Supporting Information

**Design of fluorinated hyperbranched polyether copolymers for ^{19}F MRI nanotheranostics**

Wanda Celentano[1,6], Giulia Neri[1], Francesco Distante [2], Min Li[3], Piergiorgio Messa[3], Cristina Chirizzi[4], Linda Chaabane[4], Floryan Decampo[5], Pierangelo Metrangolo[1], Francesca Baldelli Bombelli[1], Francesco Cellesi*[1]

[1] *Dipartimento di Chimica, Materiali ed Ingegneria Chimica "G. Natta", Politecnico di Milano, Via Mancinelli 7, 20131 Milan, Italy.* [2] *ETH Zurich, Department of Chemistry and Applied Biosciences, Institute of Chemical and Bioengineering, Vladimir Prelog Weg 1, CH-8093 Zurich, Switzerland.* [3] *Renal Research Laboratory, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Via Pace 9, 20122 Milan, Italy.* [4] *Institute of Experimental Neurology (INSPE) and Imaging (CIS), IRCCS San Raffaele Scientific Institute, Milan, Italy, Via Olgettina 60, I-20132 Milan, Italy.* [5] *Solvay Specialty Polymers, Bollate, 20021 Milan, Italy.* [6] *Current address: Humanitas Research Hospital, Via Manzoni 56, Rozzano, 20089 Milano, Italy.*

* E-mail: francesco.cellesi@polimi.it

Synthesis of 2-[(2,2,2-Trifluoroethoxy)methyl]oxirane

Epichlorohydrin
1 eq.

Trifluoroethyl alcohol
1 eq.

2-[(2,2,2-Trifluoroeyhoxy)methyl]oxirane
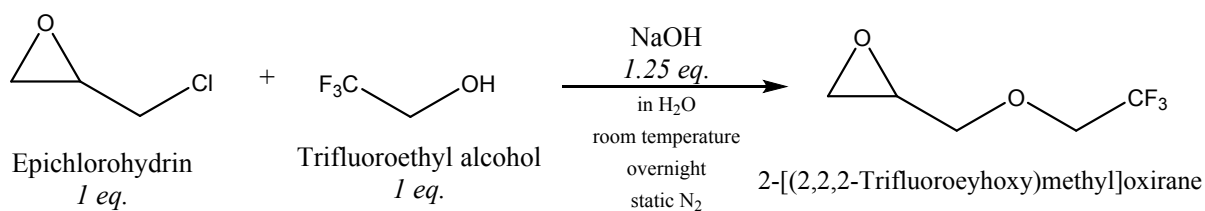
	Eq.	MW (g/mol)	ρ (g/mL)	g	mol	mL
Epichlorohydrin	1	92.52	1.183	9.2	0.1	7.78
Trifluoroethanol	1	100.04	1.38	10	0.1	7.25
NaOH	1.25	40	-	5	0.125	-

Trifluoroethanol (10 g, 0.1 mol) and epichlorohydrin (9.2 g, 0.1 mol) were added to a cooled solution of 5 g (0.125 mol) of sodium hydroxide in 60 mL of water (2.08 M). The reactants were mixed thoroughly, and the mixture was allowed to stand at room temperature overnight. Then the organic layer was separated, washed twice with water, and dried with Na_2SO_4. The reaction product was subjected to vacuum distillation. Final yield = 11%.
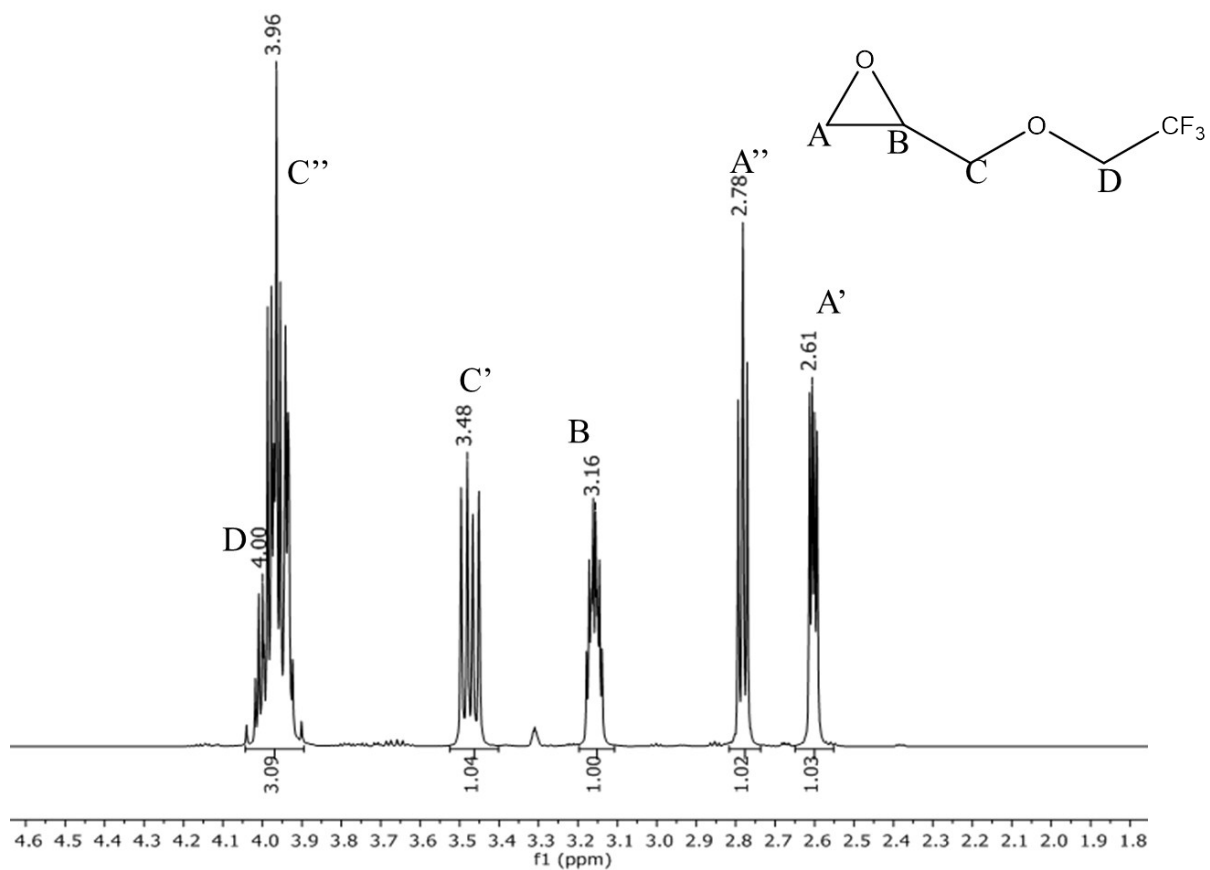
Figure S1. ^{1}H NMR (400 MHz, Methanol-d_4) δ (pmm): 4.07 – 3.88 (m, 3H, H$_D$ + H$_{C''}$), 3.47 (m, J = 11.9, 6.3 Hz, 1H, H$_{C'}$), 3.16 (m, J = 6.8, 2.6 Hz, 1H, H$_B$), 2.85 – 2.73 (m, 1H, H$_{A''}$), 2.61-259 (m, 1H, H$_{A'}$).
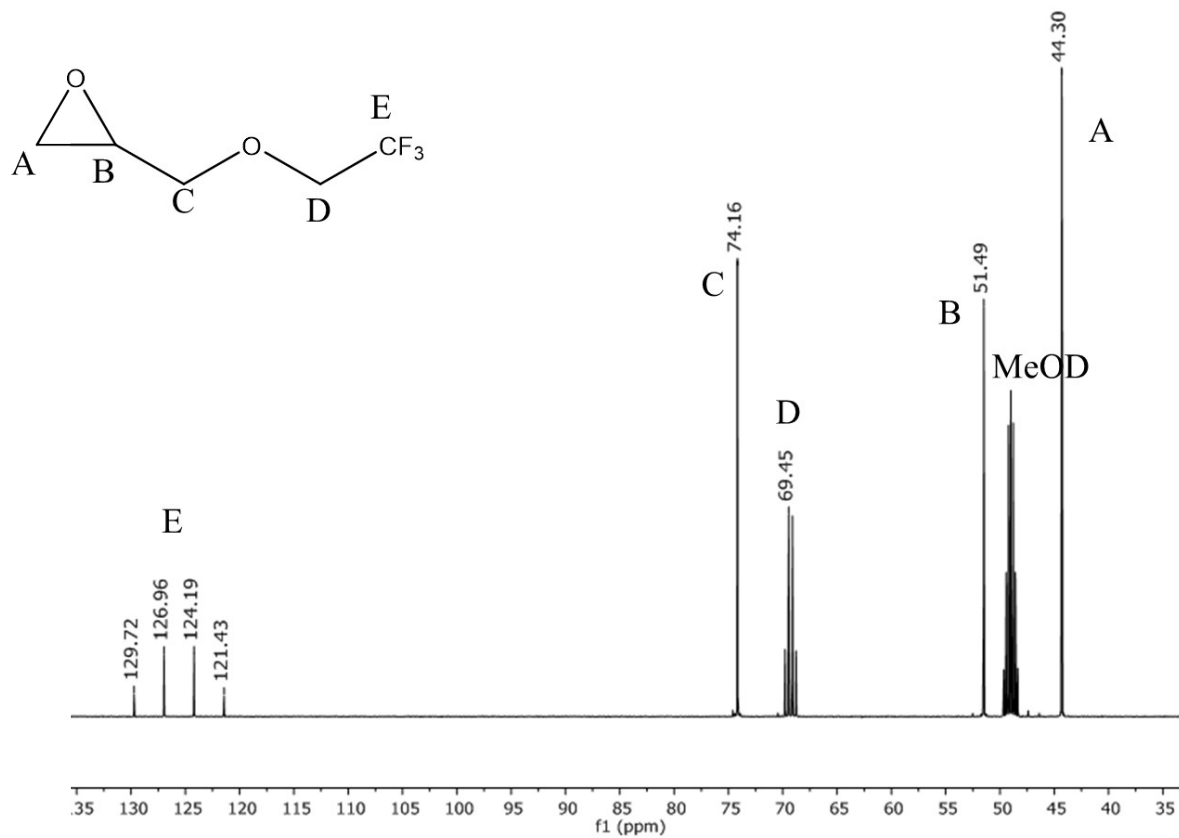
Figure S2. ^{13}C NMR (400 MHz, Methanol-d_4) δ (ppm): 125.58 (q, $J = 278.1$ Hz, C_E), 74.16 (s, C_C) , 69.28 (q, $J = 34.1$ Hz, C_D), 51.49 (s, C_B) , 44.30 (s, C_A).
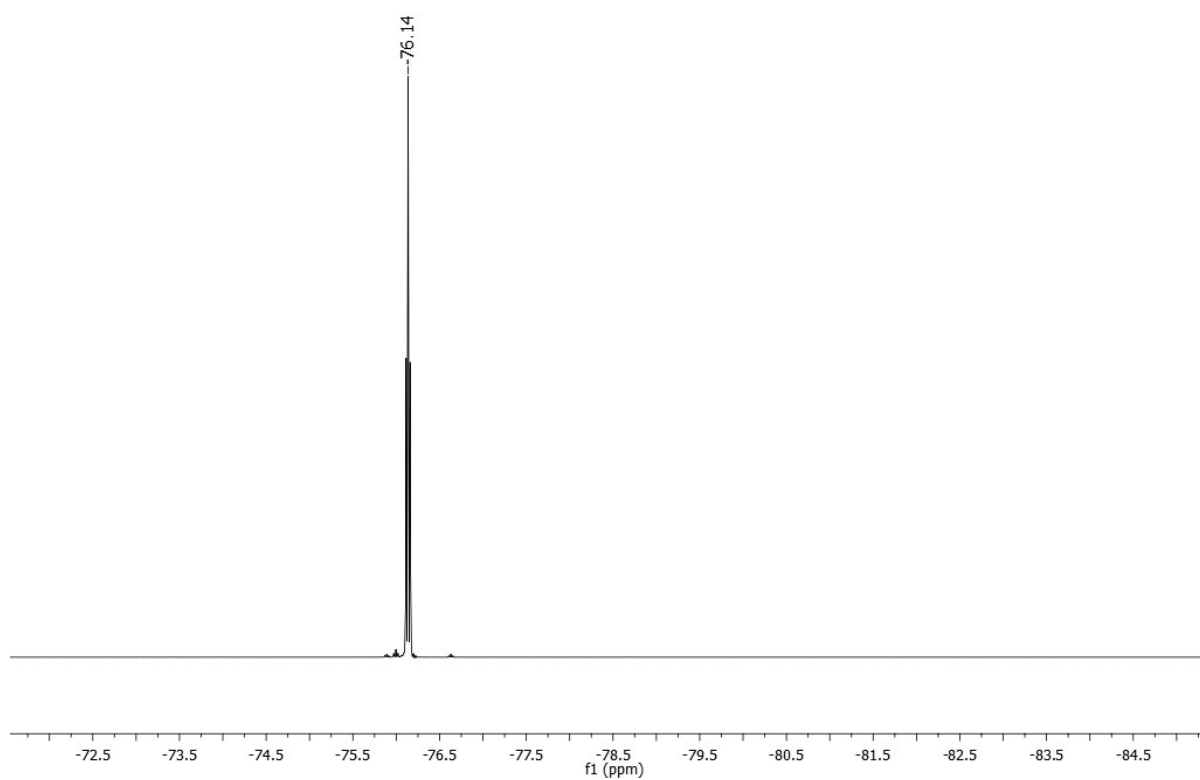
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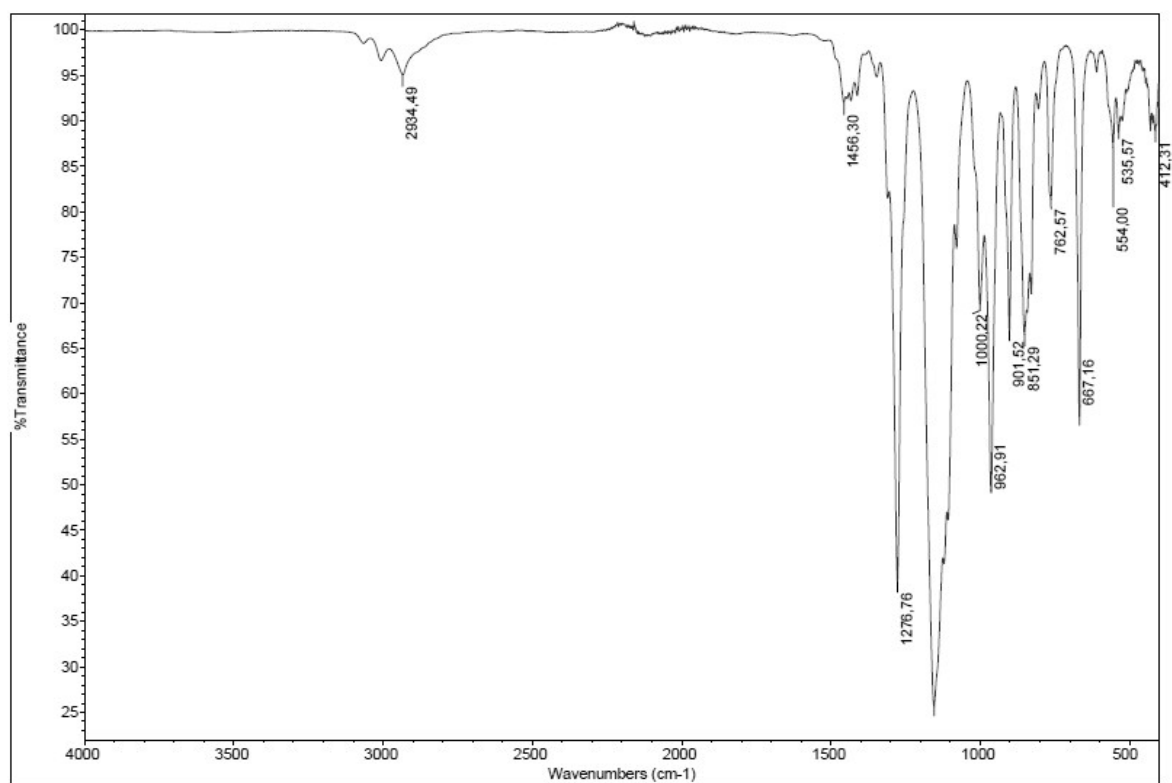**Figure S3.** ^{19}F NMR (400 MHz, Methanol-d_4) δ (ppm**): -76.14 (t, J = 8.9 Hz).

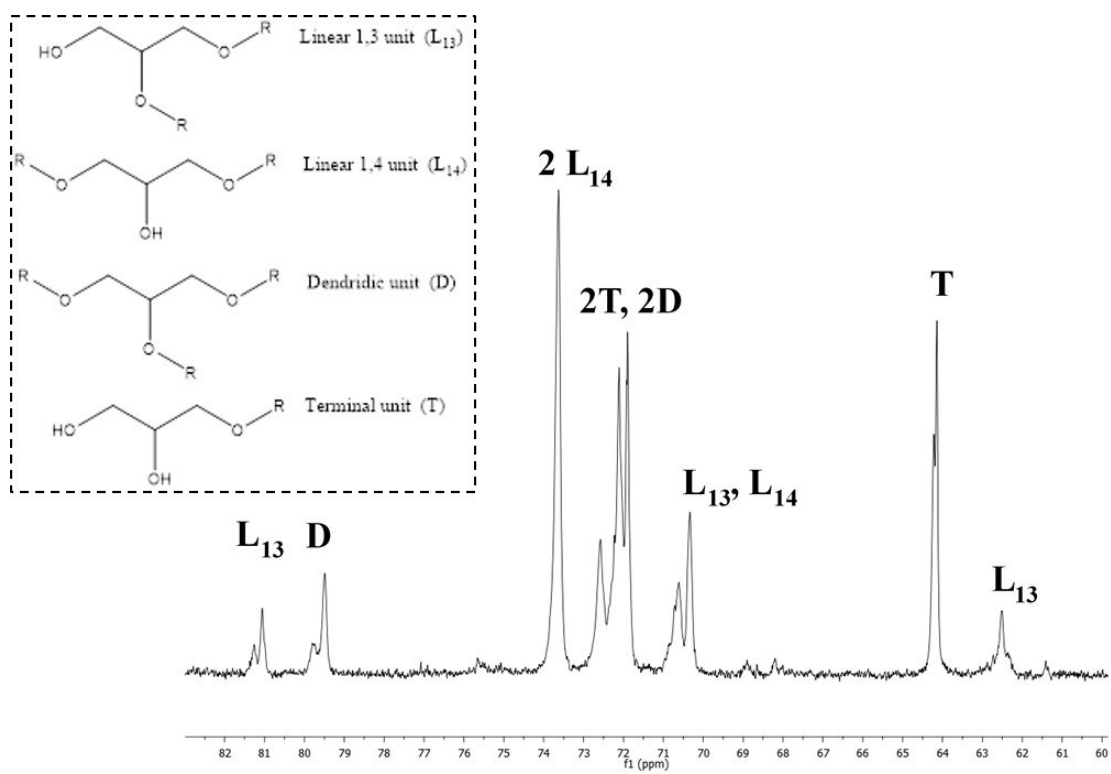**Figure S4.** FT-IR spectrum of 2-[(2,2,2-Trifluoroethoxy)methyl]oxirane.

Figure S5. ^{13}C NMR (400 MHz, Methanol-d$_4$) of HPG$_{40}$ and different structural units.

Polymerisation kinetics

Homopolymerisation of glycidol (GLY) (target DP=40), fluorinated glycidyl ether (FGE) (target DP=40), and copolymerization of GLY and FGE (feed molar ratio 1:1, target DP=40), were carried out according to the slow monomer addition (SMA) method. 30 μL of reaction mixture were collected at different times (15 min, 30 min, and every hour up to 8 hours), cooled at room temperature before addition 0.5 mL of deuterated solvent (Methanol-d4 for GLY and FGE polymerisation, DMSO-d6 for GLY-FGE copolymerization), and analysed by ^{1}H NMR. Due to the small reaction volumes available at 15 and 30 min, two additional reactions were carried out in parallel and stopped at these time points for analysis.

In Methanol-d4, the resonance peak at 0.88 ppm (corresponding to the methoxy protons of TMP) was set as a reference. For GLY and FGE polymerisation, the degree of polymerisation (DP) was evaluated by quantifying the amount of residual monomer in the reacting mixture, by integrating the peak at 2.63 ppm, which correspond to one proton of the monomeric oxirane (1H, **CH$_2$**CH).

Figure S6 shows the ^{1}H-NMR of reacting mixture collected at 4h during GLY polymerisation. The amount (mol) of GLY injected was calculated from the monomer flow rate (V = 3.75 μL/min), as $mol_{GLY}(t) = \left(\dfrac{\rho V}{M}\right)t$, where ρ is the density (1.117 g/mL), M its molar mass (74.08 g/mol) and t is the reaction time. The degree of polymerization DP was calculated as

$$DP(t) = \frac{mol_{GLY}(t) - I_{1H}(t) \cdot mol_{TMP}}{mol_{TMP}}$$

; where $I_{1H}(t)$ represents the integral of the peak at 2.63 ppm calculated at different time t, and mol_{TMP} is the quantity (mol) of the TMP initiator, which remained constant during the reaction.
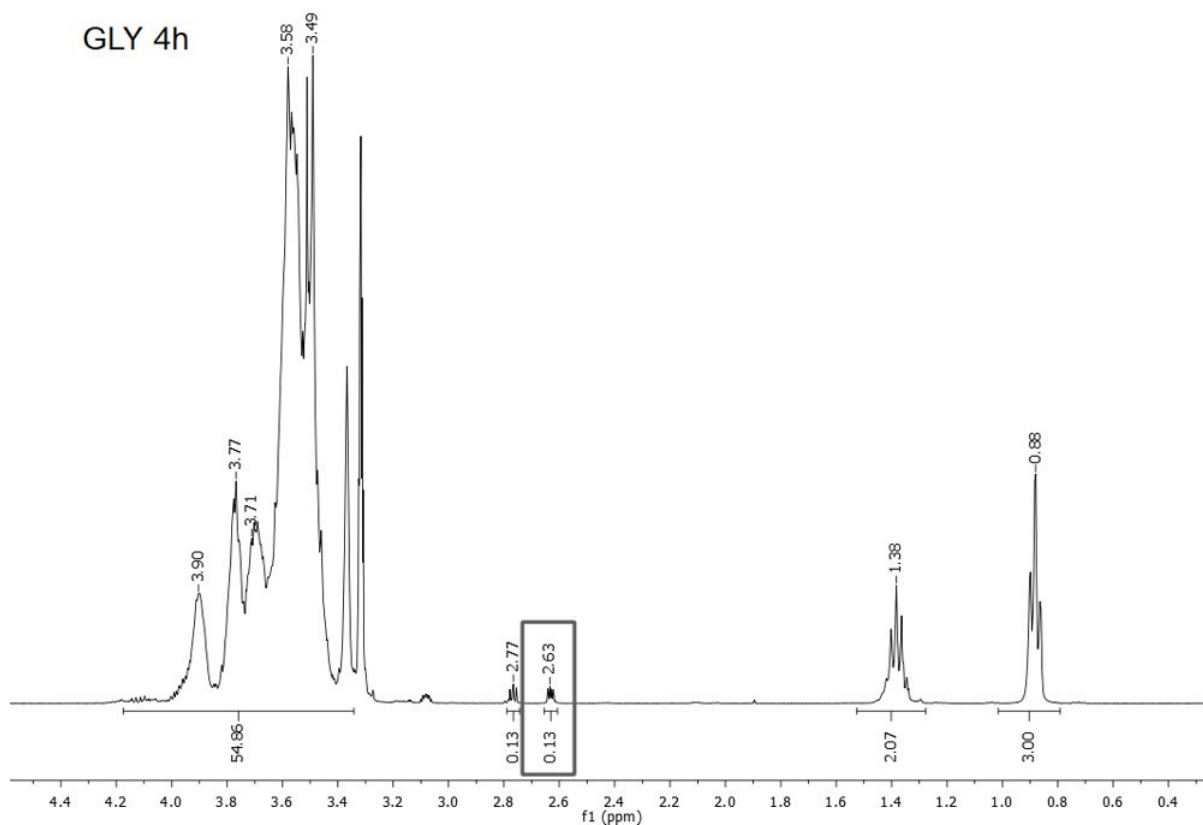
Figure S6. ^{1}H-NMR (CD$_3$OD) of reacting mixture of GLY polymerisation collected at 4h.

Similarly, Figure S7 shows the ^{1}H-NMR of reacting mixture collected at 4h during FGE polymerization. The mols of FGE injected were calculated from the monomer flow rate (V = 6.78 µL/min), as $mol_{FGE}(t) = \left(\dfrac{\rho V}{M}\right)t$, where ρ is the density (1.28 g/mL), M its molar mass (156.1 g/mol) and t is the reaction time. The degree of polymerization DP was calculated as

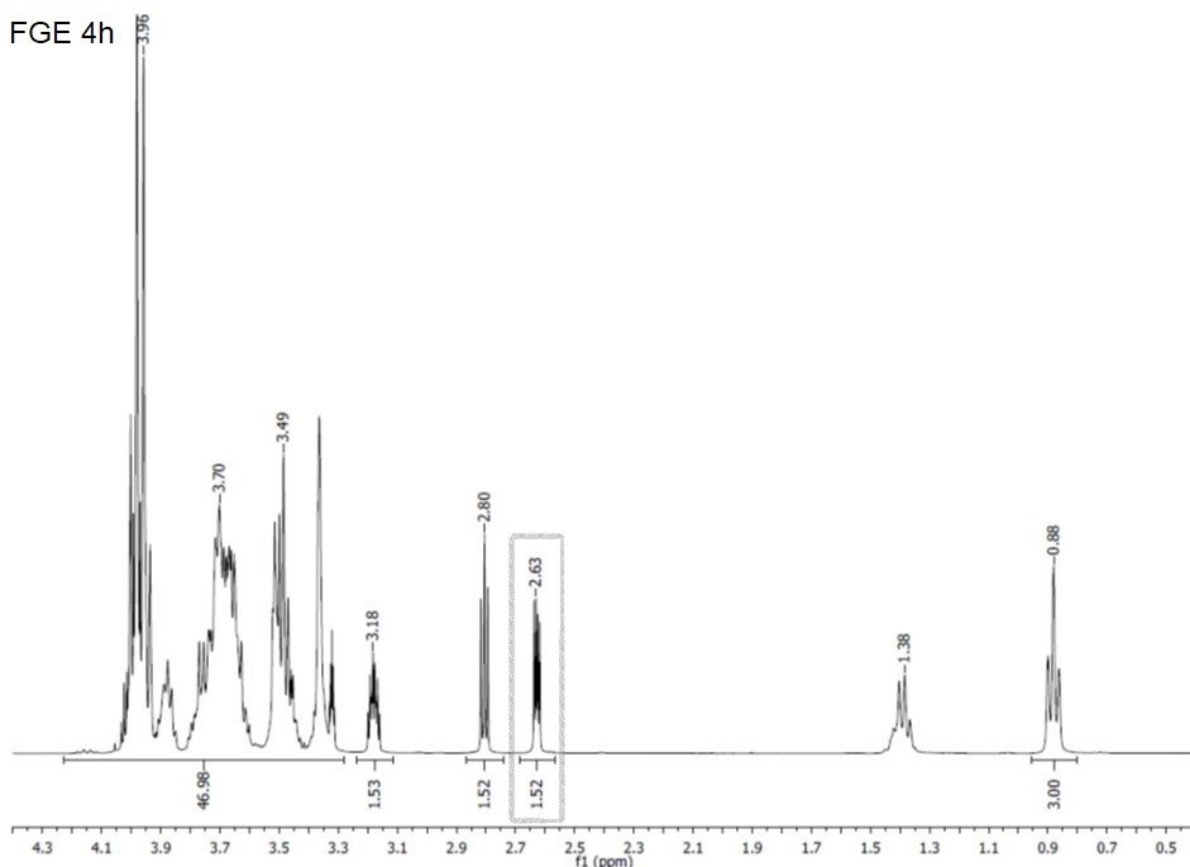$$DP = \frac{mol_{FGE}(t) - I_{1H}(t) \cdot mol_{TMP}}{mol_{TMP}}$$

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Figure S7. ^{1}H-NMR (CD$_3$OD) of reacting mixture of FGE polymerisation collected at 4h.

For GLY-FGE copolymerisation, the average number of GLY and FGE repeating units (n_{OH} and n_F, respectively) of the growing polymer chains were calculated by integrating one of the peaks which correspond to the protons of the residual monomers in DMSO-d6 (Figure S8), i.e. at 2.58 ppm (FGE, 1H, CH$_2$CH), 2.67 ppm (GLY, 1H, CH$_2$CH), 2.75 ppm (FGE, 1H, CH$_2$CH), 2.98 ppm (FGE, 1H, CH$_2$CH). The resonance peak at 0.79 ppm (corresponding to the methoxy protons of TMP in DMSO-d6) was set as a reference. Therefore, the average number of GLY and FGE repeating units were calculated as follow:

$$n_{OH}(t) = \frac{mol_{GLY}(t) - I_{1H}^{GLY}(t) \cdot mol_{TMP}}{mol_{TMP}}$$

, and

$$n_F(t) = \frac{mol_{FGE}(t) - I_{1H}^{FGE}(t) \cdot mol_{TMP}}{mol_{TMP}}$$

, where

$I_{1H}^{GLY}(t)$ and $I_{1H}^{FGE}(t)$ are the integrals which correspond to one GLY proton and one FGE proton, respectively.

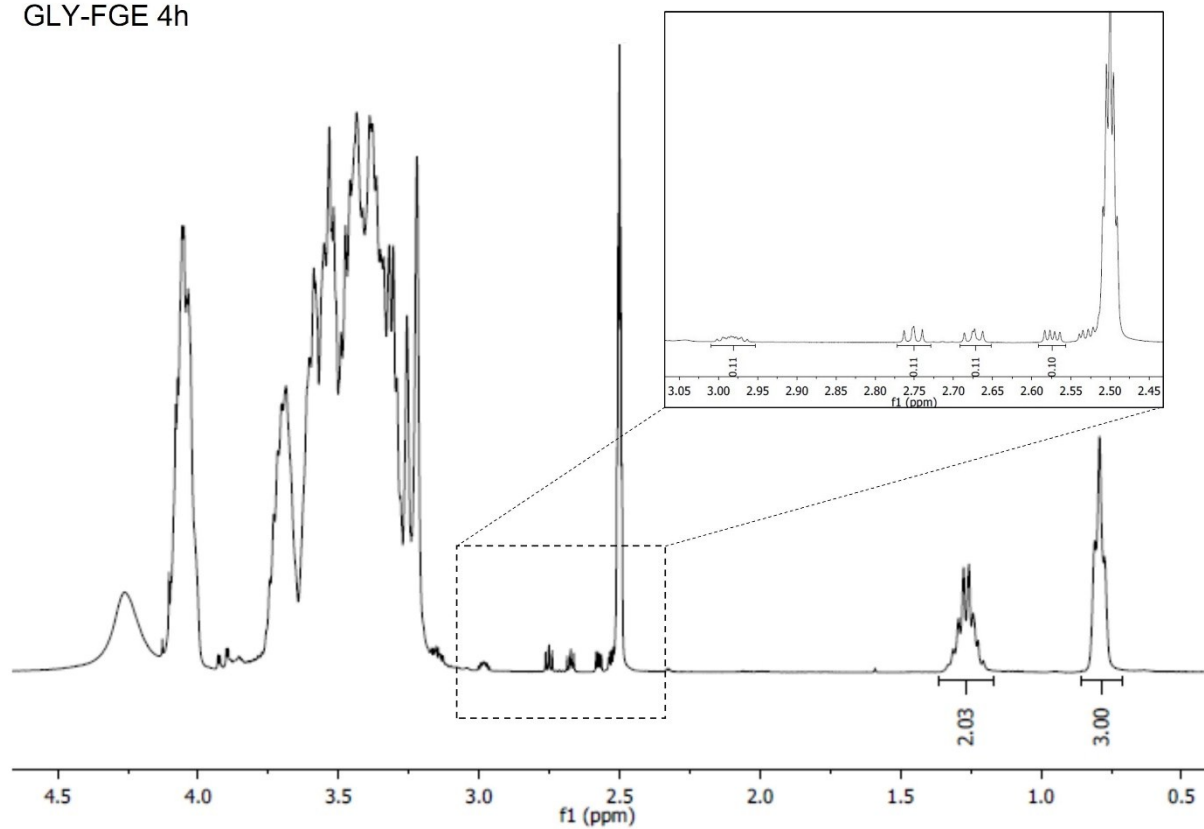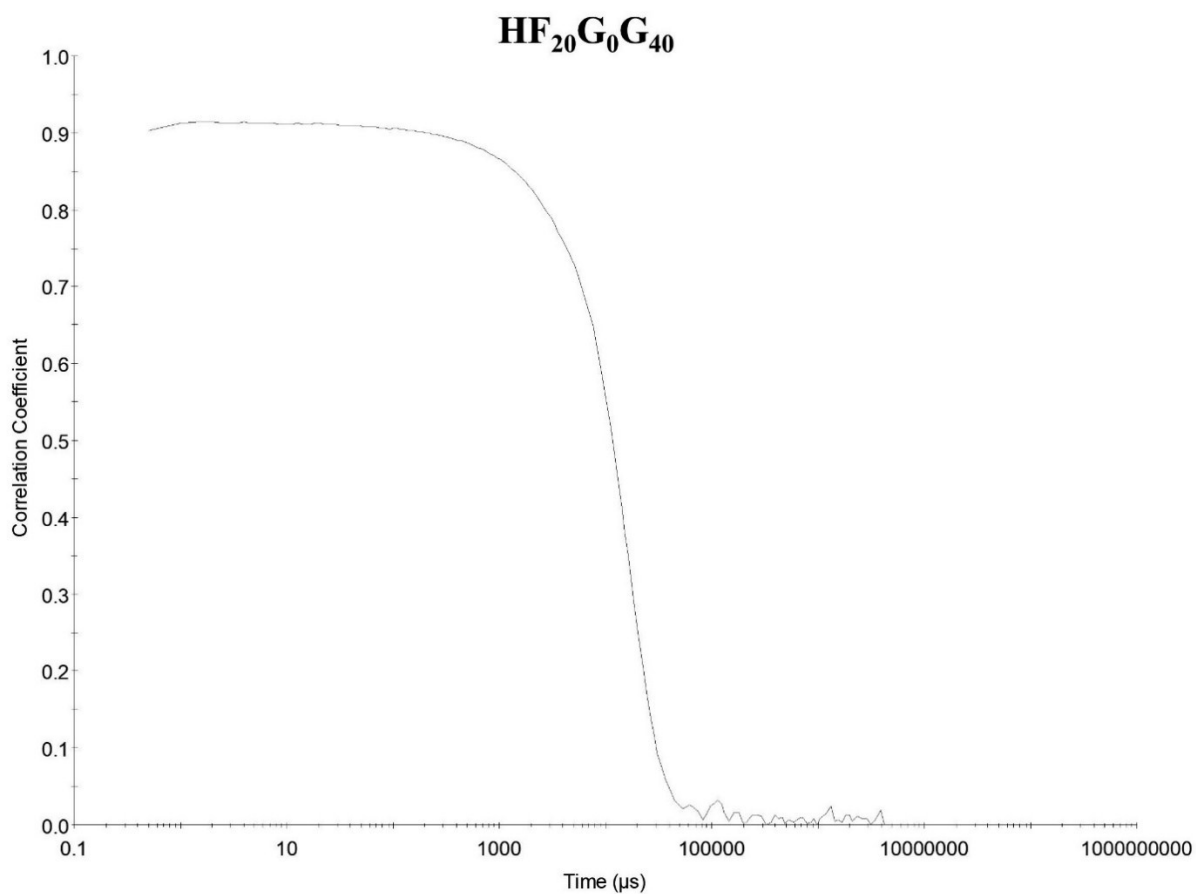**Figure S8.** ^{1}H-NMR (DMSO-d6) of reacting mixture of GLY-FGE polymerisation collected at 4h.

Figure S9. Autocorrelation function of $HF_{20}G_0G_{40}$ polymer in water (10mg/mL, 25°C). The sample contained very large particles above the upper size limit of the DLS instrument (10μm), and too polydisperse for DLS analysis.
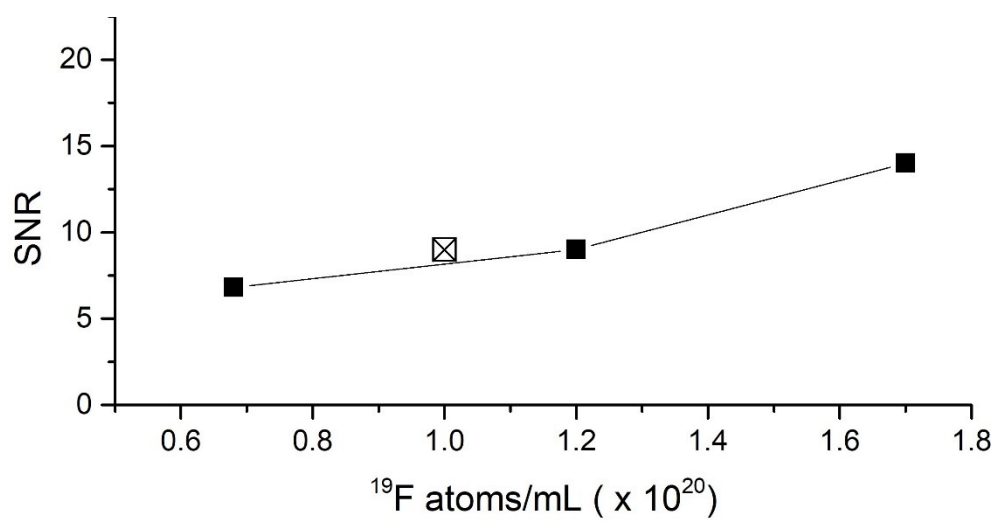
Figure S10. ^{19}F MRI Signal to Noise Ratio (SNR) vs fluorine concentration of $HF_{20}G_{20}$ polymer (black squares) and DEX loaded $HF_{20}G_{20}$ nanoparticles (crossed square).