Supporting Information

Open-cell aliphatic polyurethane foams with high content of polysaccharides: structure, degradation and ecotoxicity

Kateřina Skleničková[†], *Věra Vlčková*[‡], *Sabina Abbrent*[†], *Sonia Bujok*[†], *Aleksandra Paruzel*[†], *Lívia Kanizsová*[†], *Olga Trhlíková*[†], *Jana Říhová Ambrožová*[§], *Martin Halecký*[‡,*], *Hynek Beneš*[†,*]

[†]Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, Prague 6, 162 06, Czech Republic

[‡]Department of Biotechnology, Faculty of Food and Biochemical Technology, University of Chemistry and Technology Prague, Technická 5, Prague 6, 166 28, Czech Republic

[§]Department of the Water Technology and Environmental Engineering, Faculty of Environmental Technology, University of Chemistry and Technology Prague, Technická 5, Prague 6,166 28, Czech Republic

*Corresponding authors: Hynek Beneš (benesh@imc.cas.cz), Martin Halecký (martin.halecky@vscht.cz)

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Characterization of poly[(diethylene glycol) adipate] triol

Hydroxyl number and *acid number* of poly[(diethylene glycol) adipate] (PDEG-AD) triol were determined according to ISO 2554:1974 and ASTM D 4662-93, respectively.

Viscosity of PDEG-AD triol was measured using a Bohlin Gemini HR nano-rheometer (Malvern Instruments) with cone/plate geometry (40 mm diameter, 4° angle, 0.15 mm gap) at a temperature of 23 °C in the range of shear rates 0.01−100 s^{-1}.

Water content in PDEG-AD triol was determined using the Karl Fischer titration method according to ISO 760.

Size exclusion chromatography (SEC) of PDEG-AD triol was performed on a Modular GPC system equipped with a refractive index detector Shodex RI-101 (Showa Denko K.K., Japan) and an UV−VIS photometric detector LCD 2084 (ECOM, Czech Republic) operated at λ= 254 nm, and a set of two columns PLgel 10E3 and 50 Å, 10 μm particle size, 300 mm × 7.5 mm (Polymer Laboratories, UK) was used. Chromatographic data were collected and treated using Clarity software (Data-Apex, Czech Republic). Tetrahydrofuran was used as a mobile phase (flow rate of 1 mL min^{-1}). Polystyrene standards with weight average molecular weights (M_w) of 500, 1000, 3000, and 10 000 were used for calibration.

Table S1. Properties of the synthesized poly[(diethylene glycol) adipate] triol.

hydroxyl number, mg KOH g^{-1}	46±1
acid number, mg KOH g^{-1}	5.7±0.2
viscosity at 23°C, mPa s	4 900±500
water content, %	0.15±0.02
M_n, g mol^{-1}	14 700
M_w, g mol^{-1}	3 800
M_w/M_n	3.9

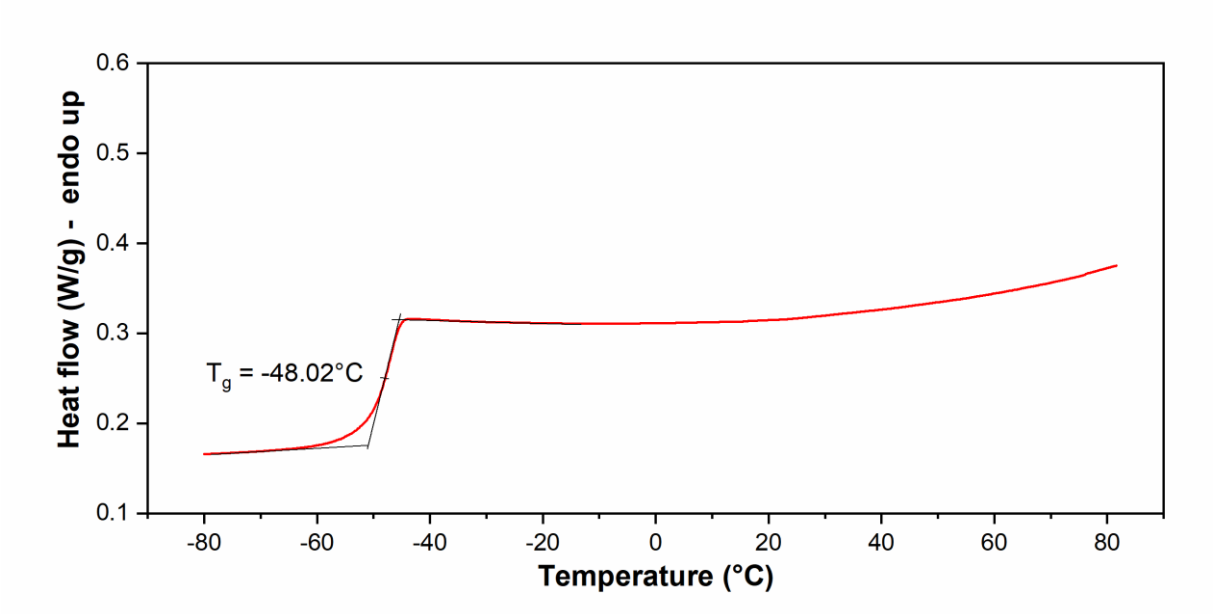


Figure S1. DSC results of poly[(diethylene glycol) adipate] triol. The 2nd DSC heating run shows a glass transition temperature (T_g) at –48 °C. No melting peak revealed a fully amorphous character of the synthesized triol.

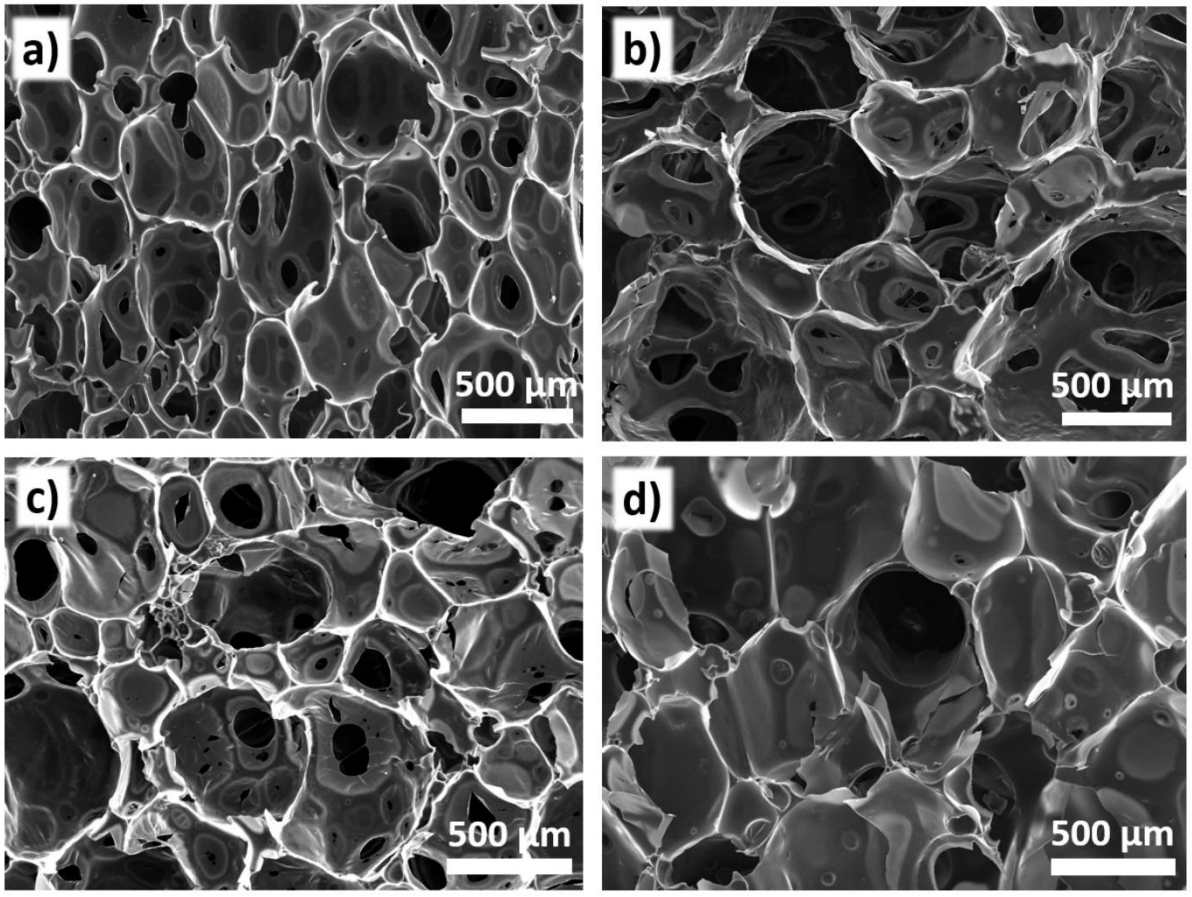


Figure S2. SEM images of the investigated foams: a) PUR, b) PUR_starch and c) PUR_HEC. d) SEM image of PUR foam with 30 wt% starch without clay addition demonstrating the effect of clay on the cellular morphology of PUR foams. A comparison of two PUR foams with 30 wt% of starch (Figure S2b and S2d), the first of which is prepared with 2 % clay addition (PUR_starch), (b) and the second without clay addition (d), shows that the addition of clay initiates cell rupture and promotes the formation of an open-cell structure.

Table S2. Basic characteristics of PUR foam with 30 wt% starch without clay addition.

Foam type	Apparent density (kg m^{-3})	Open cell content (%)	Average cell size (mm)
Semi-rigid	98±10	82±3	0.53±0.24

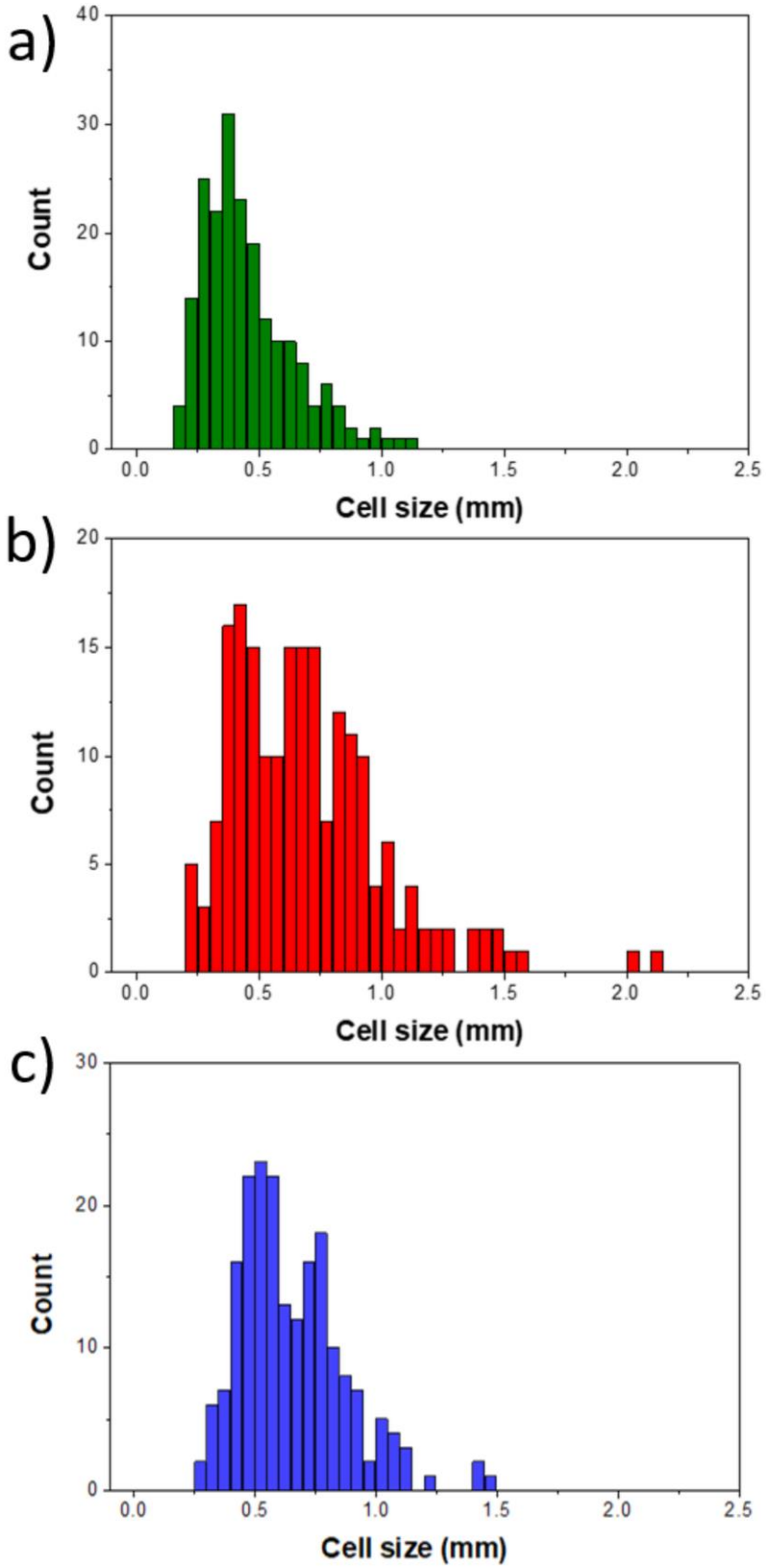


Figure S3. Cell size distributions of a) PUR, b) PUR_starch and c) PUR_HEC foams determined from optical microscopy.

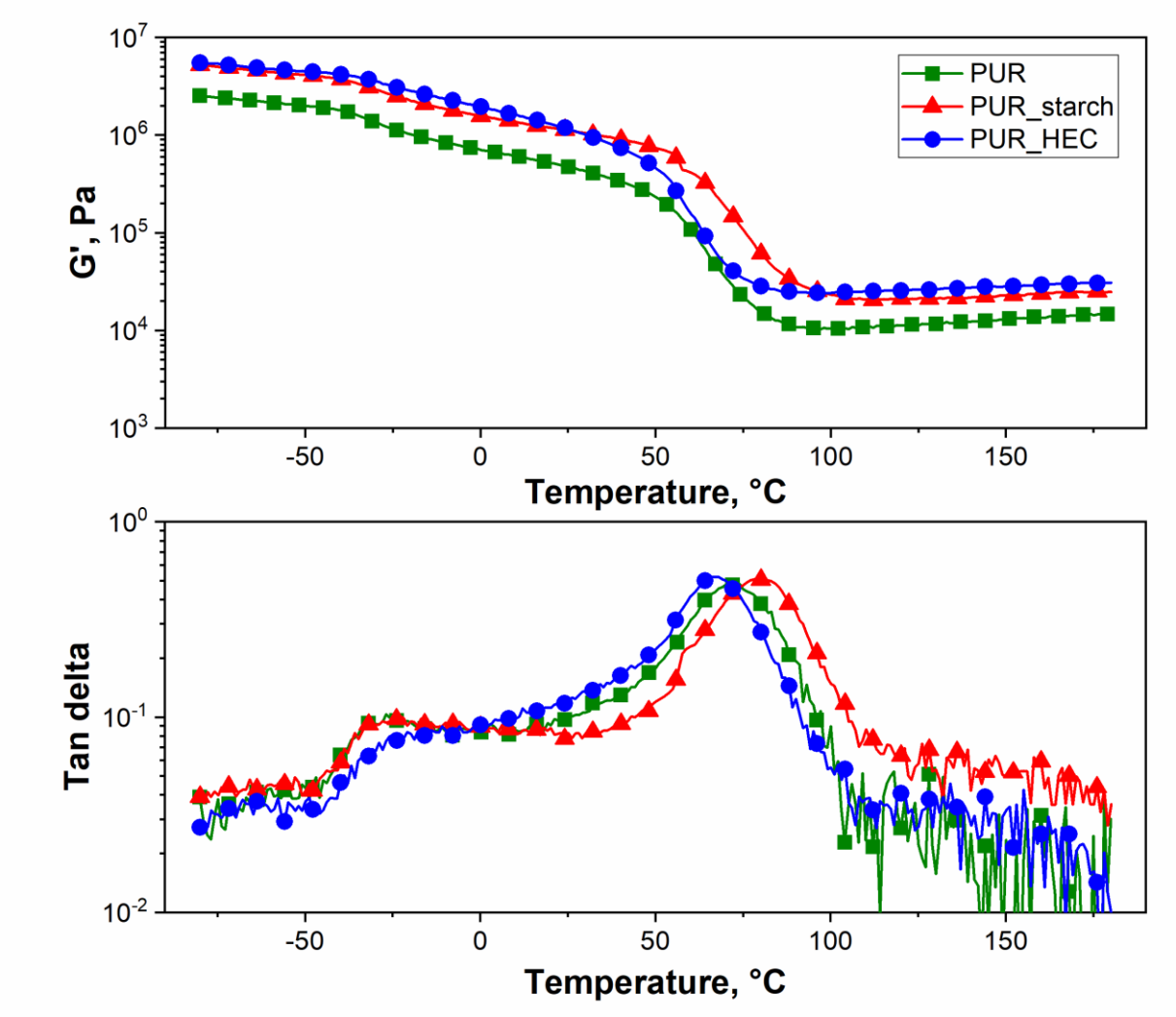


Figure S4. DMTA results of PUR, PUR_starch and PUR_HEC foams.

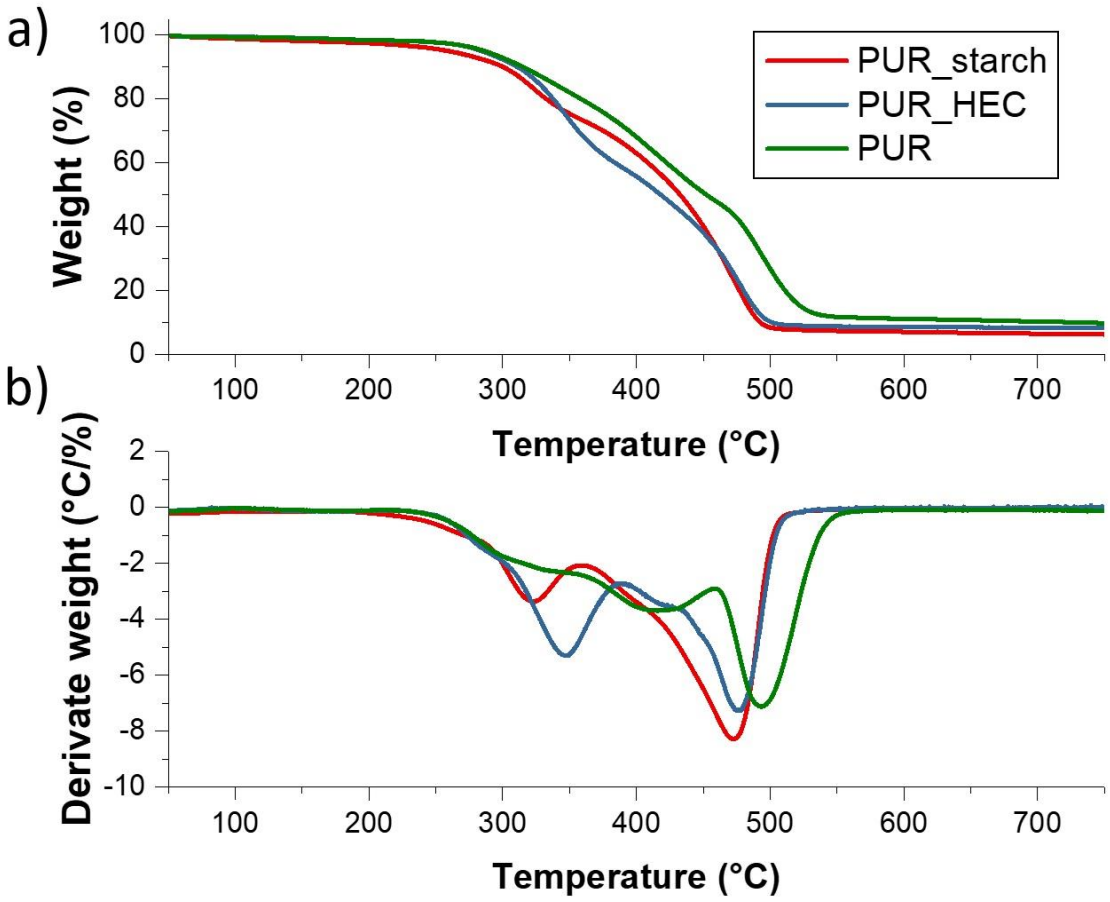


Figure S5. a) TGA results of PUR, PUR_starch and PUR_HEC foams. b) dTGA results of PUR, PUR_starch and PUR_HEC foams.

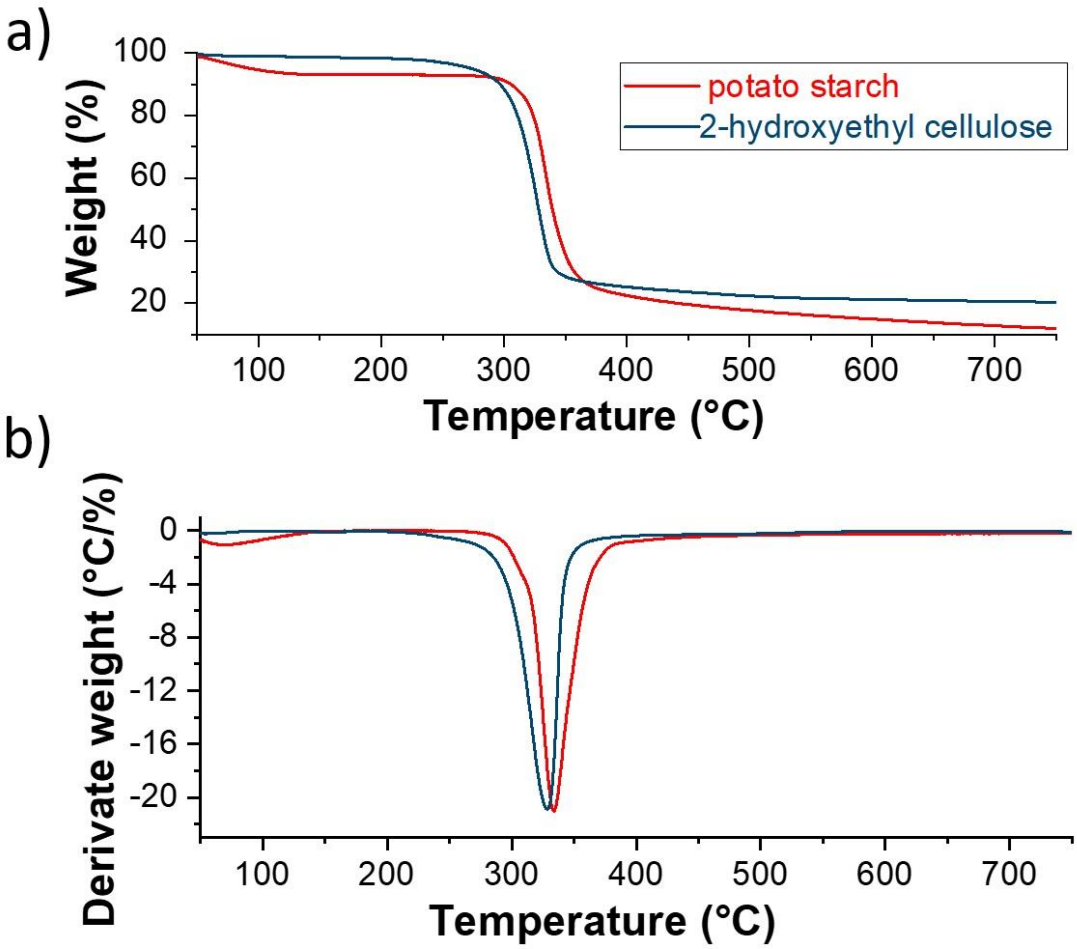


Figure S6. a) TGA results of potato starch and 2-hydroxyethyl cellulose. b) dTGA results of potato starch and 2-hydroxyethyl cellulose.

Gas chromatography-mass spectrometry analysis (GC-MS) was performed on Perkin Elmer Clarus 680 Gas Chromatograph directly coupled with a Perkin Elmer Clarus SQ 8 T Mass spectrometer detector. Capillary column DB-35MS (30 m, 0.25 mm, 0.25 μm) was used. Temperature program in the gas chromatograph was as follows: initial temperature 50 °C was held for 5 min, increased to 250 °C at 10 °C min^{-1}, and then held isothermally to complete the analysis. Temperature of the injector was 200 °C. The carrier gas was helium with the flow rate 1 ml min^{-1}. For GC-MS detection, an electron ionization system was used with ionization energy of 70 eV, ion source temperature 200 °C, scan mass range of *m/z* 15-620, and interface line temperature 200 °C. The identification of the compounds was performed by comparison of the measured mass spectra with MS spectra in NIST (version 14) and Wiley Libraries (version 9). Prior to analysis, sample was placed in a 2 mL disposable glass vial and let dry for at least 24 hours at ambient temperature. Then, a derivatizing agent N,O-bis(trimethylsilyl)trifluoroacetamide (BSTFA; ≥99%, Sigma Aldrich) was added to the dried sample, the vial was sealed and heated at 70 °C for 60 min and derivatized sample was injected into the gas chromatograph. Trimethylsilyl derivatives of low molecular weight degradation products in aqueous phase after 6-week abiotic hydrolysis of neat PUR foam (PUR) at 80 °C were detected (Figure S7).

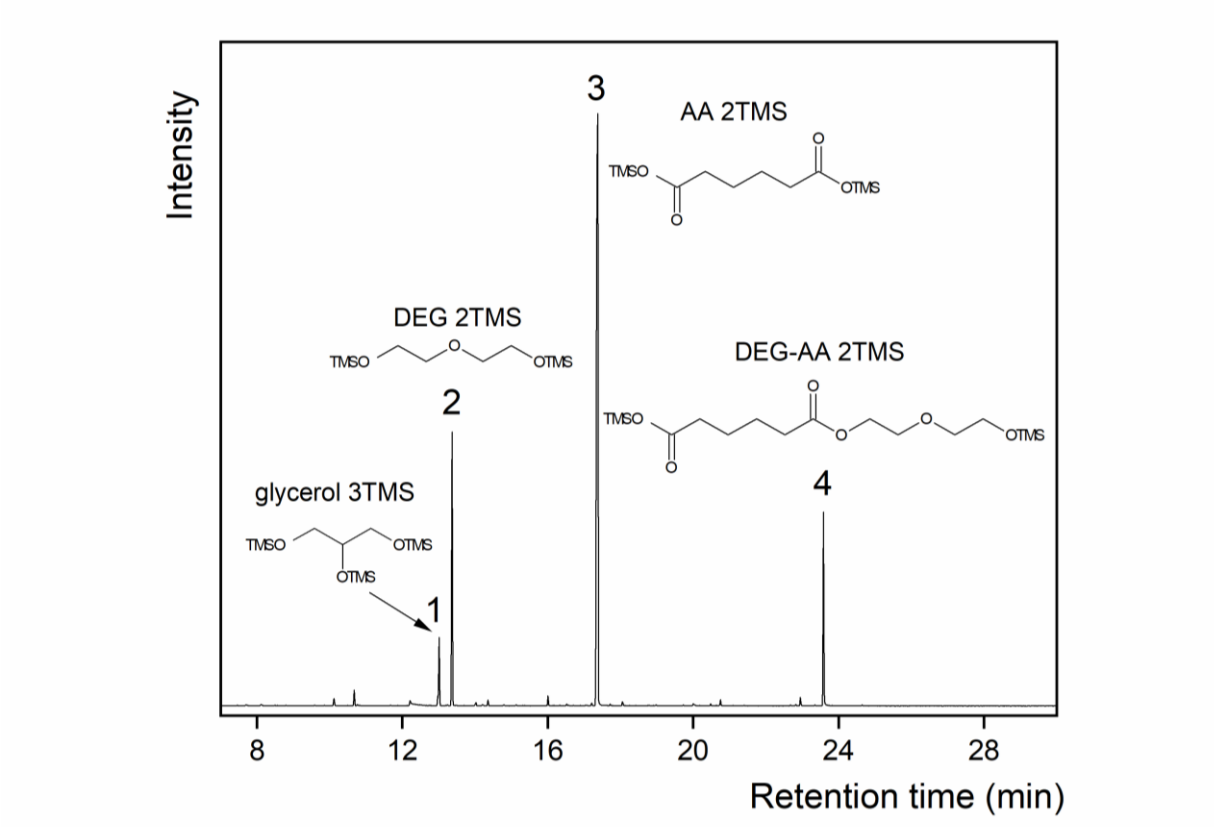


Figure S7. GC chromatogram of derivatized aqueous phase after 6-week abiotic hydrolysis of neat PUR foam (PUR) at 80 °C. Peak 1 is attributed to glycerol 3TMS derivative (r.t. 13.01 min), peak 2 to diethylene glycol 2TMS derivative (r.t. 13.37 min), peak 3 to adipic acid 2TMS derivative (r.t. 17.38 min) and peak 4 to DEG-AA 2TMS derivative (r.t. 23.59 min).

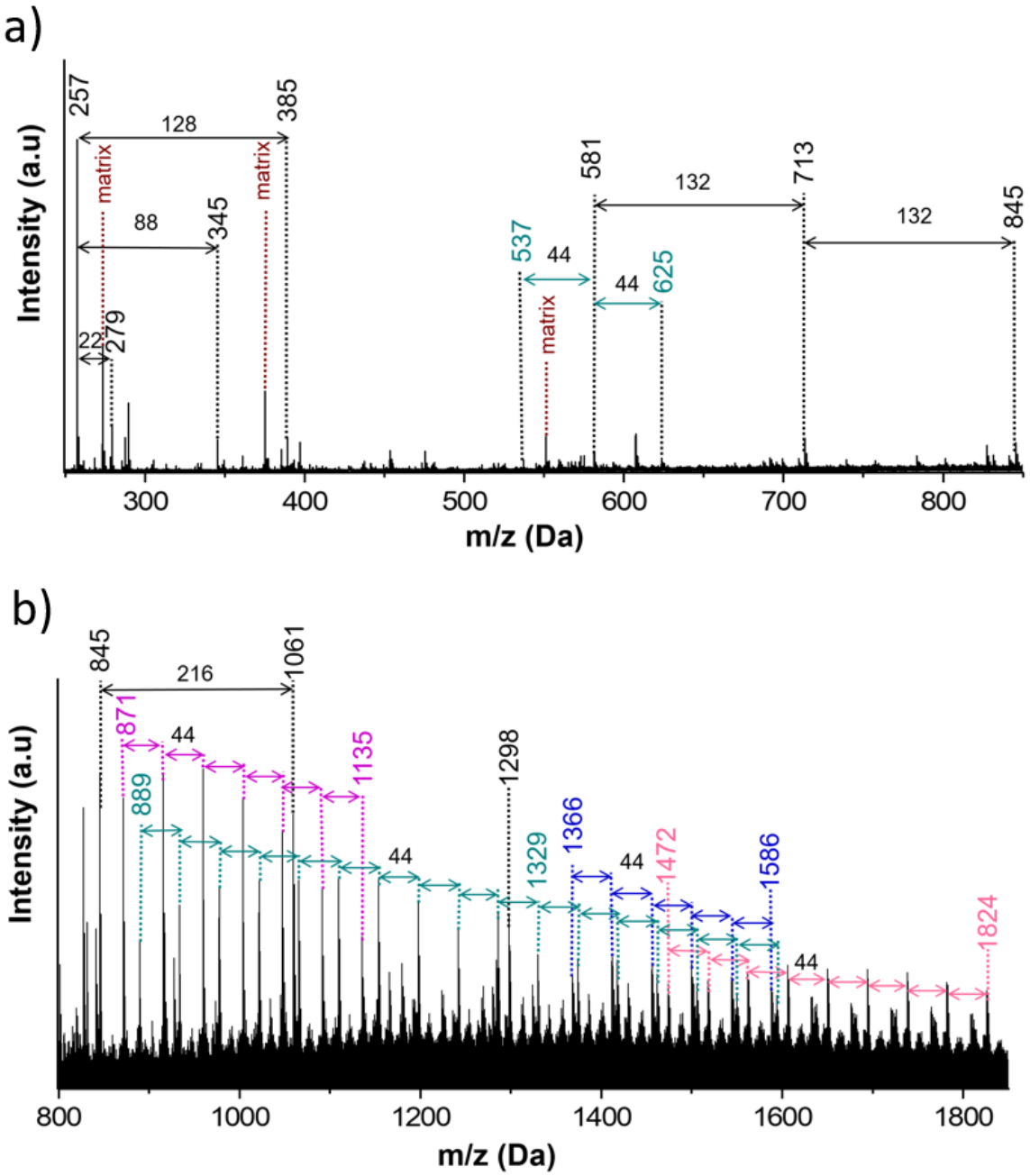
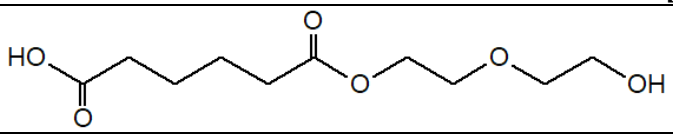
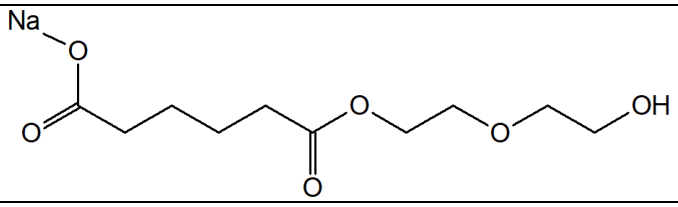
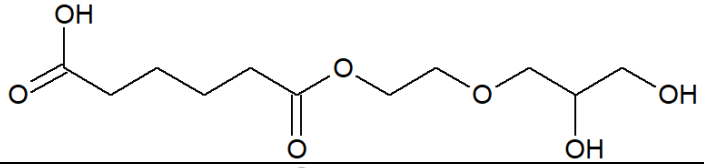
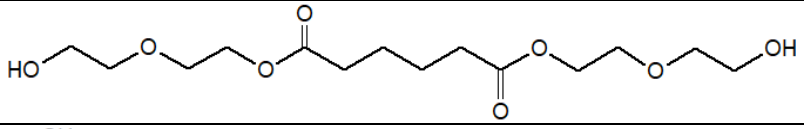
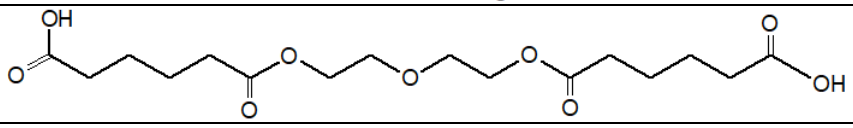
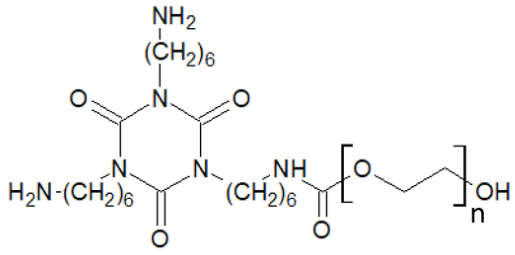
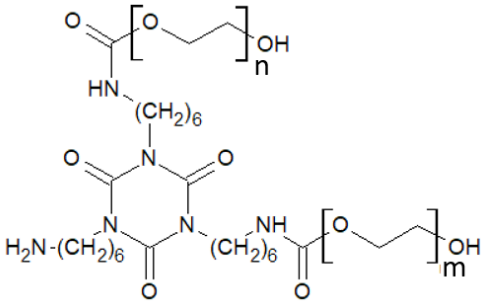
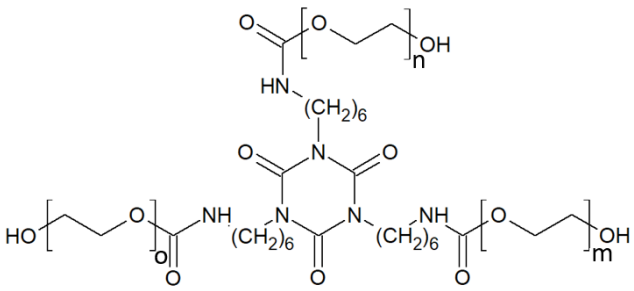
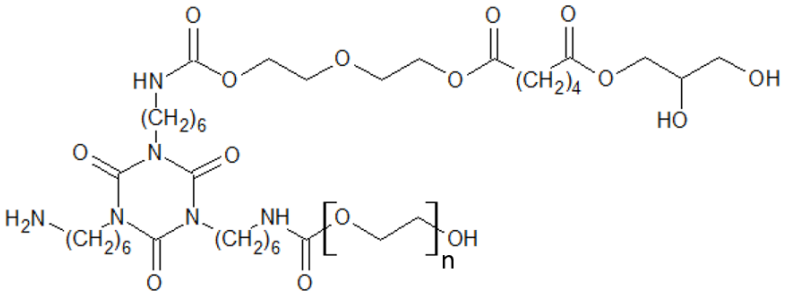
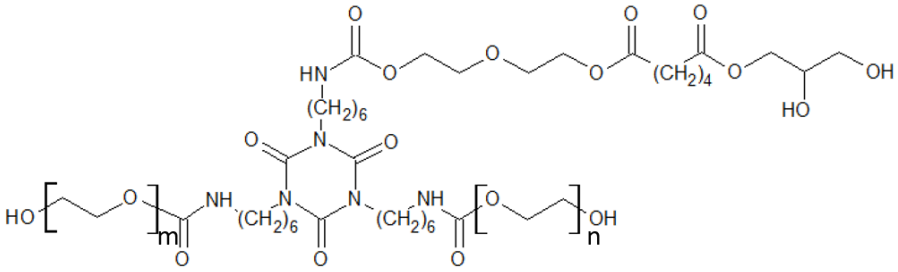
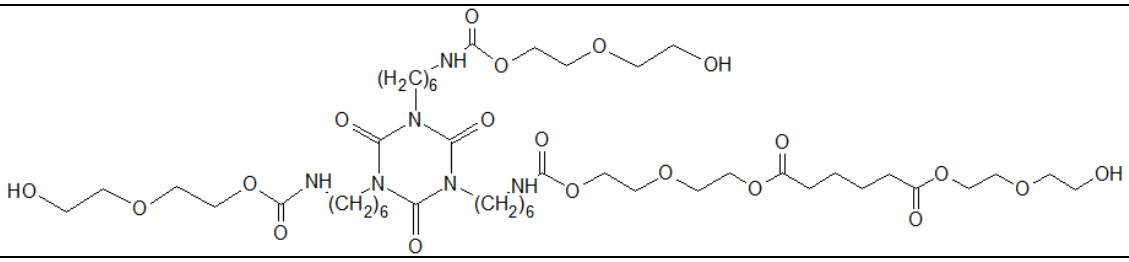
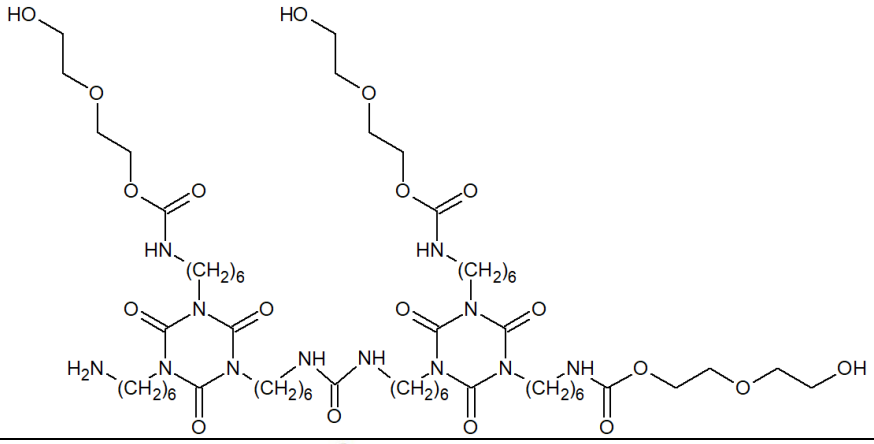
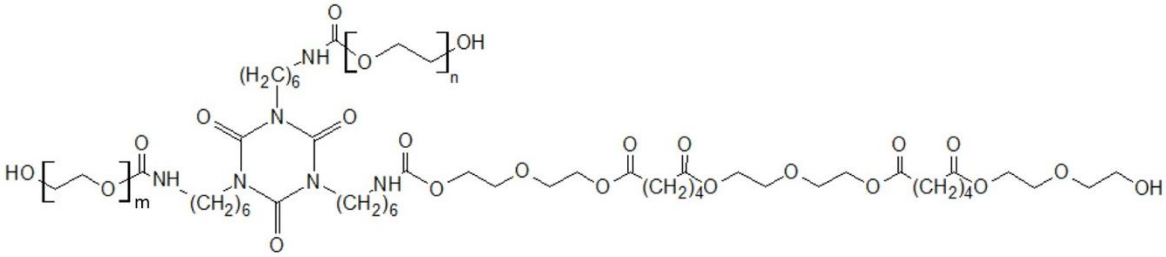


Figure S8. MALDI-TOF mass spectra of aqueous phase after 6-week abiotic hydrolysis of neat PUR foam (PUR) at 80 °C; a) *m*/*z* range of 250 – 850 Da, b) *m*/*z* range of 800 – 1850 Da.

Table S3. The structures identified by MALDI-TOF mass spectrometry in aqueous phase after 6-week abiotic hydrolysis of neat PUR foam (PUR) at 80 °C.

m/z (Da)	Defined structures $[M+Na]^+$
257	
279	
287	
345	
385	
537–1593 (cyan)	 n=1–25  m + n = 2–24  m + n + o = 3–23

871–1135 (magenta)	 n=1–7  m + n =2–6
1061	
1298	
1366–1586 (navy)	 m + n = 6 – 11

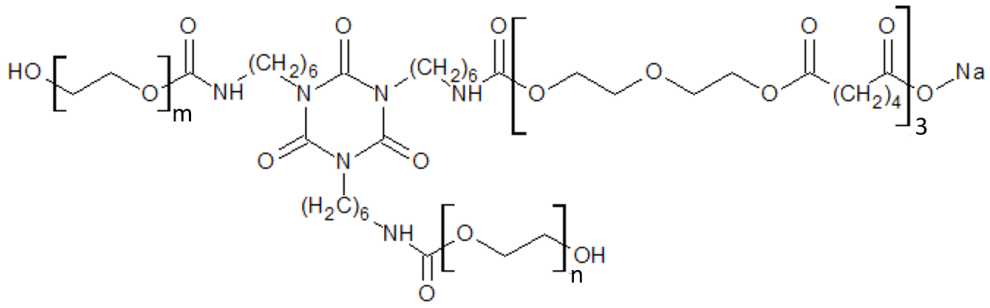
1472–1824 (pink)	 m + n = 5–13

Table S4. Extracellular protease and esterase activities at the end of BOD experiments (after 5 days).

Microorganisms / PUR foam ID	**Protease activity (U L^{-1})**	**Esterase activity (U L^{-1})**		
		pNFA	**pNFB**	**pNFD**
Pseudomonas sp.				
PUR	0.81±0.47	15.23±0.27	1.82±0.11	0.38±0.03
PUR_starch	0±0	2.78±0.32	1.13±0.04	0.88±0.02
PUR_HEC	7.82±10.86	4.27±1.50	1.20±0.38	0.15±0.02
Fusarium solani				
PUR	2.36±0.31	16.85±0.42	2.77±0.24	0.21±0.03
PUR_starch	3.24±1.50	12.70±0.68	12.25±1.56	1.70±0.09
PUR_HEC	6.29±1.63	3.55±0.35	1.56±0.16	0.42±0.04

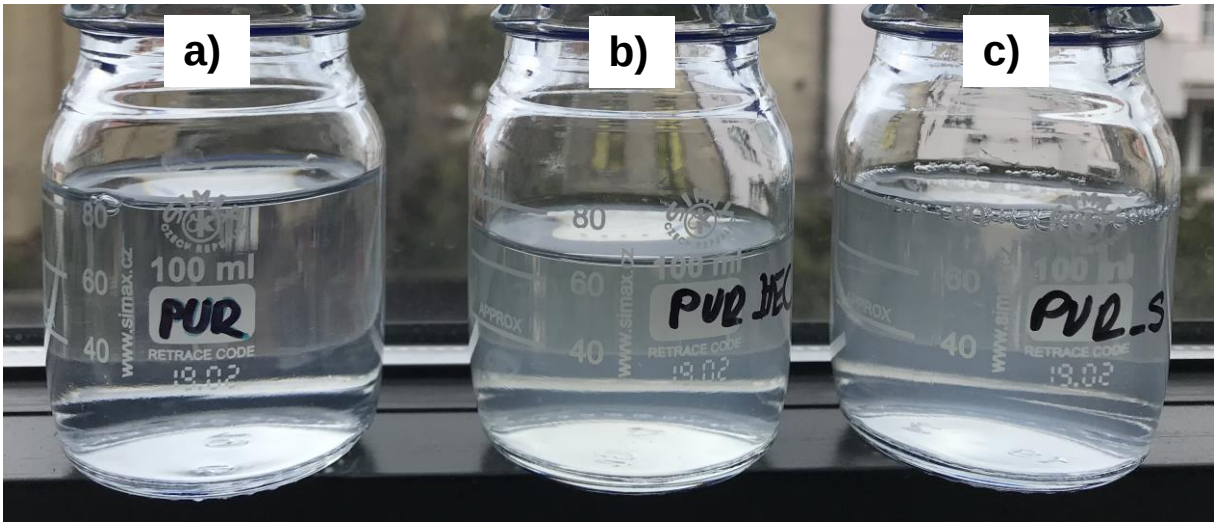


Figure S8. Photos of leachates for ecotoxicity evaluation prepared from a) PUR, b) PUR_HEC and c) PUR_starch. The weight concentrations of soluble fraction in the leachates determined gravimetrically were: 0.12 g L^{-1} (PUR), 0.26 g L^{-1} (PUR_HEC) and 0.33 g L^{-1} (PUR_starch).