FP7 project - SAM.SSA

Sugar Alcohol based Materials for Seasonal Storage Applications

Workshop and Onsite Demonstration– CiCenergigune

Miñano, Alava, Spain

SAM.SSA

Major Outcomes of SAM.SSA Project

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Fraunhofer

SOLVAY

cnrs

CIC energiGUNE

AIDICO INSTITUTO TECNOLÓGICO DE LA CONSTRUCCION

EURICE EUROPEAN RESEARCH AND PROJECT OFFICE GMBH

IMNR

TU/e

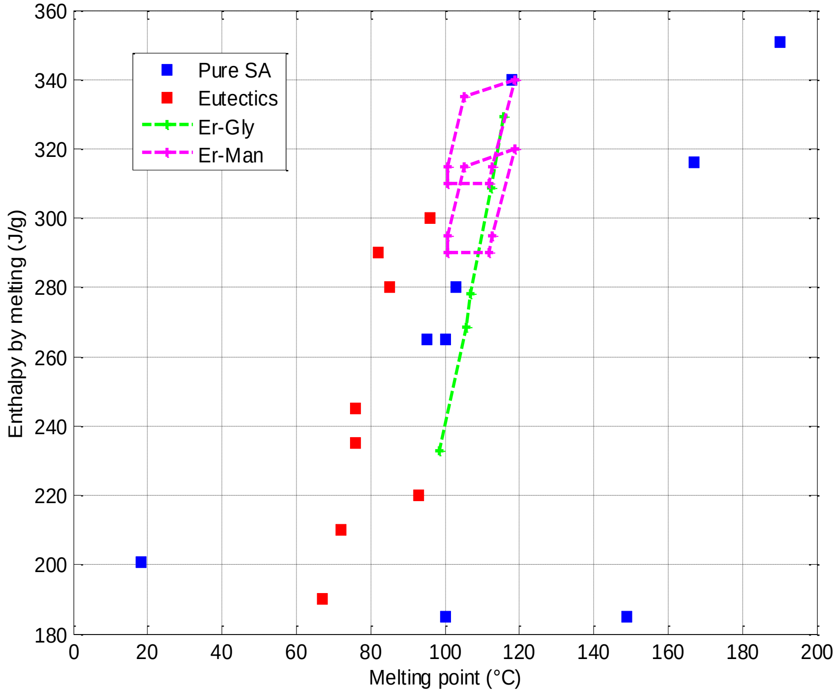
PCM

Provide a thorough impulse on knowledge related to fundamental and applied research in the area of storage for heating applications

In the medium term the materials developed will lead to deploy cost effective and fully environmentally based energy supply systems

PCMs for SSA
SA & SA-blends

8 eutectics with melting point less than 100°C and latent heat ranging from 190 J/g to 300 J/g



- Melting point fitted to the application
- High energy density in the range of temperature of use (120 – 190 kWh/m3)
- High and stable undercooling
- Moderate-to-low volume changes

- Non toxic, not flammable, not polluting
- Coming from renewable resources (abundant, sustainable)

- Compatibility with commonly used container materials
- Long-term stability (very promising results)

- Acceptable initial cost

COMPARED TO COMPETITOR MATERIALS

	Charging Temp.	Energy density kWh/m3	Thermal losses	Source	Safety	Corrosion	Stability	Price	System complexity
Water	<100°C	30-60		Renewable					
Sodium acetate	<100°C	89	Supercooling						
Zeolite 13X	> 100°C	140	Sorption						
MgCl2	> 100°C	472	Reaction						
Zeolite – MgSO4	> 100°C	180	Sorption Reaction				Not yet, but promising		
SA blends	<100°C	120-190	Supercooling	Renewable			Not yet, but promising		

FULL CHARACTERIZATION

- Key thermodynamics (Tm, ΔHm)
- Key physical properties in liquid and solid and their variation with temperature
- Nucleation rates and crystal growth kinetics as a function of undercooling
- Thermal stability

NEW EXPERIMENTAL TECHNIQUES

- Fast estimation (< 2h) of a phase diagram (screening oriented)
- Determination of heterogeneous nucleation rates
- In situ investigation of crystal

MULTI-SCALE MODELLING APPROACH

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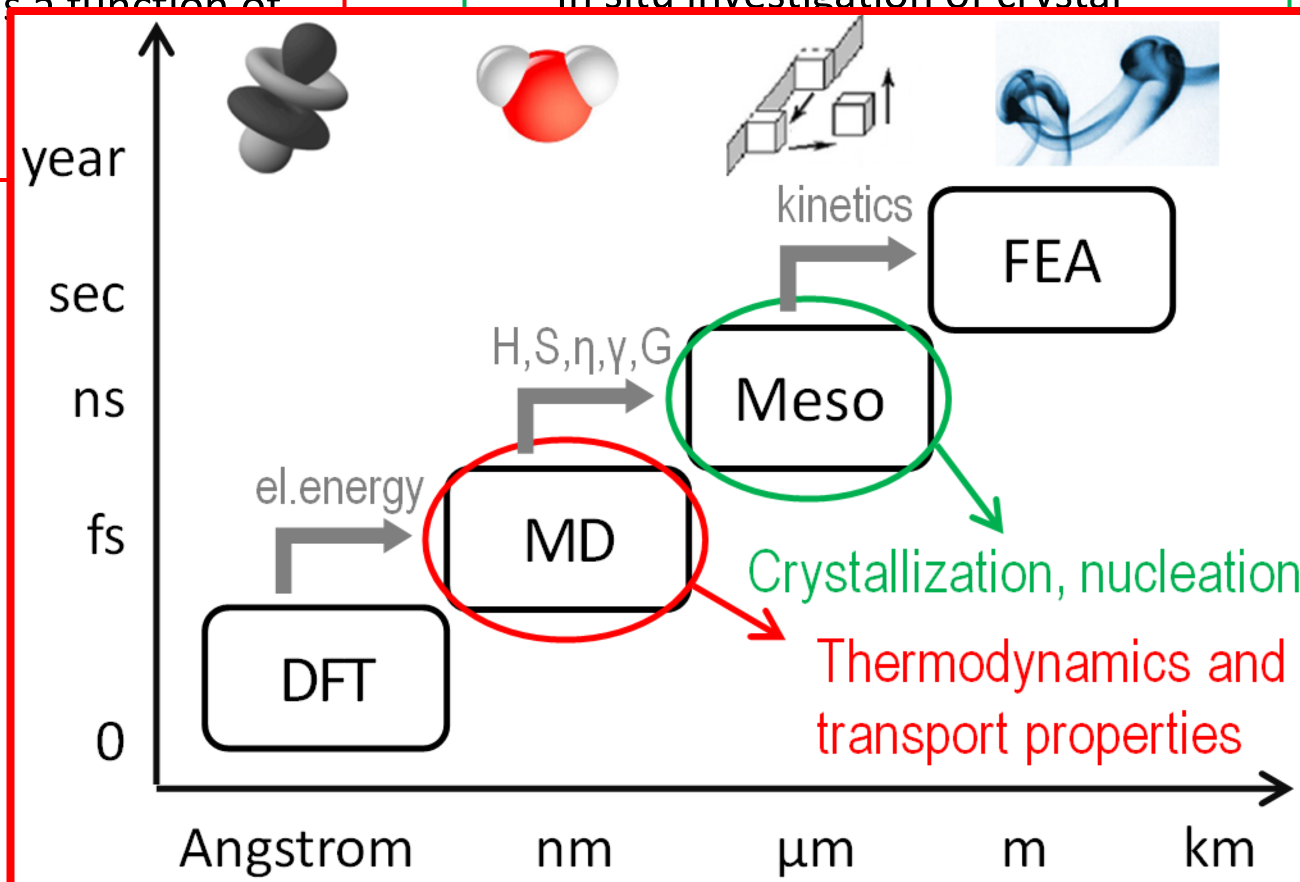
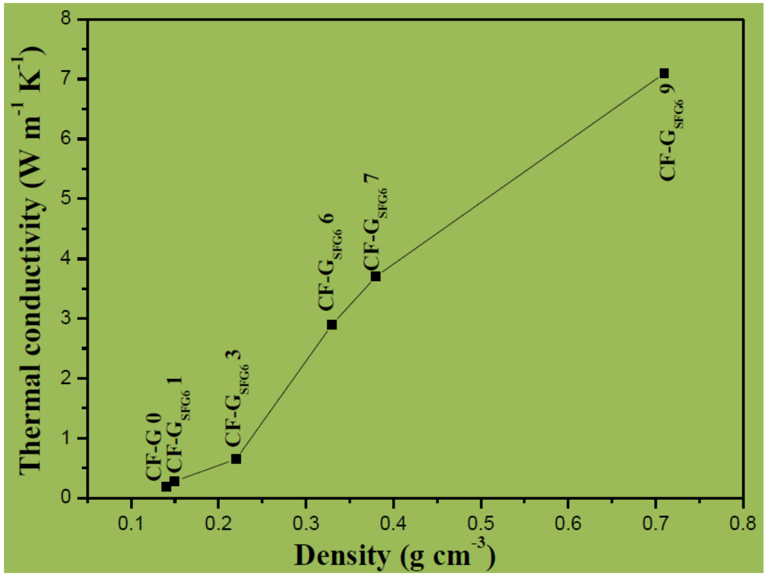
FUNDAMENTAL KNOWLEDGE



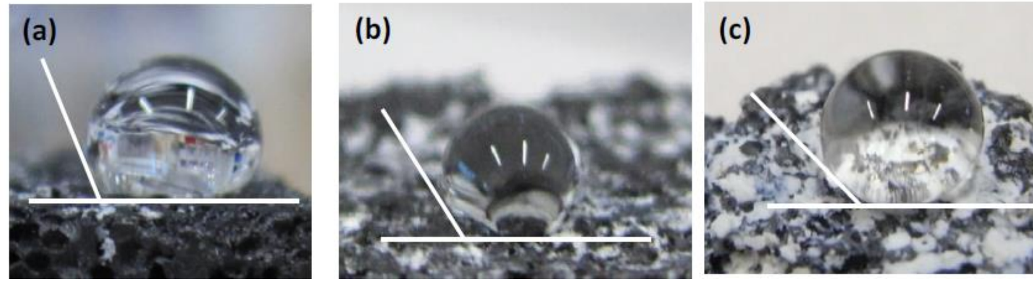
Taylor-made carbon porous structures for thermal conductivity enhancement



- Produced from cheap, natural precursors
- Highly porous structures with open porosity ranging from 70 to 94%
- Apparent density from 0.15 to 0.70 g/cm3
- Thermal conductivity up to 7 W/m/K
- Estimated cost: 3 – 7 €/kg
- Easily infiltrated with SA

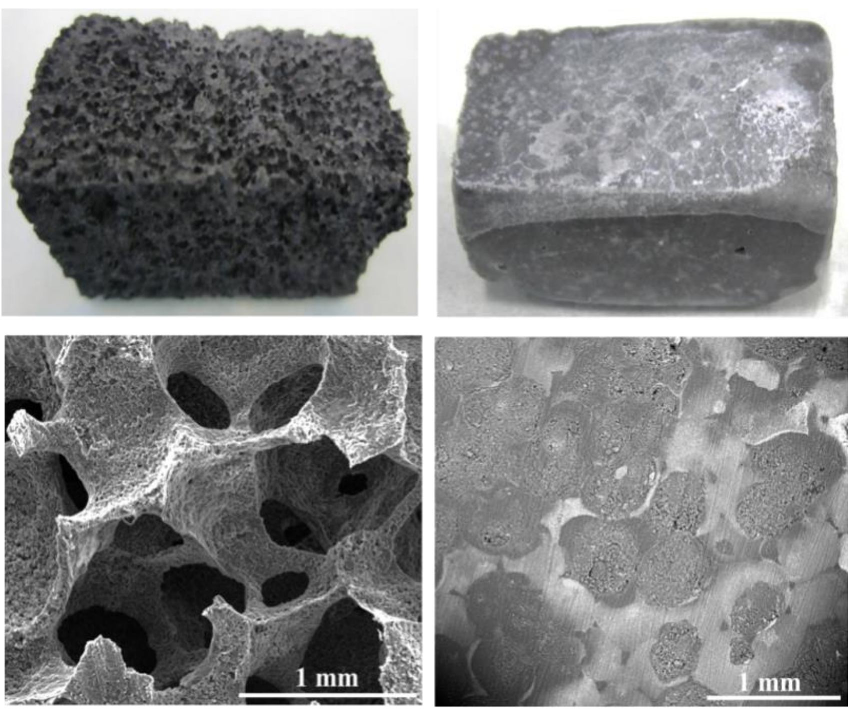
USEFULL FOR INCREASING THE THERMAL CONDUCTIVITY OF MANY OTHER PCMs

HYDROPHOBISATION achieved by different surface treatments. Fluorination is the most effective in preventing heterogeneous nucleation on the carbon wall



COMPOSITES Carbon/SA

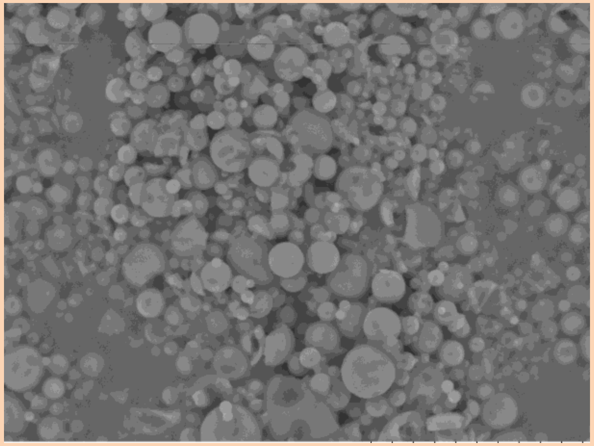
- Prepared by simple impregnation method and/or infiltration under vacuum
- Infiltration rates up to 92% can be achieved
- The chemical compatibility between the SA (Er and Xy/Er) and the carbon structure has been proven
- The thermal conductivity of the composite is higher than that of the empty foam
- The latent heat of the composite can be predicted by the theory of mixtures



Microencapsulation of Sugar Alcohols

<table>
<tr>
<td>Organic (polymeric) shells
Polycondensation
Solvent evaporation
Spray-drying

nm</td>
<td>Feasibility proven in spite of the high reactivity of –OH groups

Thermal cycling stability should be optimized</td>
<td></td>
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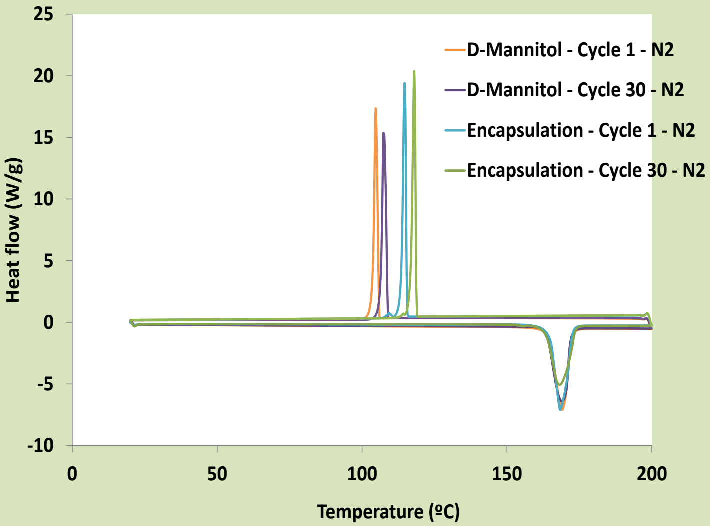
<tr>
<td>Inorganic shells
Sol-gel technique
(SiO_2, TiO_2)

µm</td>
<td>Easy processing

Composite SA-TiO_2 with high performances and high thermal stability

Processing optimization to reach reproducibility in particles size</td>
<td>
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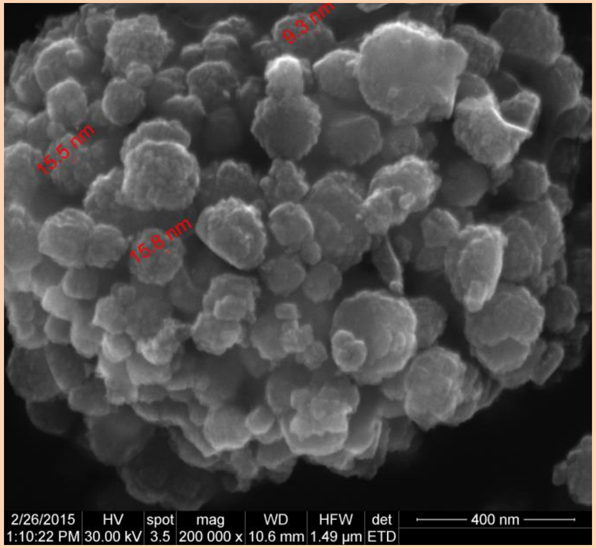
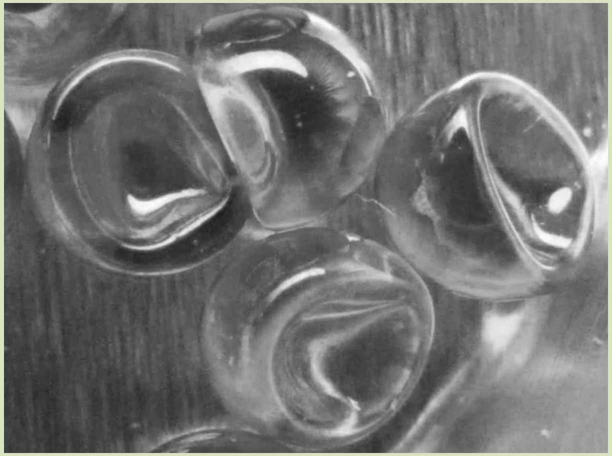
Inorganic shells Solvothermal encapsulation in ZnO **nm**	Low energy consuming processing Composite SA-ZnO with high structural stability and improved compatibility between phases Optimization of the ratio O/I should be performed	
Hybrid shells Encapsulation via UV-curable Monomeric and Hibripolymeric Building Blocks **0.5 – 5 mm**	Core-shell type morphology **Building blocks for high strength and flexible elastomeric shells applicable** Further R&D needed for integrating nucleation agents and to increase processing temperature beyond 120°C	

Activation of the SA and SA-blends crystallization

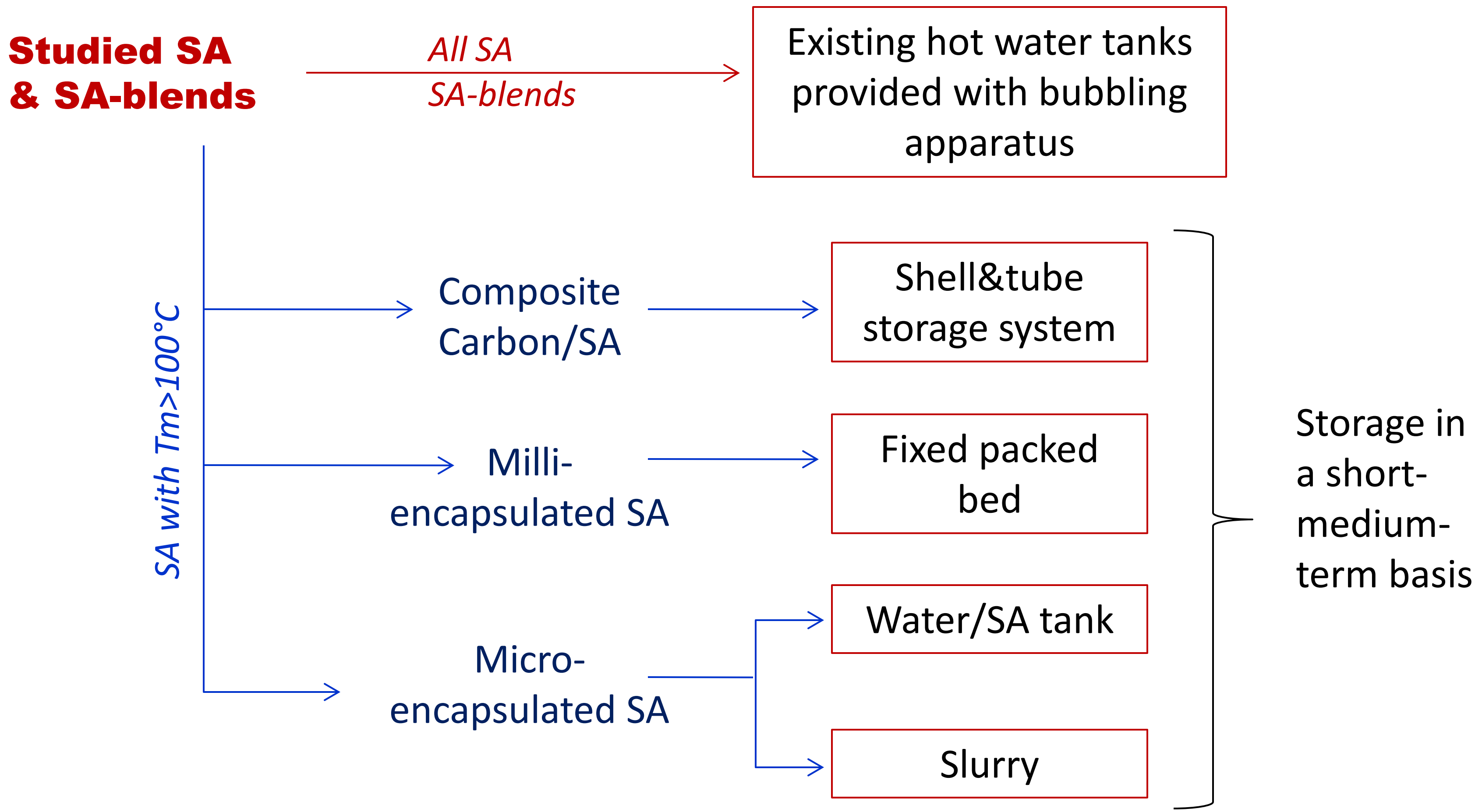
Quite efficient and low intrusive
Easy implementation

NEED FURTHER INVESTIGATIONS!!

STIRRING BY BUBBLING!

- Allows activating the crystallization of highly undercooled melts of Xy and Xy/Er
- The activation of the crystallization can spread the full system
- Short times of induction and recalescence can be achieved, with end temperatures close to the melting point
- The addition of appropriate solvents can improve the performances
- Mechanisms leading to the nucleation as well as key parameters have been identified

Routes for SA-based materials integration into the storage system



Thank you for your attention