

# Group of Phase Equilibrium Diagrams

## GENERAL PRESENTATION



- **Complete denomination:** **Ceramic and Glass Institute (ICV-CSIC)**
- **Location (city, country):** **Kelsen 5, Madrid, Spain**
- **Director:** **A. J. Sánchez-Herencia**
- **Contact person in NEWGEN:** **C. Baudín**
- **Working Group involvement:** **Group 1**
- **Staff:** P Pena, C. Baudín, M. A. Rodriguez, A. H. De Aza, M. A. Sainz, A. Caballero, S. Serena, L. Contreras, A. García-Prieto, M. Canillas.
- **Research topics:**

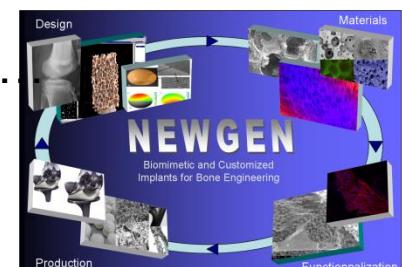
*Bioceramics and bioglasses for bone substitutes*

*Advanced structural ceramics, Refractories*

*Electroceramics, Ceramics for energy production and storage, Glasses*

**Researchers expertises:** **interdisciplinary** (Chemists, Physicians, Engineers, Geologists)

- Powder synthesis and characterisation, shaping and densification.
- Microstructural, thermal, mechanical and electrical characterisation.
- + a team for technological support to industries



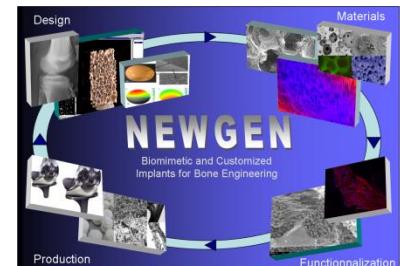
Instituto de Cerámica y Vidrio, ICV  
Spanish National Research Council, CSIC  
Kelsen 5  
28049, Madrid - Spain

COST Action MP1301

### Research topics:

*Material design focusing properties*

- ✓ Phase equilibrium diagrams: experimental and simulation.
- ✓ Advanced structural ceramics based on  $\text{Al}_2\text{O}_3$ ,  $\text{Al}_6\text{Si}_2\text{O}_{13}$ ,  $\text{ZrO}_2$ ,  $\text{Al}_2\text{TiO}_5$ ,  $\text{ZrTiO}_4$ .
- ✓ New cements and refractories.
- ✓ Thermomechanical characterisation.
- ✓ Porous materials and membranes.
- ✓ Ceramics and glasses for bone regeneration and substitution.

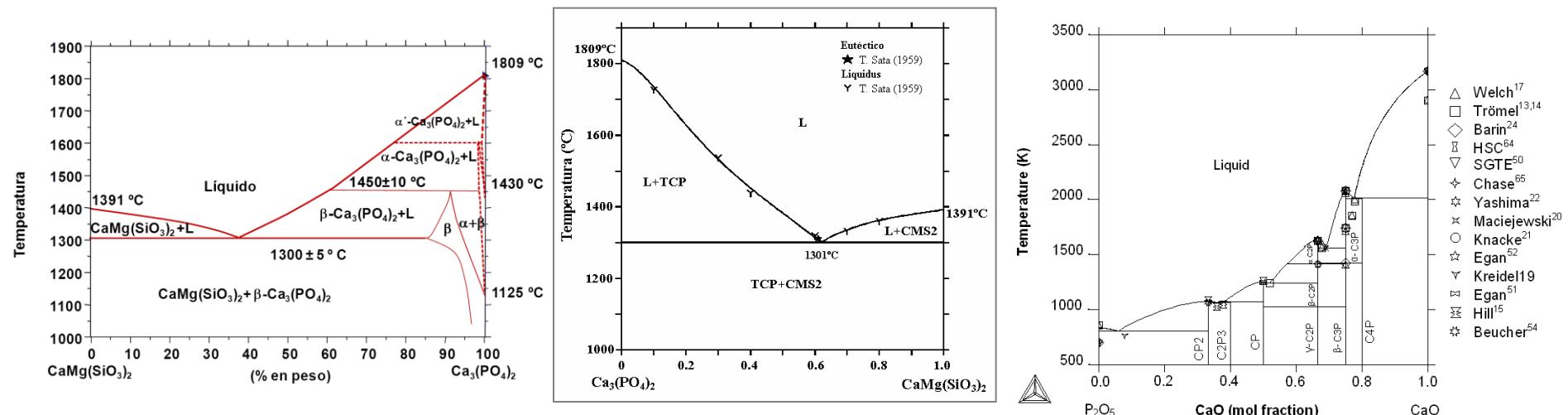


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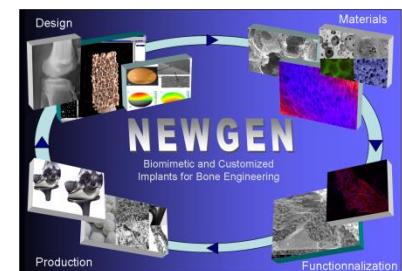
## BIOMATERIALS/NEWGEN TOPICS

### Phase equilibrium diagrams

- Simulation studies using CALPHAD (Calculation of Phase Diagrams)
- Experimental studies (quenching method, FE-SEM, XRD, ND, TDA-TG, ...)



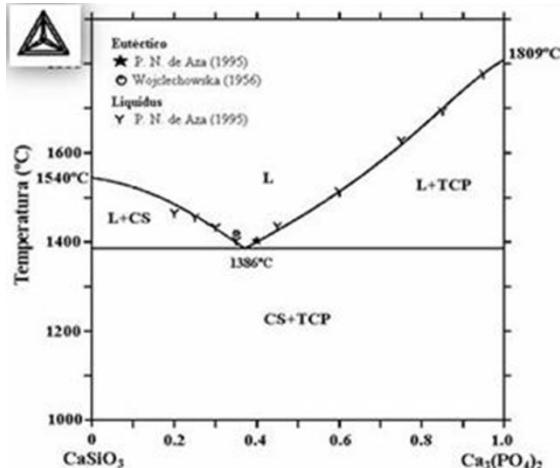
- S. Serena, L. Carbajal, M. A. Sainz, A. Caballero. "Thermodynamic Assessment of the System  $\text{CaO}-\text{P}_2\text{O}_5$ : Application of the Ionic two-sublattice model to glass-forming melts. *J. Am. Ceram Soc.* 94 (2011)3094-3103
- L. Carbajal, M.A. Sainz, S. Serena, et al. "Solid-State Compatibility in Two Regions of the System  $\text{ZnO}-\text{CaO}-\text{P}_2\text{O}_5$ " *J. Am. Ceram Soc.* 94 (2011)2213-2219
- R. Garcia Carrodegas, A.H. De Aza, I. Garcia-Paez, et al. "Revisiting the Phase-Equilibrium Diagram of the  $\text{Ca}_3(\text{PO}_4)_2$ - $\text{CaMg}(\text{SiO}_3)_2$  System" *J. Am. Ceram Soc.* 93 (2010) 561-569



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## FACILITIES

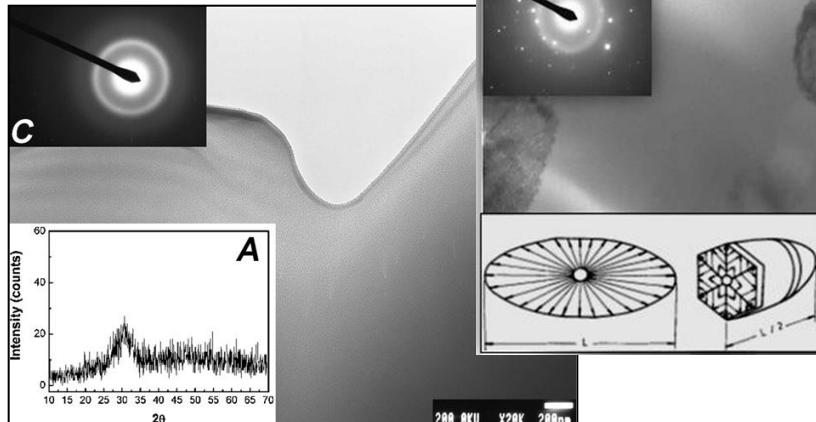
**3<sup>rd</sup> generation BIO-materials. Function: Bone regeneration**



**$\text{Ca}_3(\text{PO}_4)_2\text{-CaSiO}_3$  System**

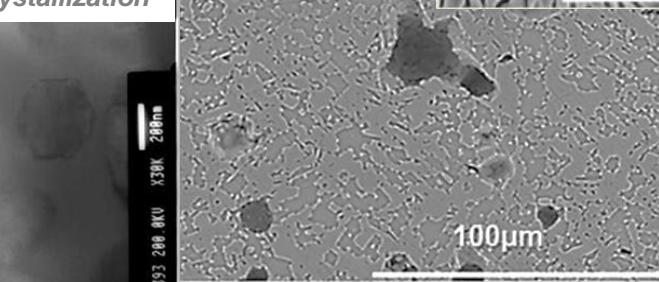
**Glass-ceramics.**

**Glass**

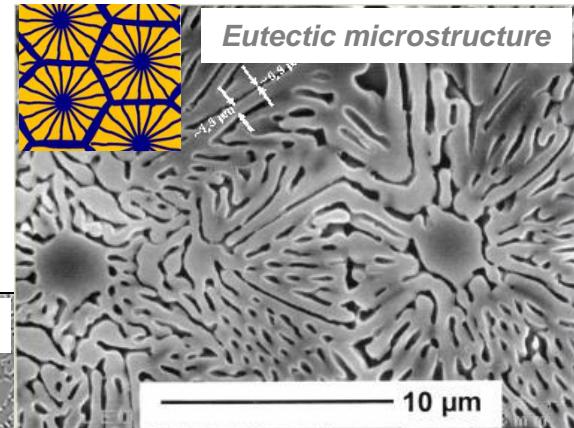


**Nucleation and crystallization**

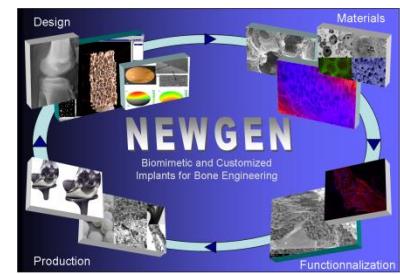
**Solid state sintering**



**Ceramics.**



*Acta Biomaterialia* 6, 2797-2807 (2010);  
*Acta Biomaterialia* 7, 3536–3546 (2011);  
*Acta Biomaterialia* 8, 820-29 (2012)

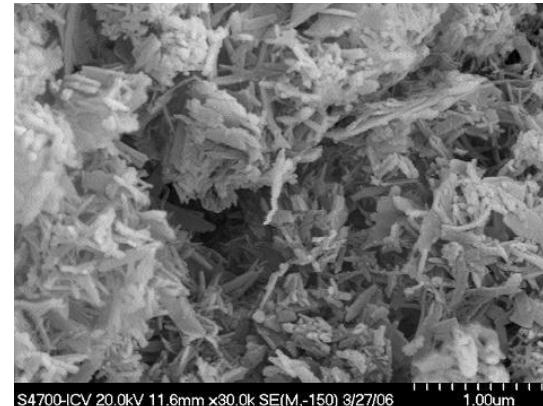
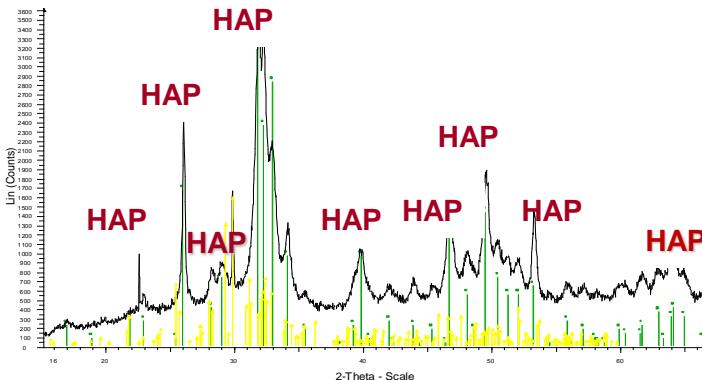


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### Raw materials

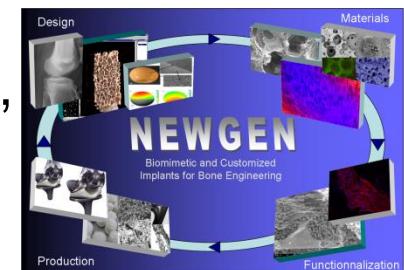
#### Synthesis

- ✓ **Powders:** SHS, Combustion, Soft chemistry, Solid state reaction.



#### Characterisation

- ✓ **Physical:** size ( $\mu\text{m}$  and nm), specific surface area, pycnometry.
- ✓ **Chemical analysis:** XRF, ICP-analysis.
- ✓ **Structural:** XRD, IR, Raman, TEM ...
- ✓ **Microstructural:** RLOM, FESEM-EDS, micro Raman, atomic force microscopy...



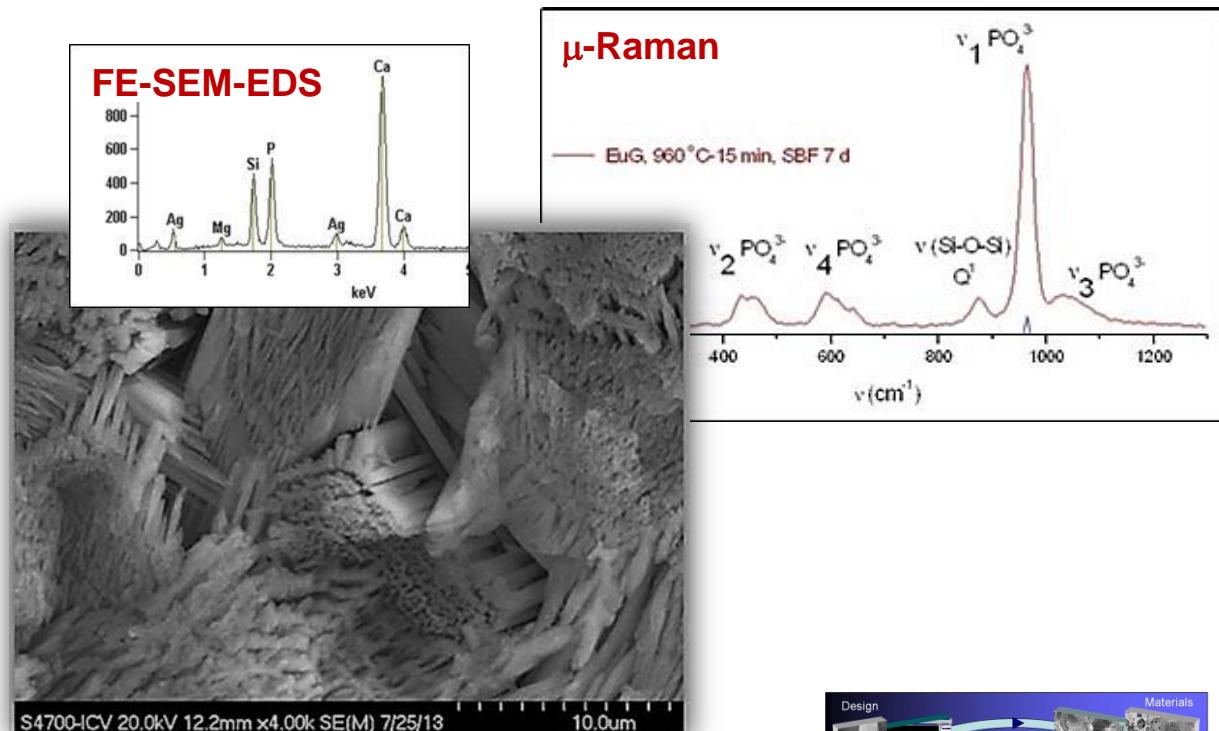
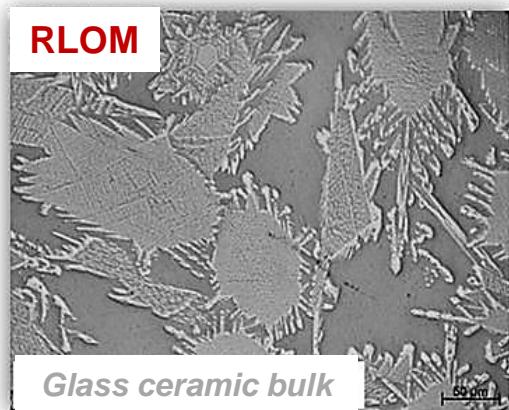
# Group of Phase Equilibrium Diagrams

## FACILITIES

### Characterisation of bulk ceramics and coatings

- ✓ **Physical:** density, porosity
- ✓ **Microstructure:** RLOM, FE-SEM-EDS, micro-Raman, TEM, XRD.

*SBF In vitro studies of  
 $\text{Ca}_3(\text{PO}_4)_2\text{-CaSiO}_3\text{-CaMg}(\text{SiO}_3)$   
glass-ceramics*



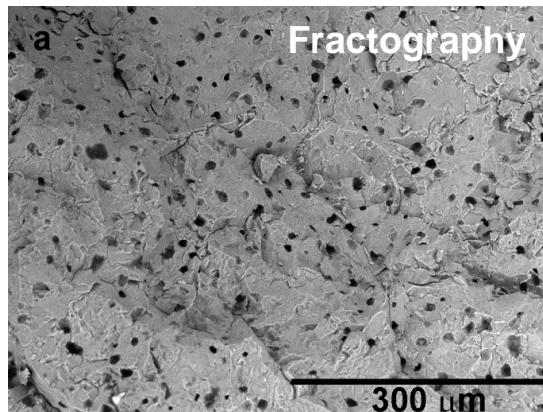
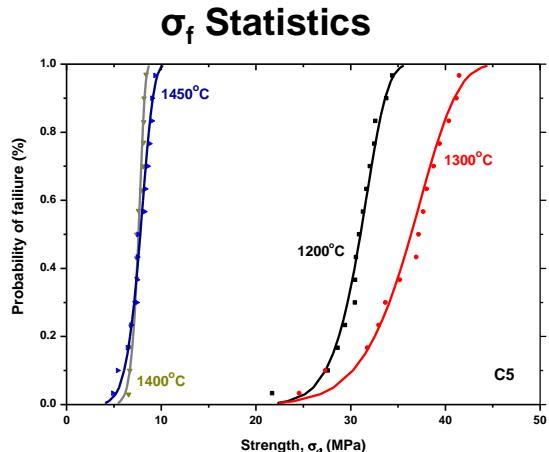
- M. Magallanes-Perdomo, Z.B. Luklinska, A.H. de Aza, R.G. Carrodeguas, S. de Aza, P. Pena "Bone-Like Apatite Forming Ability of Apatite-Wollastonite Glass Ceramic" *J Eur Ceram Soc* 31 (2011) 1549 -1561
- European Conference of Biomaterials. Madrid Spain. Sep. 2013

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## FACILITIES

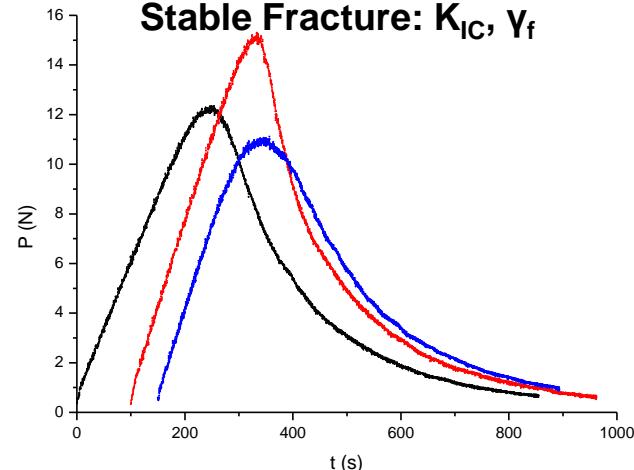
### ✓ Mechanical behaviour of surfaces and bulk ceramics

#### Macro



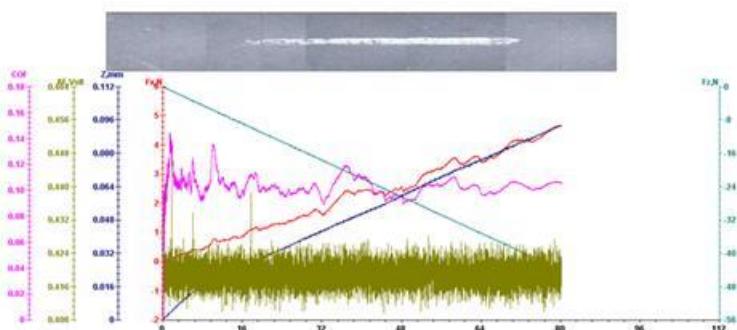
- Dynamical and static Young modulus.

#### **Stable Fracture: $K_{IC}$ , $\gamma_f$**



#### Local

- Macro, micro and nanoindentation. Instrumented.
  - Micro and nanoscratch.
  - Wear (pin-on-disc)



I.H. García-Páez, R. García Carrodeguas, A.H. de Aza, C. Baudín, P. Pena "Effect of Mg and Si co-substitution on microstructure and strength of tricalcium phosphate ceramics" *J Mech Behav Biomed Mater.*, 30 (2014) 1–15  
C. Baudín, A. Tricoteaux, H. Joire "Improved resistance of alumina to mild wear by aluminium titanate additions" *J Eur Ceram Soc* 34 (2014) 69–80

