CO$_2$-blown microcellular non-isocyanate polyurethane (NIPU) foams: from bio- and CO$_2$-sourced monomers to potentially thermal insulating materials

B. Grignard $^a$, J.-M. Thomassin $^a$, S. Gennen $^a$, L. Poussard $^b$, L. Bonnaud $^b$, J.-M. Raquez $^b$, P. Dubois $^b$, M. –P. Tran $^c$, C. B. Park $c$, C. Jerome *$^a$, C. Detrembleur *$^a$

ESI1: $^1$H NMR characterization of poly(ethyleneglycol) biscyclocarbonate
ESI2: $^1$H NMR characterization of CSBO
a) **Coupling of ethylene carbonate with n-heptyl amine.** 1 g of ethylene carbonate (11.35 mmol) was introduced in a glass tube containing 1.68 mL of n-heptyl amine (11.35 mmol), 1,3-bis-(2-hydroxyhexafluoroisopropyl)benzene (0.142 mL, 5 mol%) and 4mL of dioxane. The reaction mixture was then heated to 60°C and the conversion was determined by online Raman spectroscopy using a red laser ($\lambda = 785$ nm) according to a procedure described elsewhere. Spectra were recorded every 3 minutes and conversions were determined (after normalization of the Raman spectra) by comparing the evolution of the intensity of the peak characteristic of ethylene carbonate at 716 cm$^{-1}$ with a signal that did not evolve during the reaction ($\nu = 835$ cm$^{-1}$).

b) ![Reaction scheme](image)

c) ![Conversion-time graph](image)

ESI3: a) Experimental section for the coupling of ethylene carbonate with n-heptyl amine in the presence of 1,3-bis(hydroxyhexafluoroisopropyl) benzene as catalyst; b) Reaction scheme for this reaction; c) Comparison of the evolution of the conversion with time for this reaction carried out in the presence (purple) or not (black) of 1,3-bis(hydroxyhexafluoroisopropyl) benzene (5 mol% compared to ethylene carbonate). Conditions: Solvent = dioxane, $T = 60^\circ$C, [EC] = [n-heptylamine] = 1.76 M.
ESI4: Compression stress/strain curves for NIPU 1 (sample C, Figure 6) and NIPU 2 (sample G, Figure 6) (2 mm/min.).

Reference: