



MORTADA NOURHAN

**MOUSSES MINÉRALES: DÉVELOPPEMENT,
STRUCTURE PORALE ET PROPRIÉTÉS D'USAGES**

2018-2021

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Encadrante: **PHÉLIPOT-MARDELE Annabelle**

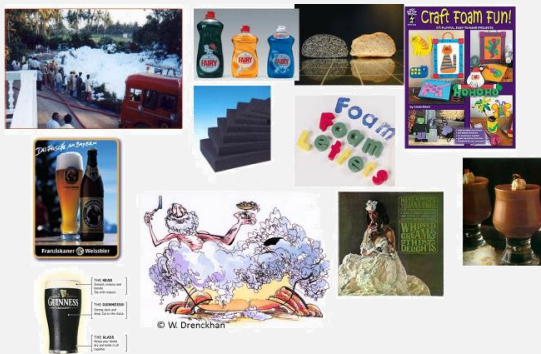
Problematic

- Energy consumption
- Greenhouse gas emissions
- Consumption of natural resources

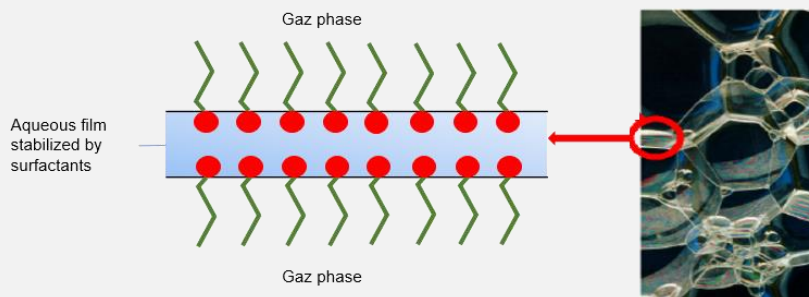
Formulate and characterize mineral foams by direct foaming and pre-foaming methods using different foaming agents

1. Lightweight material $300 < \rho < 750 \text{ kg/m}^3$
2. Thermal insulation $\lambda < 0.2 \text{ W/(m.k)}$
3. Sufficient MBV
4. Sufficient R_c

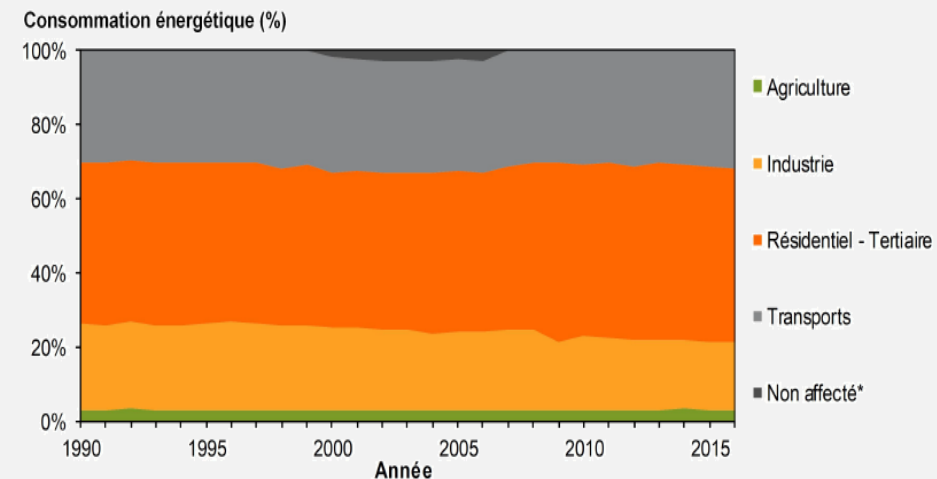
Foam ?



Examples of foams for everyday use



Surfactant adsorption at the Liquid/Gas Interface



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Liant	Gypse			
Foaming agent	OSB	EA	AB	AB/OSB
E/L ratio	0,6 - 0,65 - 0,7 - 0,75 - 0,8		0,7	0,7
content	CMC = 0,08%, CMC/2, CMC/4, CMC/8	1%, 0,5%, 0,25%, 0,125%, 0,0625%	1%, 2%, 5%	0,08% ou 0,06% OSB et 1% ou 2% AB
Foaming method	DF	DF	PF	DF
Mixing time [min]	2 à 20	2 à 20	7 à 20	7
Molded specimens	51	34	10	12
Characterized specimens number	100	68	20	24

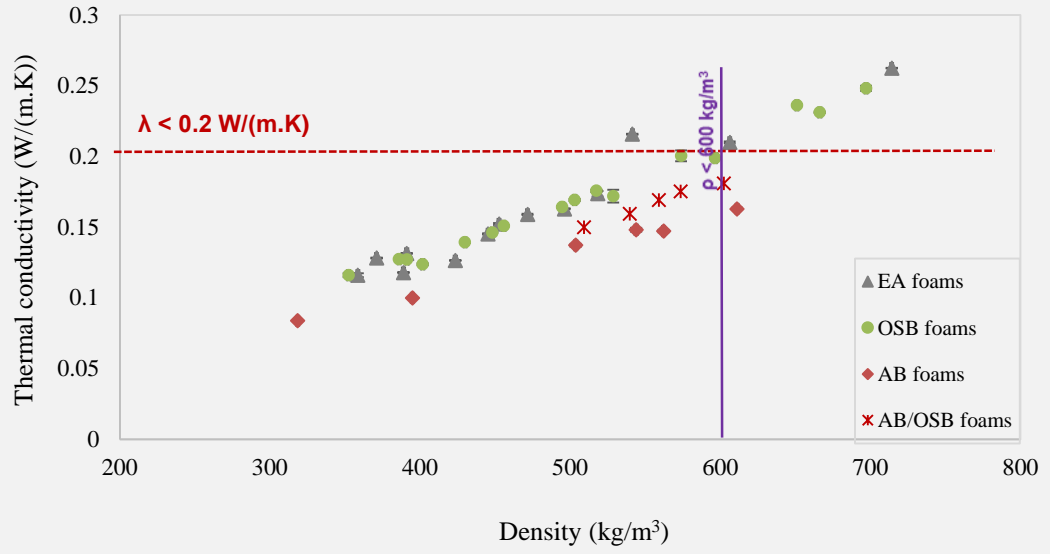


Direct foam method : Kitchen Aid mixer – bowl 5 l – 1 blade and 1 whisk

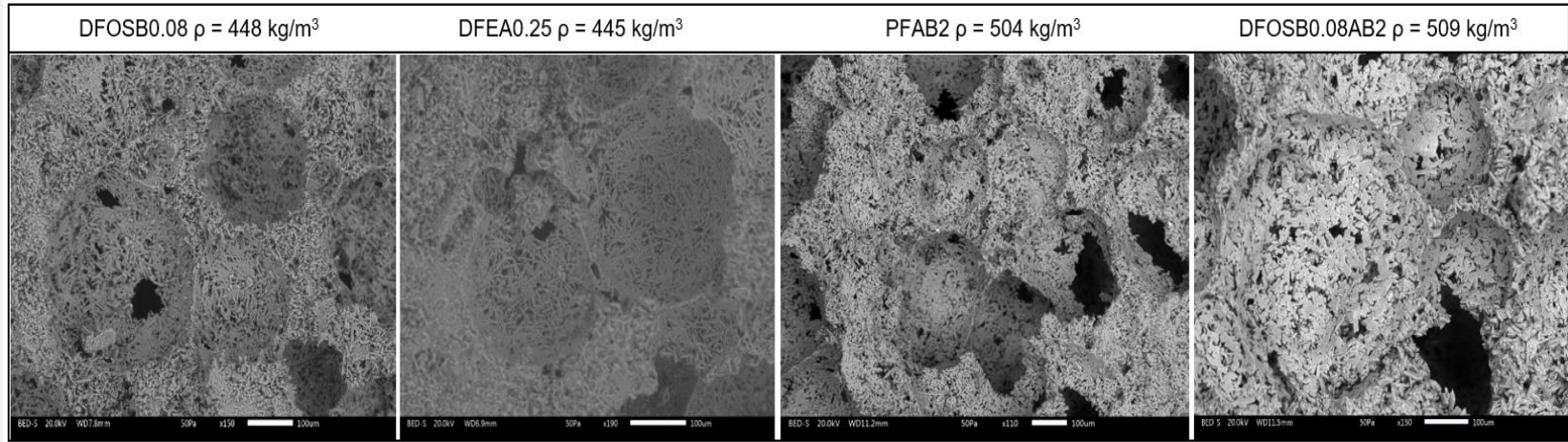
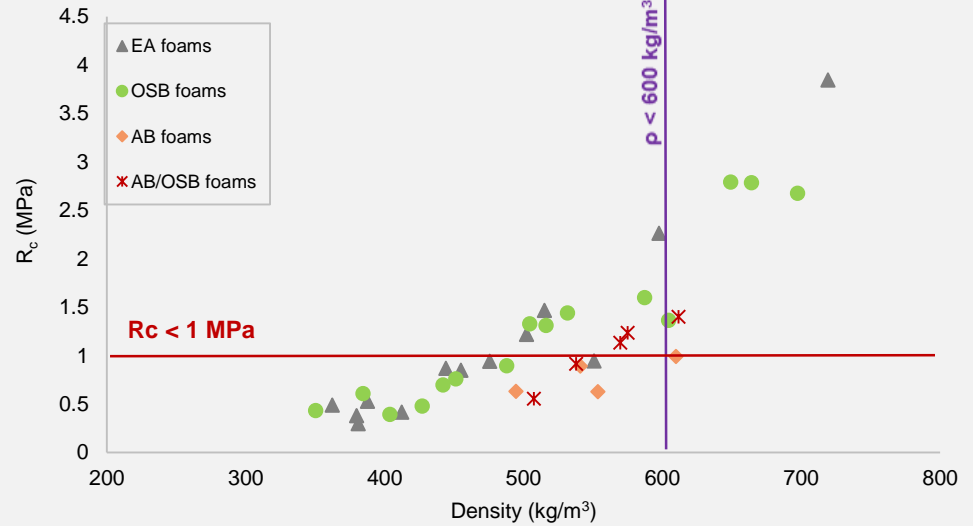


Prefoaming method

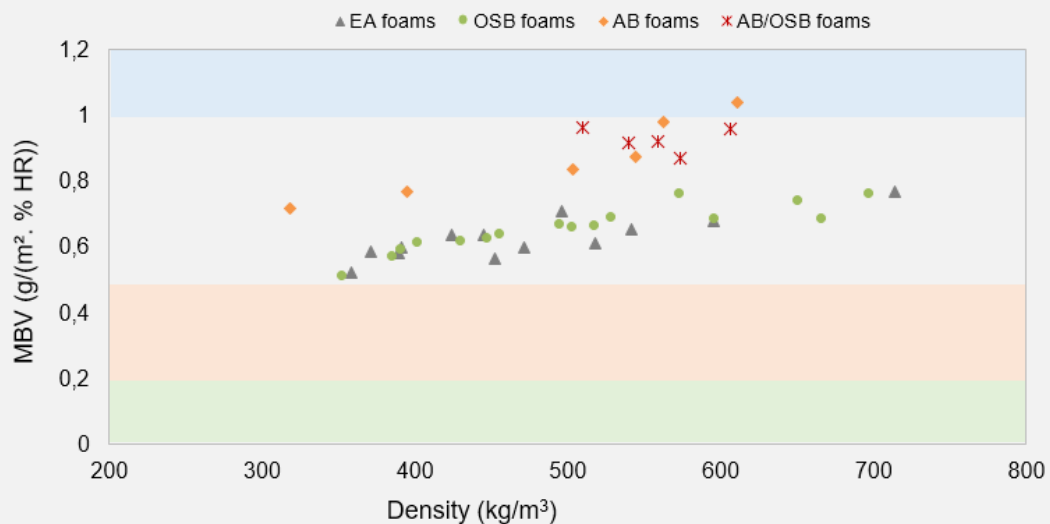
Thermal conductivity



Compressive strength



MBV test



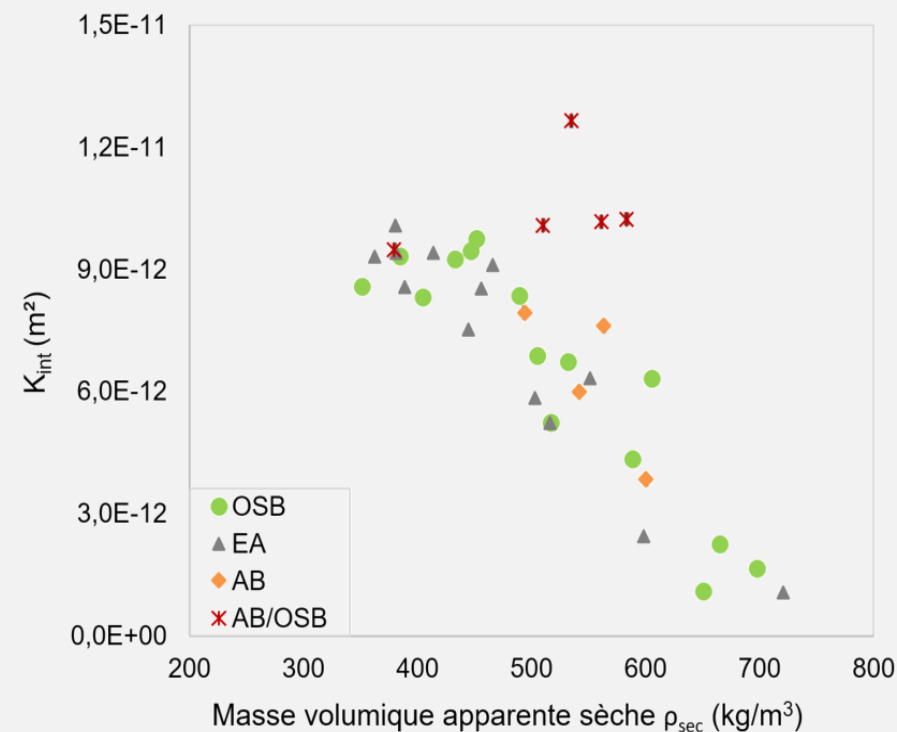
MBV values versus hardened bulk density of all type of gypsum foams

$$p_T = p_M + p_{AF}$$

$$MBV = A \cdot p_M + B \cdot p_{MA}$$

$$\frac{MBV}{p_M} = B \cdot \frac{p_T}{p_M} + A - B$$

	A	B	A/B
OSB	2,1335	0,5319	4,01
EA	2,0472	0,5523	3,71
AB	2,9604	0,6282	4,71
AB/OSB	1,2599	1,2117	1,04



Water vapor permeability

Gypsum foam	$\rho_{23^{\circ}\text{C}-50\text{HR}\%}$ (kg/m ³)	δ_p (kg/(m.s.Pa)) $\times 10^{-11}$
DFOS1	573,93	1,95
DFOSB4	448,14	1,85
DFOSB9	651,08	1,77
DFOSB10	697,12	1,56
DFEA1	541,44	1,5
PFAB4	611,27	1,95



THANK YOU