TITLE

Non-Uniform PVC Foams

Iram Ahmad – Advisor: Prof. Ernesto Di Maio

Curriculum: Ingegneria dei Materiali e delle Strutture

Abstract:

The long history of PU foams development has dealt principally with chemistry optimization aimed at controlling the two reactions of curing and blowing and make them synchronized to have the required polymer viscosity increase while bubbles grow. The characteristic reactions duration is of the order of 10-100s. Water as the Chemical Blowing Agent, often in conjunction with Physical Blowing Agents, like hydrocarbons (e.g., pentane), are providing the gas to inflate bubbles typically formed during the vigorous mixing of reactants. From the engineering point of view, the system can be described as governed by highly coupled mass, momentum and heat transport phenomena with reacting species. A complex playground for innovation.

Nowadays, spatially non-uniform (graded) foams are gaining interest and several strategies are reported to achieve foams with graded densities and/or morphologies, along with theoretical studies which point to enhanced properties of the graded foams as regards as their uniform counterparts. We have recently introduced graded foams in thermoplastic polymers, achieved through time-varying the boundary conditions of the mass transport of the physical blowing agent to induce a non-uniform blowing agent profile in the expanding polymer before foaming [1]. Knowledge of the sole material property at play, namely the blowing agent diffusivity, suffices to design the sorption process to attain different spatial distribution of bubbles (hence of the foam density and morphology) and, in turn, of properties.

In this context, we foresee the immense opportunity for improvement by applying a similar approach to thermosetting polyurethanes [2], to achieve advanced foams with non-uniform spatial distribution of both foam density and morphology to improve properties or reduce material usage, allowing a more sustainable use of the matter. Advanced foamed structures can be designed and achieved to cope with the loading conditions (in terms of structural and functional stimuli) of the specific application.

In the present project, we will design the thermosetting polyurethane foams manufacturing process

to achieve such non-uniform structures by adopting the time-varying boundary conditions approach on the heat and mass transport phenomena.

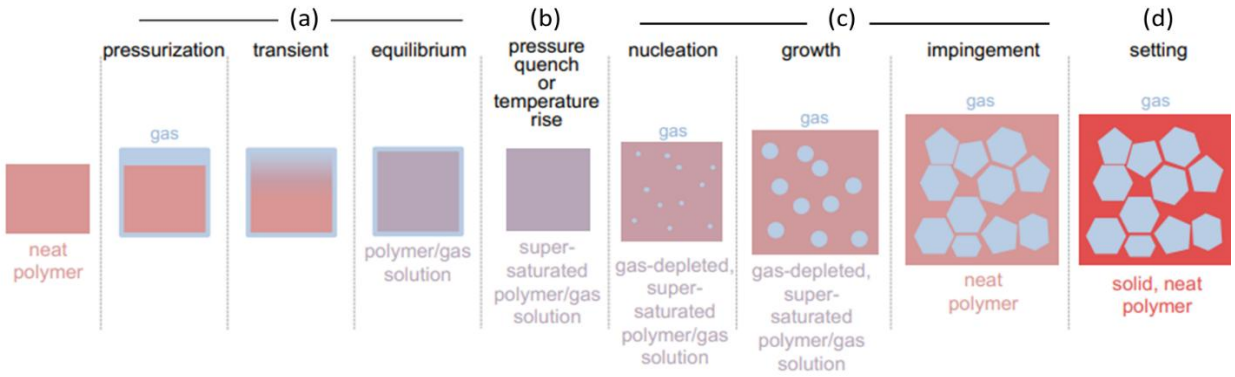

Figure. Schematic description of the foaming process.

References

1. M. Trofa, E. Di Maio, P.L. Maffettone, Multi-graded foams upon time-dependent exposition to blowing agent, Chemical Engineering Journal, 362 (2019) 812–817

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e-mail address: iram.ahmad@unina.it