# Water-induced self-blown non-isocyanate polyurethane foams at room temperature

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**Key words:** non-isocyanate polyurethane, foams, self-blowing, water

**Abstract:** Polyurethanes (PUs) foams, expected to reach a world-wide production of 12.7 million tons by 2024, are present in an impressive range of products in many sectors (construction, transportation, sport, health, etc). For 80 years, the industrial production of self-blown PU foams remains unchanged by reacting polyisocyanates with polyols in the presence of water. The partial hydrolysis of isocyanates delivers the blowing agent, carbon dioxide ($CO_2$), that expands the PU matrix during its construction. Although versatile, this toxic isocyanate-based chemistry is currently rising severe environmental and regulatory concerns, causing their restriction of use. Combined to the need to decarbonize the plastic sector, these incentives push the researchers to rethink the fabrication of PU foams by an isocyanate-free route by exploiting raw chemicals issued from bio-renewables and/or gaseous waste effluents (e.g. $CO_2$). Many routes exist for isocyanate-free PUs, however none of them mimics the simple and cost-effective PU chemistry for foaming, i.e. by *in-situ* forming and releasing $CO_2$ by partial hydrolysis of one of the comonomers.

In this talk, I will describe the first preparation of self-blown non-isocyanate polyurethane (NIPU) foams by utilizing water to generate the blowing agent by partial hydrolysis of one of the comonomers.[1-2] The addition of a tiny amount of water and a catalyst enables to self-blown solvent-free formulations composed of $CO_2$-based cyclic carbonates and diamines in 30 min at 100 °C under optimal conditions. This process is adaptable to the reactive-injection molding (RIM) technology that utilizes heated mold for the industrial production of foams of precise shape.

Many commercialized PU foamed materials (e.g. matrasses) are also produced in very short periods of time (5-10 min) from room temperature (RT) formulations. However, achieving a so fast self-blowing with NIPUs starting from RT formulations was never reported and is extremely challenging due to the low reactivity of the cyclic carbonate comonomer. In the second part of the talk, I will address this challenge and explain how our water-based process can be adapted to deliver NIPU foams in record timeframes (about 5 minutes) from RT formulations. The potential of the system will be illustrated for the production of NIPU foams of various properties, including foams of high bio-based content (70-90 wt%). I will also illustrate one recycling scenario of these foams.

This simple water-induced self-blowing process is highly versatile, gives access to foams of diverse properties potentially answering the huge foam market demands, and is potentially compatible to existing PU foaming infrastructures. It is therefore of high potential for the production of the next generation of greener foamed materials responding to the sustainability demand of our modern society.

## References :

[1] : Maxime Bourguignon, Bruno Grignard, Christophe Detrembleur, *Angew. Chem. Int. Ed.* **2022**, *61*, e202213422.
[2] : Maxime Bourguignon, Bruno Grignard, Christophe Detrembleur, *WO 2023/104362A1*.
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