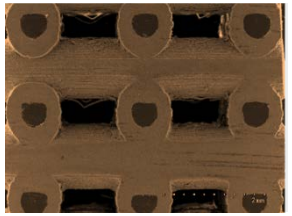


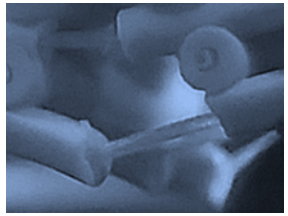


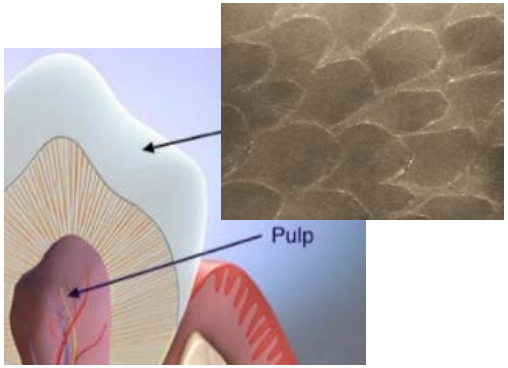
Description of your research interest

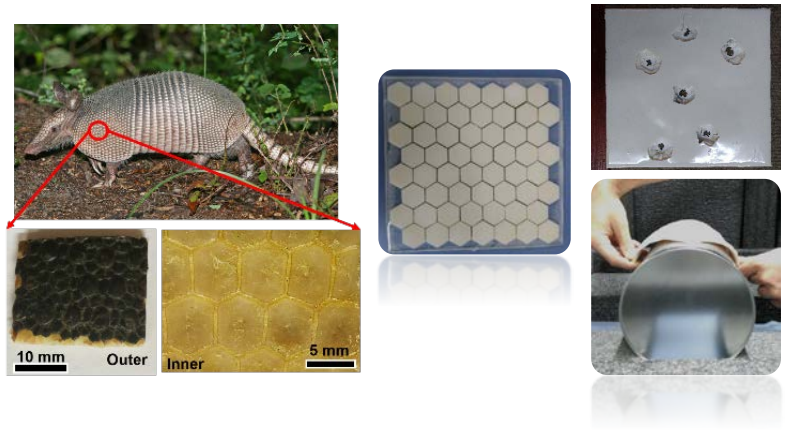
Additive manufacturing of **ceramic** and ceramic/non-ceramic co-continuous bioactive **composites** for **customized** and **biodegradable scaffolds** used in bone regeneration (TCP, HAp, 45S5 & 13-96 bioglasses...). **Bioinert ceramic** (Al_2O_3, ZrO_2, $MoSi_2$...) and **bioinspired composites** for **dental** and other engineering (e.g. armor) applications.





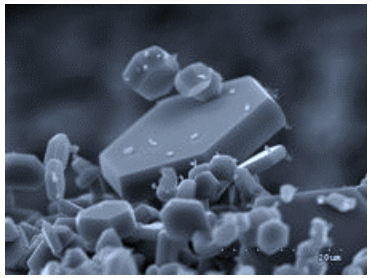
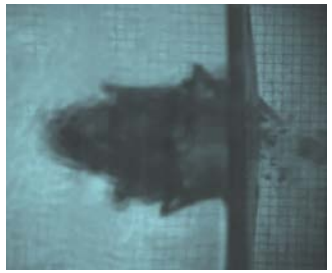






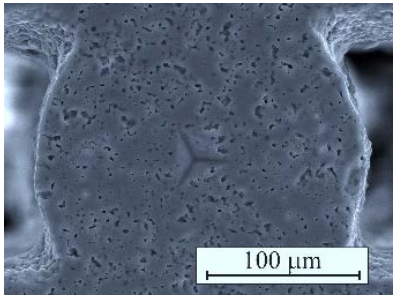
Description of your research interest

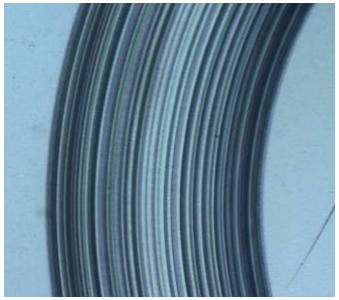
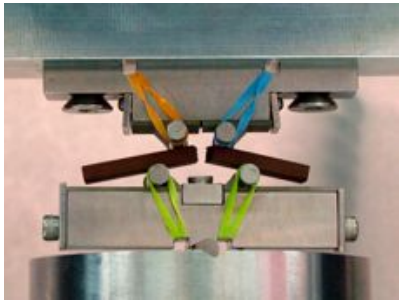
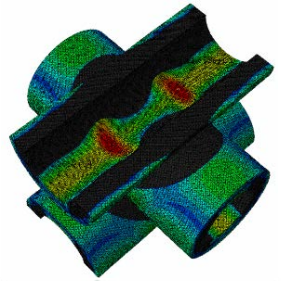


Processing and characterization of **materials for extreme environments**, including **ultra-high temperature ceramics** (ZrB_2, ZrC, HfB_2...) for aerospace and energy-related applications and **ultra-hard ceramics** (SiC, B_4C…) **and cermets** for extreme wear and impact resistance (cutting tools, armor…) and **porous ceramics** for **membranes**, heat exchangers and catalytic applications.

Multiscale characterization and modelling (including by finite element modelling, FEM) of the **mechanical and tribological behavior** of materials: structural, biomaterials, thin films/coatings and other multilayered and geometrically complex systems.



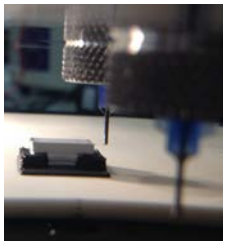
Project Idea

HORIZON-CL4-2022-RESILIENCE-01-12: Functional multi-material components and structures (RIA)

GEMA research lines in (1) **near-net shape fabrication** of various materials **by additive manufacturing** for all type of applications, (2) **ultra-fast sintering** of materials, and (3) the **analysis of microstructure-property relations** are all linked to this topic goals.

Contribution to the Impacts:

- GEMA's expertise can contribute to the **energy efficient, low-cost and environmentally friendly fabrication** of multi-material parts by applying techniques of **ultra-fast sintering** (spark-plasma, microwave or flash sintering techniques).
- GEMA's expertise can contribute to develop **multi-materials featuring optimised macro-, meso-, and micro-structures**, for **improved** operational **performance and weight**, by using **additive manufacturing** techniques, including **nanofabrication** by 2PP.
- GEMA can also contribute to **validating** the **mechanical/tribological performanc**e of the multi-materials fabricated.



Multimaterial AM

Contribution in Scope:

- GEMA can contribute to **develop new additive manufacturing processes** for the fabrication of multi-material devices and to **join dissimilar materials** with any desired design (at the macro-, meso-, and micro-scales).
- GEMA can perform detailed **microstructural characterisation at any relevant scale** of the individual constituents and the multi-material parts fabricated, **even during the fabrication/consolidation process** with their state-of the art SEM and XRD high-temperature facilities and unique expertise.
- GEMA could perform detailed **analysis of mechanical/tribological performance** under any relevant conditions (dynamic and static loads, high temperature, different environments) of the individual constituent and the multi-materials fabricated **to quantify** their **properties, quality and lifespan**.

High temperature testing

Project Idea

HORIZON-CL4-2022-RESILIENCE-01-13: Smart and multifunctional biomaterials for health innovations (RIA)

Major GEMA research lines are the development of **bioactive/biodegradable multi-material** (ceramic/non-ceramic) **scaffolds** by additive manufacturing for bone regeneration and of **multilayered materials** and **biocomposites** for dental applications

Contribution to the Impacts:

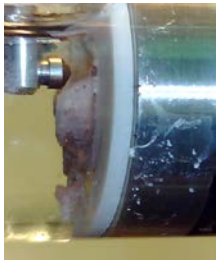
GEMA's expertise in **multi-material additive manufacturing** and state-of-the-art materials processing and characterization facilities will enable the **development of any required multifunctional biomaterials**, especially those involving the use of bioceramics in their composition, designed to address any unmet clinical needs identified by the consortium;

GEMA expertise in **mechanical properties optimization and characterization,** especially regarding ceramics and composites, will contribute to **enhancing the longevity** of developed medical devices **and their capacity to meet all biomechanical constraints** for the intended application

Multimaterial Additive Manufacturing

Contribution in Scope:

- GEMA could participate in activities oriented to the **development of** Advanced Medical Devices including **implants**, **bioinks** for bioprinting platforms, **microfluidics**, bioactive **scaffolds**, etc.
- GEMA is also weel suited to contributing to the **validation** of specific multifunctional biomaterials, micro systems or medical device, especially in terms **of their mechanical performance** at all relevant scales (**from nano- to macroscale**), under **static or dynamic loads** and under **any required environmental conditions including inmersed in body fluids** and at body temperatures. **Testing of fatigue and wear** under any required conditions is, thus, possible.
- GEMA couls also contribute to **optimizing the cost** of fabrication and the **sustainability and environmental impact** of the manufacturing process of the device through the use of **fast sintering** processes (microwave or spark plasma sintering)



Nanoindentation of soft tissue in liquid

Project Idea

HORIZON-CL4-2022-RESILIENCE-01-19: Advanced materials modelling and characterisation (RIA)

Understanding **structure-property relationships in engineering materials** is the foundation of all GEMA research lines. As a result, GEMA has developed considerable **expertise in the modelling and characterization of microstructure and mechanical properties at different length-scales** in a variety of materials, including ceramics for extreme environments, ceramics and composites for biomedical engineering/dental applications, and natural materials.

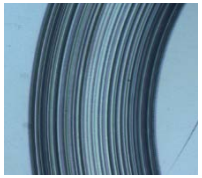
Contribution to the Impacts:

- GEMA could contribute to the development of **novel experimental methods**, as well as to the adaptation of currently existing ones, to **characterize** the **mechanical response and long-term degradation** of advanced engineering materials
- GEMA could participate in the development of **novel** analytical and numerical (FE) **models** to **predict** the **mechanical response and lifetime** of engineering materials
- GEMA could contribute to the **identification of the key structural elements that result in failure and long-term degradation** of materials, and to the extraction of guidelines to **improve material durabiity**.

Contribution in Scope:

- GEMA can contribute to the **development of novel experimental methods** based on mechanical testing, FE modelling and microstructural analysis to **characterize the combined effects of fatigue and wear** of materials **at different length-scales (from nano- to macro-scale)**
- GEMA could participate in the **application of advanced methods** based on mechanical testing, FE modelling and microstructural analysis to **characterize the long-term mechanical degradation** of materials under complex, multiaxial loading configurations (static and dynamic) and environments, at different length-scales
- GEMA could participate in projects aimed at the **application of advanced methods** based on mechanical testing, FE modelling and microstructural analysis to **characterize** the mechanical response of **challenging materials** at different length-scales
- GEMA could participate in projects aimed at the **development of tools/databases** for the **prediction** of material **lifetime** and **selection** of durable materials

High temperature testing



Wear testing

Fatigue testing

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