4° Conferenza Nazionale Poliuretano Espanso rigido

Poliuretano 4.0

Roma, 10 Ottobre 2019

Schiume poliuretaniche termoindurenti ottenute mediante CO_2 come agente espandente fisico

Inseguire la reazione di sintesi con la pressione

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Sara Cavalca
Vanni Parenti

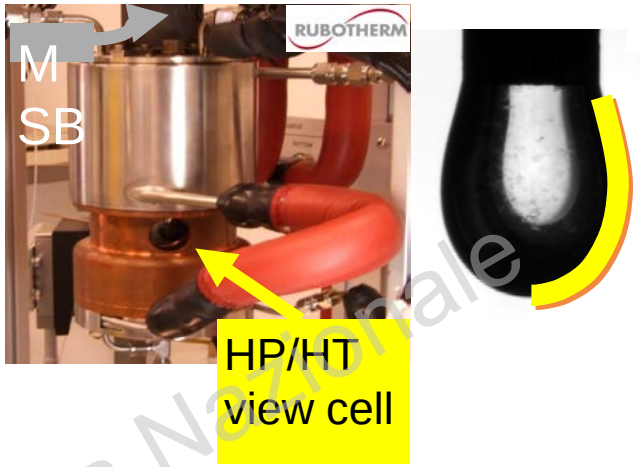
foamLab

www.foamlab.unina.it

new characterization tools
new processing tools
new understanding
new materials & products

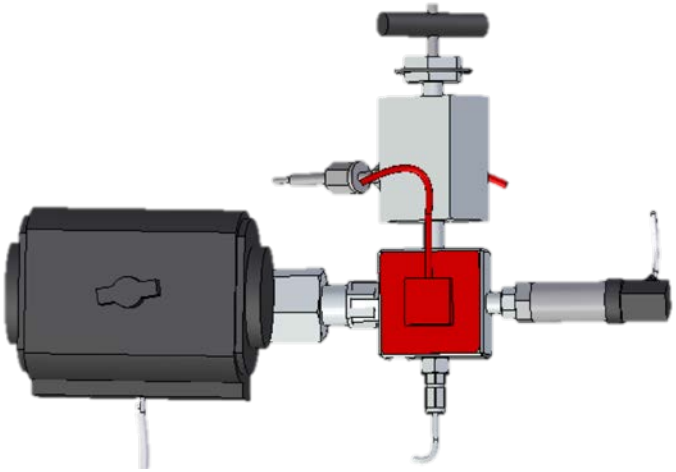
new characterization tools

coupled sorption/drop shape analysis



Pastore Carbone et al., Polymer Testing 2013

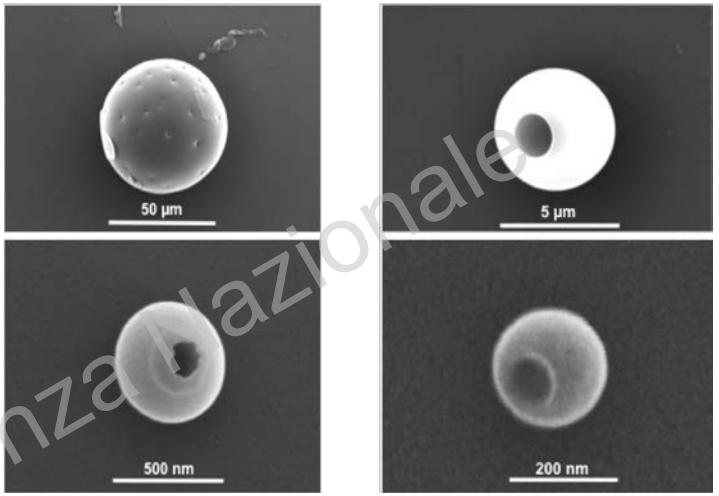
new processing tools

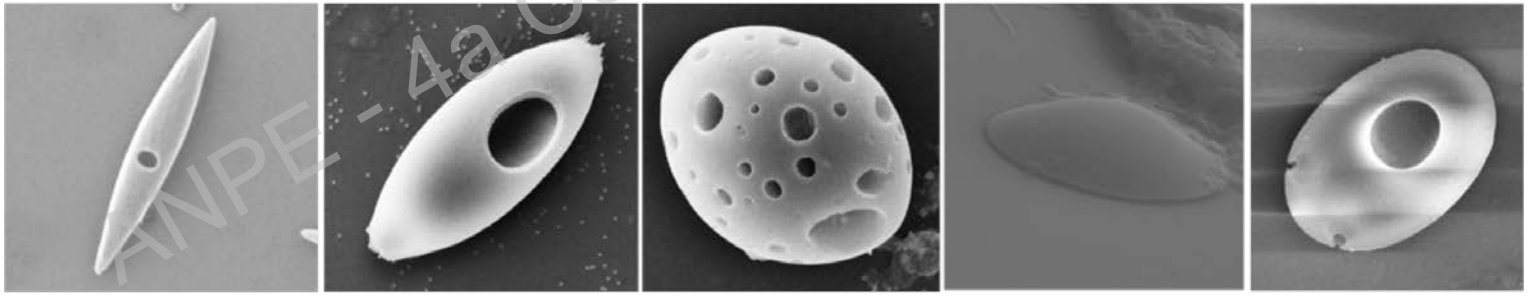


Tammaro et al., J Cell Plast 2015

Tammaro et al., I&CER 2016

new materials & products





Orsi et al., Nano Research 2014

so far… **thermoplastic** foams by physical blowing agents

thermosetting polyurethane foams by physical blowing agents

thermosetting PU foaming by high pressure CO_2:

why?

Montreal protocol (Substances that deplete the Ozone layer)

- chlorofluorocarbons (CFCs) (in the late 1950s)
- hydro-chlorofluorocarbons (HCFCs) (at the beginning of 1990s)
- hydrocarbons (HCs) (e.g. pentane)

$O(10^2\ s)$

chemical reaction

?

$O(10^{-2}\ s)$

pressure quench

thermosetting PU foaming by high pressure CO_2

thermosetting PU foaming by high pressure CO_2:

how?

1. sorption under high pressure
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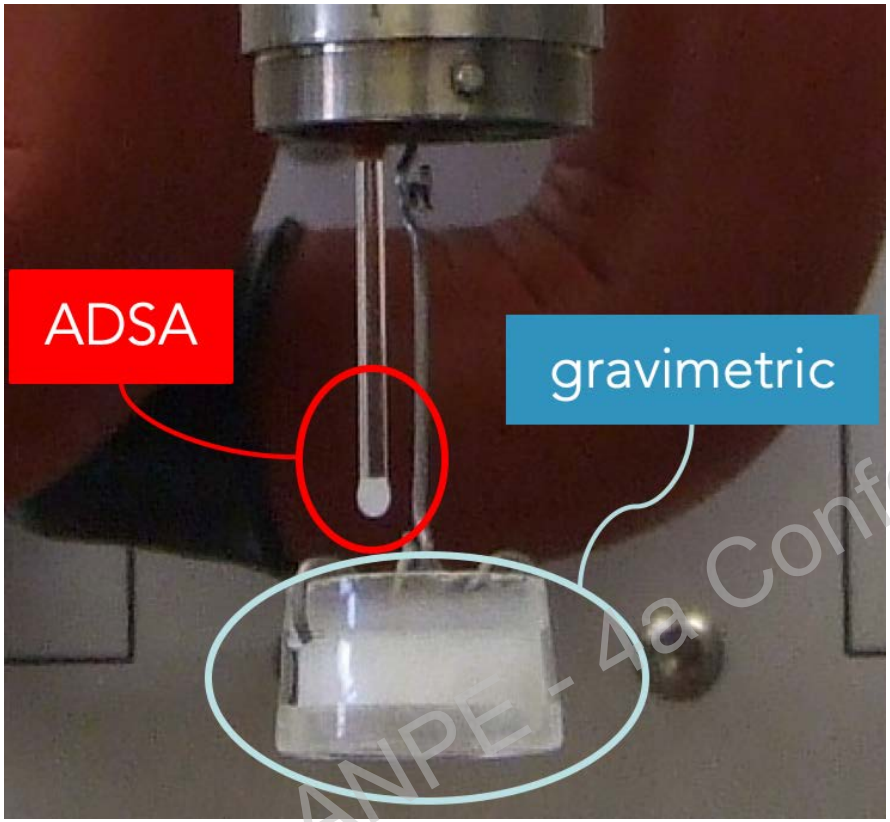
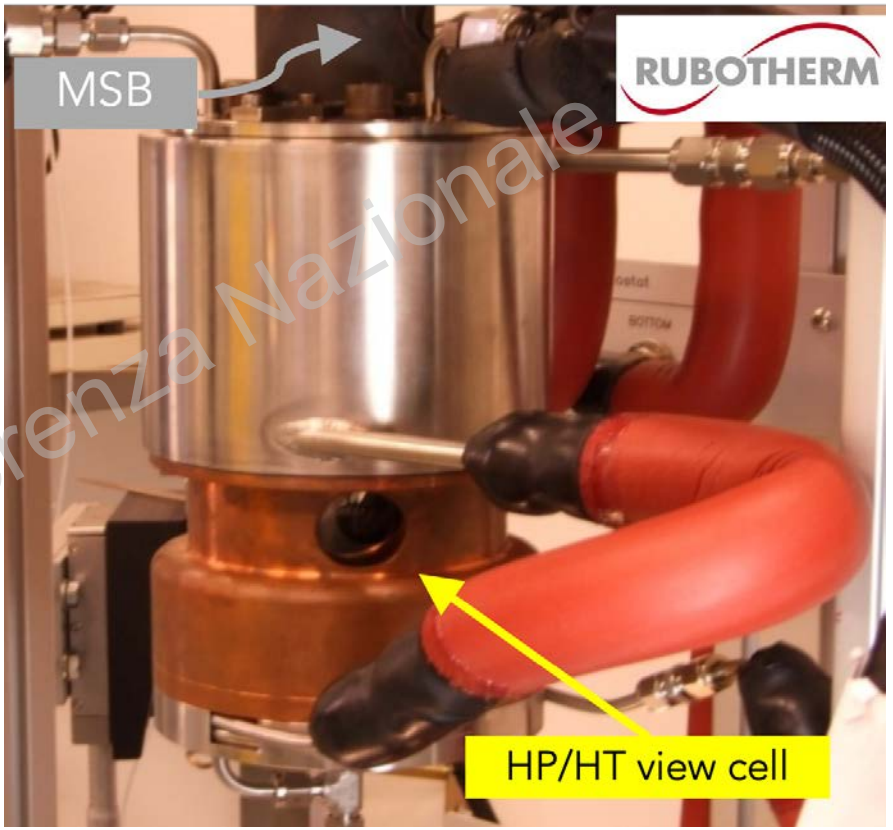
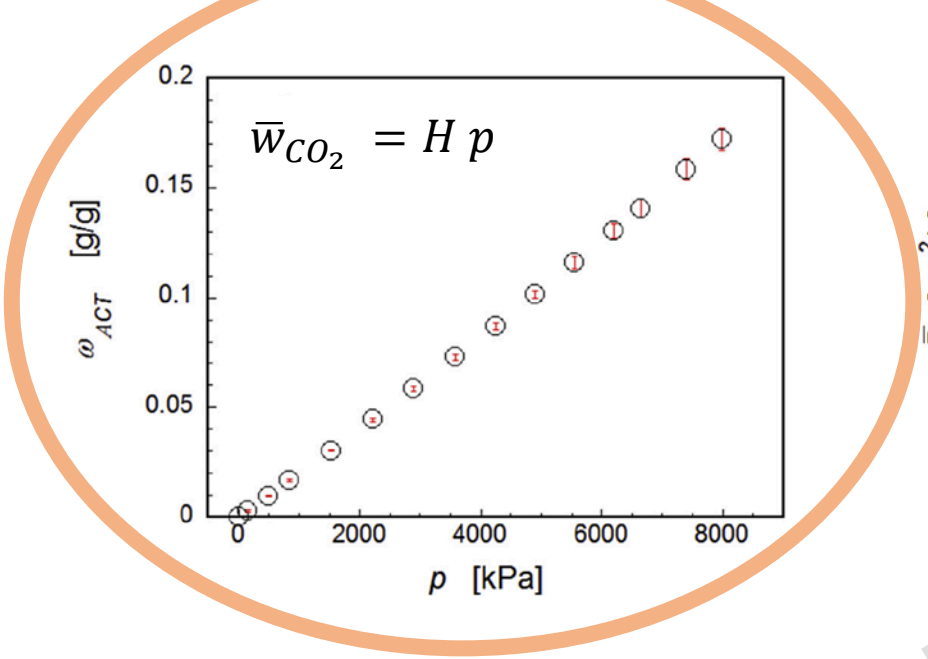
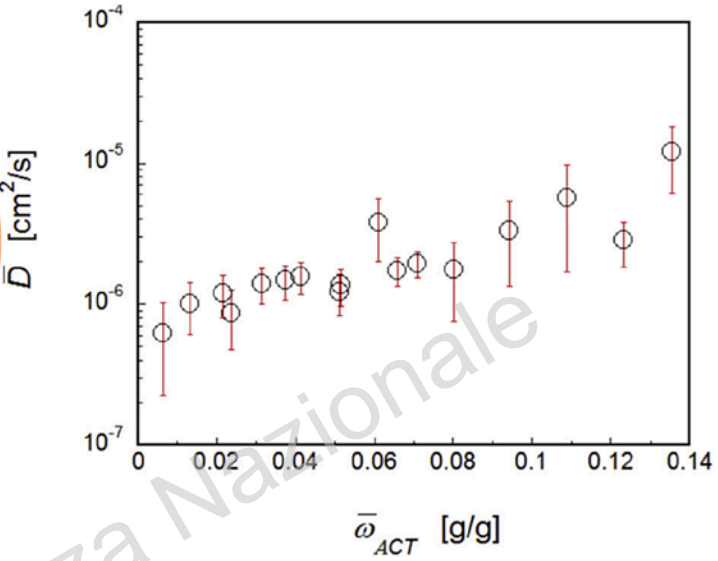
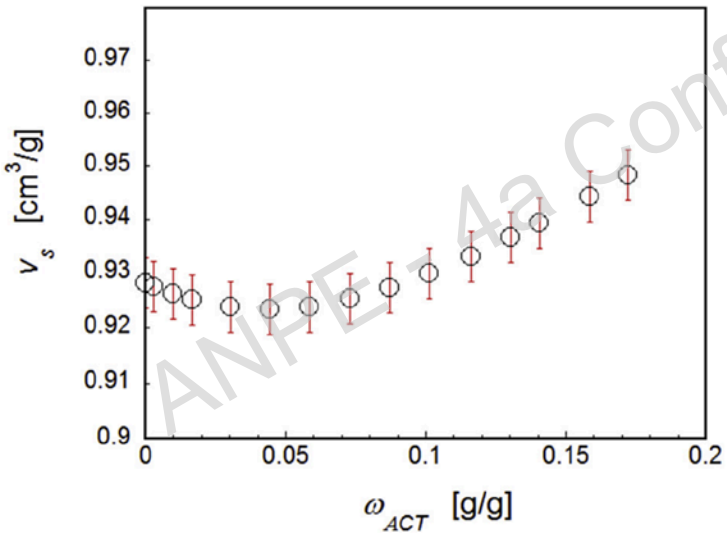


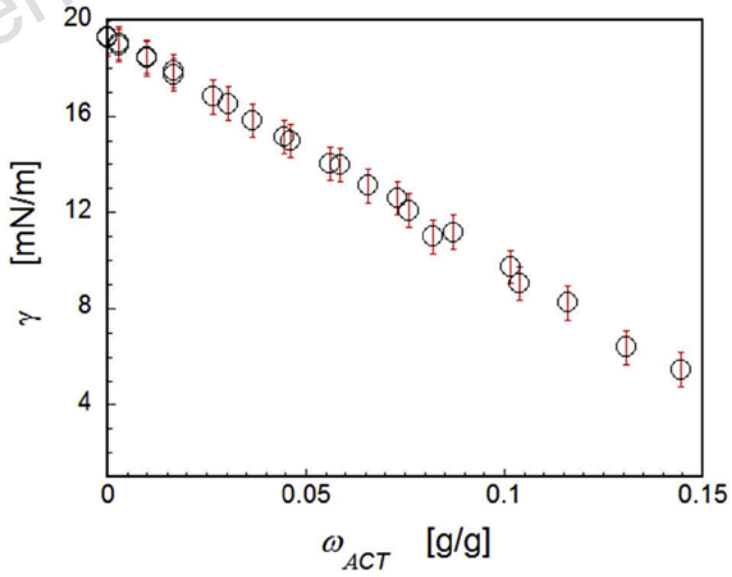


Pastore Carbone et al., *Polymer Testing, 2011*









Di Caprio et al., Fluid Phase Equilibria, 2016
Di Caprio et al., Fluid Phase Equilibria, 2018

FoamLab

thermosetting PU foaming by high pressure CO_2:

how?

1. sorption under high pressure
2. curing under high pressure
3. foaming at pressure release

$$\bar{w}_{CO_2} = H\,p$$

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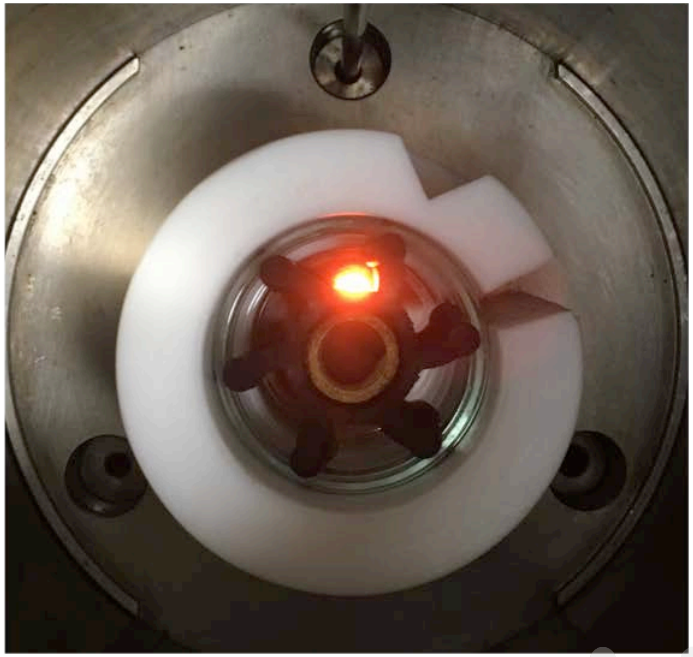
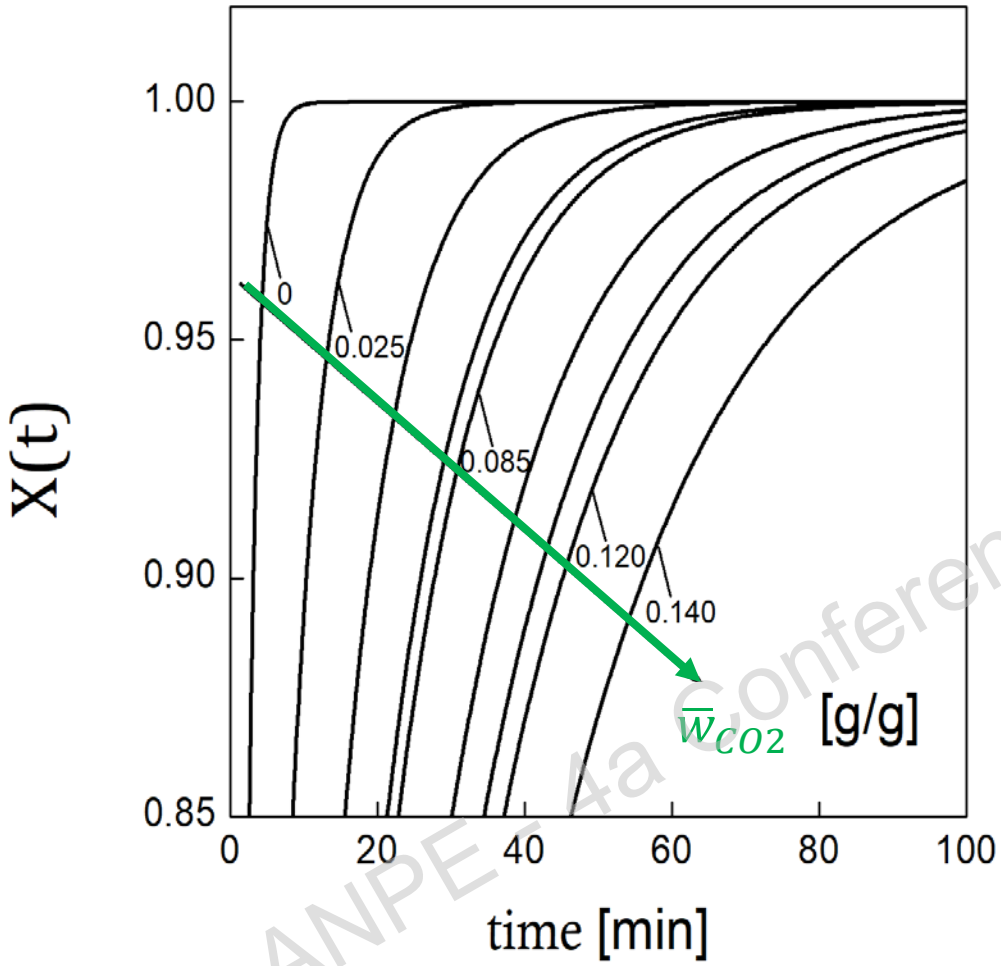
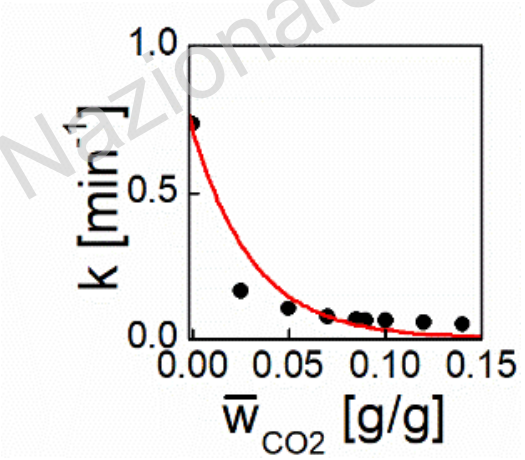


Di Caprio et al., Polymer Testing, 2016c



$$X(t) = \frac{A_{NH}}{A_{NH_f}} = 1 - e^{-kt}$$



$$k(\bar{w}_{CO_2}) = A\, e^{-B\, \bar{w}_{CO2}}$$

$$k\,(p) = A\, e^{-B\, H\, p}$$

Di Caprio, Brondi et al., European Polymer Journal, 2019

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ready to go!

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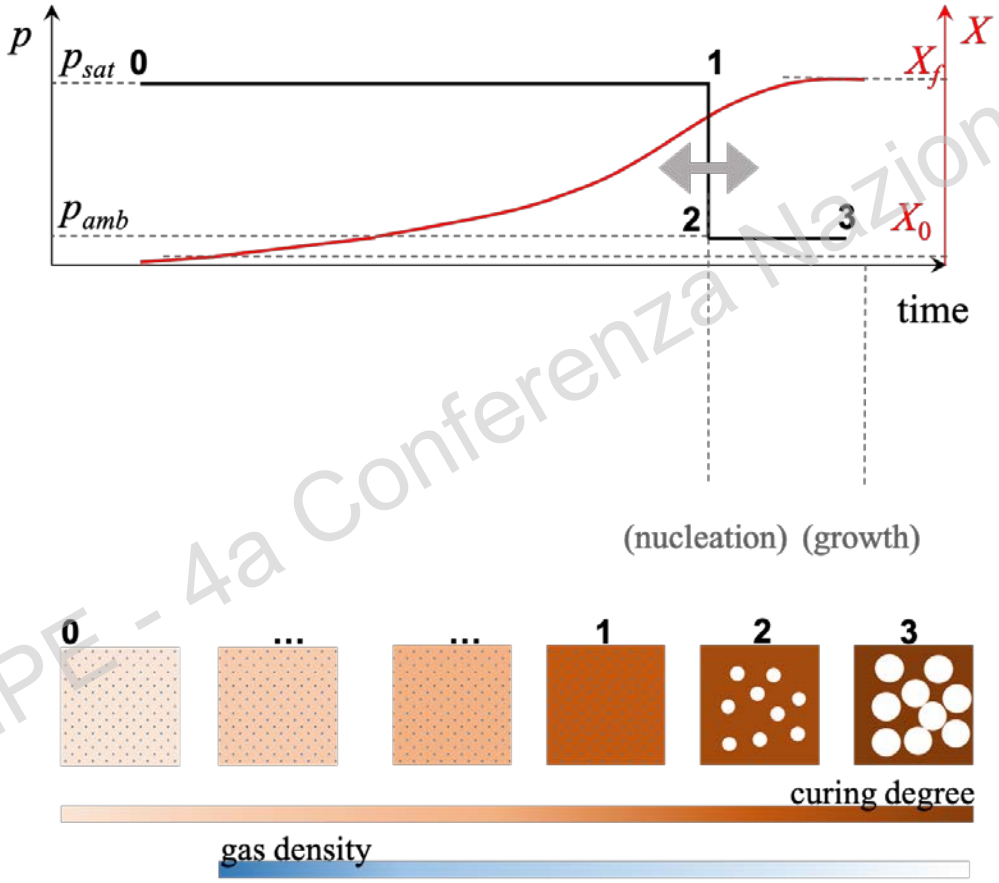
Di Caprio et al., Fluid Phase Equilibria, 2018
Di Caprio, Brondi et al., European Polymer Journal, 2019

state of the art

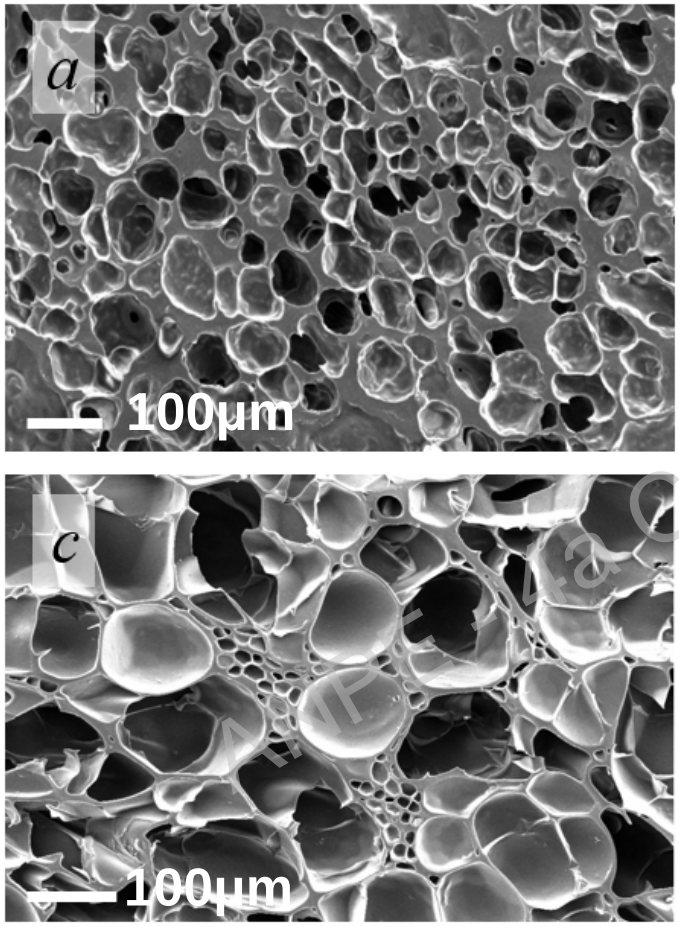


available processing variable

Yang et al., J. Supercritical Fluids, 2019

$\theta(10^2\ s)$ $\theta(10^{-2}\ s)$

one-stage foaming



ONE-STAGE

how to deal with this time scales mismatch?

$O(10^2\ s)$

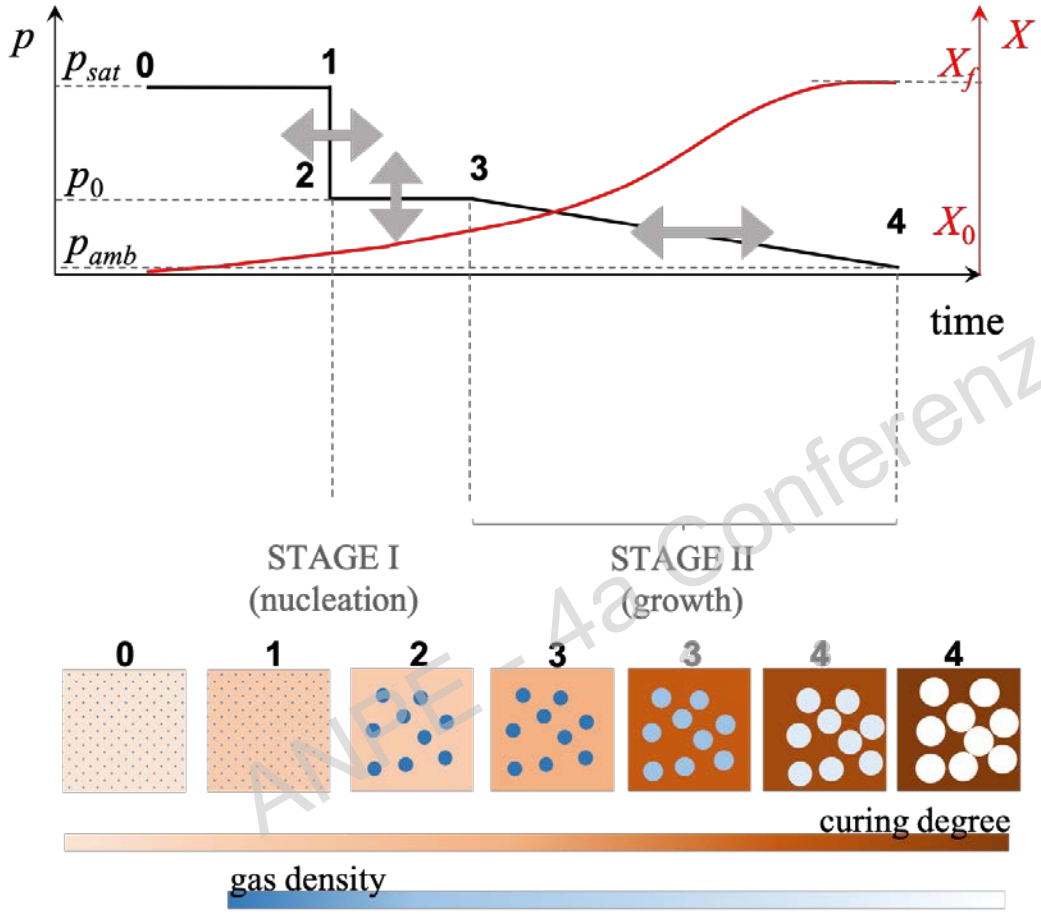
chemical reaction

$O(10^{-2}\ s)$

pressure quench

how to have an **abrupt** pressure drop but still, do **not stress** the material too much?

O(10^2 s) O(10^{-2} s) our approach

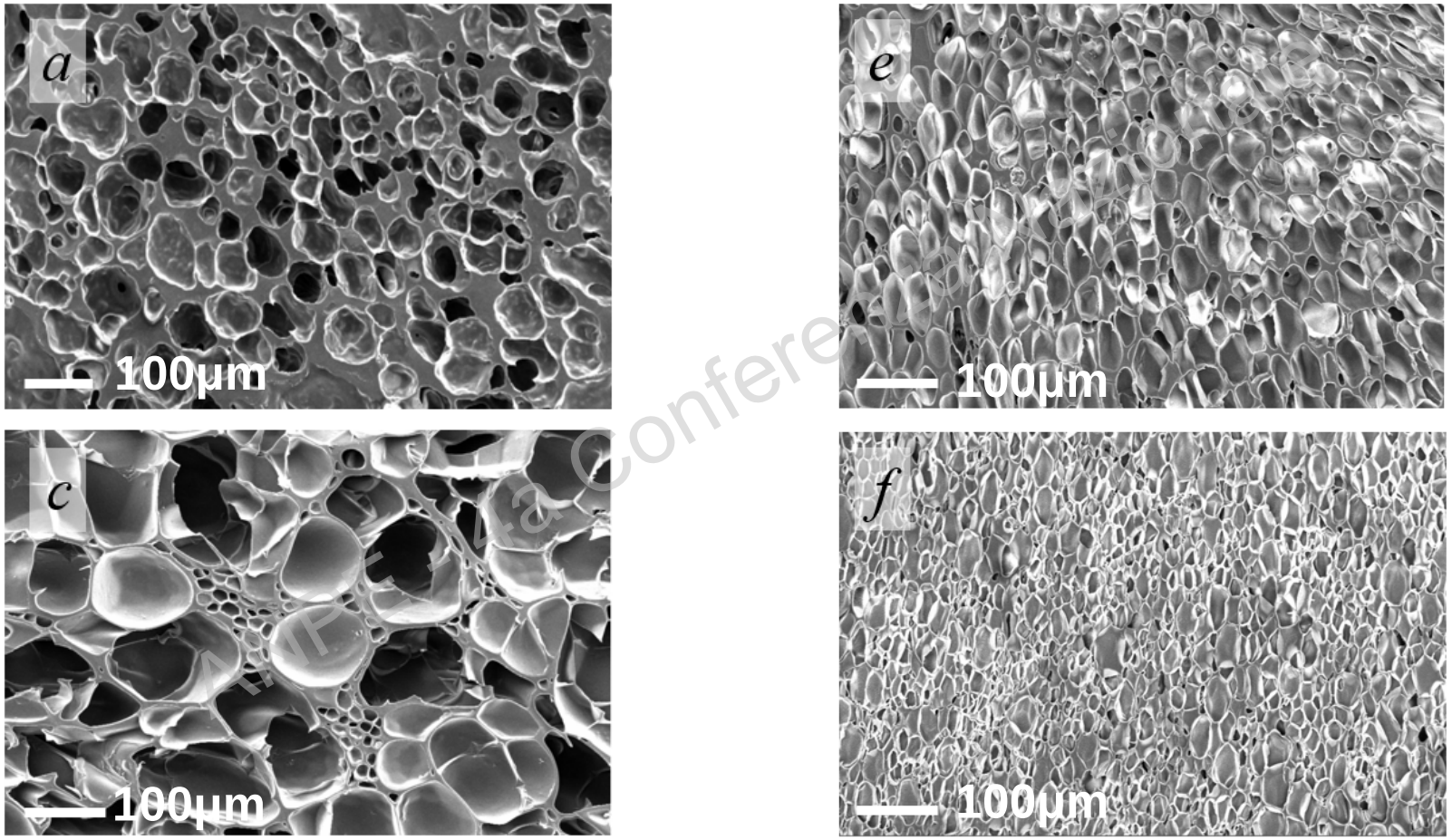


$$\dot{p} = \frac{A}{B\,H}\frac{(1 - e^{-B\,H\,p_0})}{ln\left(\frac{1 - X_0}{1 - X_f}\right)}$$

Brondi et al. J. Supercr. Fluids 2019

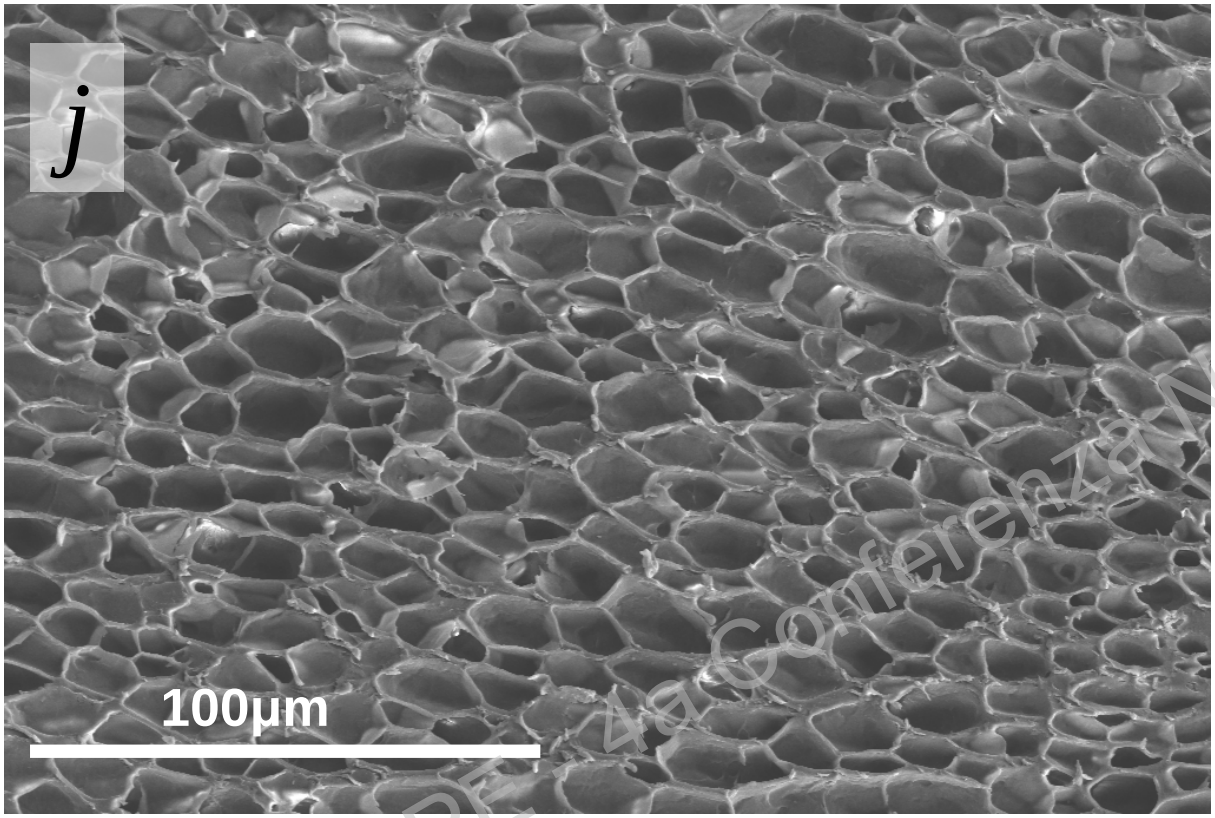
O(10^2 s) O(10^{-2} s) our approach

chasing the synthesis reaction with the pressure!



ONE-STAGE TWO-STAGE

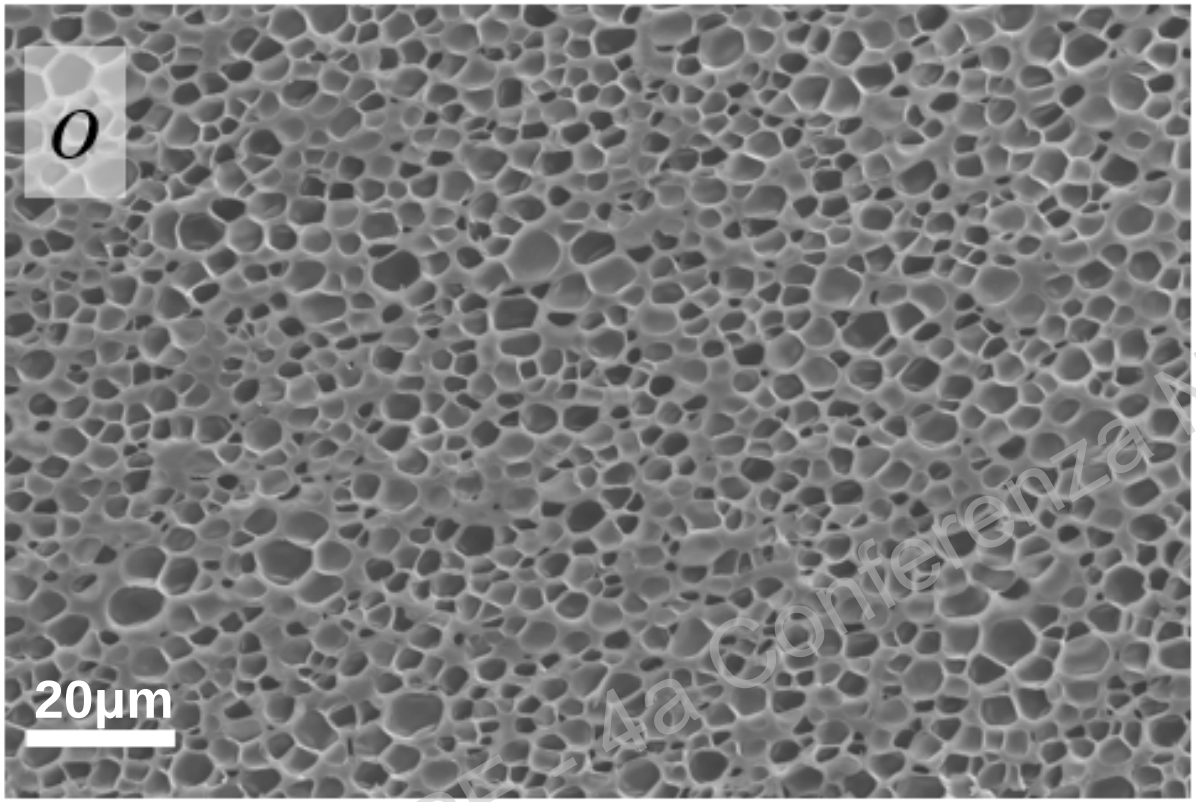
Brondi et al. J. Supercr. Fluids 2019



TWO-STAGE

chasing the synthesis reaction with the pressure!

Brondi et al. J. Supercr. Fluids 2019



TWO-STAGE

chasing the synthesis reaction with the pressure!

Brondi et al. J. Supercr. Fluids 2019

Poliuretano 4.0

Roma, 10 Ottobre 2019

chasing the synthesis reaction with the pressure

reactionem pressione urgēre

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