**Supporting information**

# Dual Stimuli Responsive PEG Based Hyperbranched Polymers

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## Experimental Section

### Materials

The monomers poly(ethylene glycol) methyl ether methacrylate (PEGMEMA *Mn* = 475), 2-(2-methoxyethoxy) ethyl methacrylate ($MEO_2MA$), and ethylene glycol dimethacrylate (EGDMA) were purchased from Sigma-Aldrich. The ethyl 2-bromoisobutyrate (98%, Aldrich) was used as the initiator. bis(2-dimethylaminoethyl) methylamine (99%, Aldrich), copper(II) chloride ($CuCl_2$, 97%, Aldrich), L-ascorbic acid (99%, Aldrich), butanone (99%, HPLC grade, Aldrich) and hexane (95%, Aldrich) were used as received.

### Synthesis and Purification of PEGMEMA-$MEO_2$MA-EGDMA Copolymers

The copolymers were prepared in butanone using a two-necked round bottom flask (the volume ratio of total monomers to solvent is 1: 2). Copper chloride (0.25 equiv), ethyl 2-bromoisobutyrate (1 equiv) and bis(2-dimethylaminoethyl) methylamine (0.25 equiv) were added into the flask and oxygen was removed by bubbling argon through the solutions for 25 min. L-ascorbic acid (0.375 equiv) that was diluted in deionized water was added with a microliter syringe. The solution was stirred at 800 rpm and

the polymerisation was conducted at 50 $^{o}$C in an oil bath for a desired reaction time. The experiment was stopped by opening the flask and exposing the catalyst to air. EGDMA was removed by dropping the solution into a large excess of hexane. The precipitated mixture was dissolved in deionized water and purified by dialysis (spectrum dialysis membrane, molecular weight cut off 8000) for 4 days in dark at 4 $^{o}$C. Polymer samples were obtained after freeze-drying and weighed to obtain the final yields.

**Characterizations of PEGMEMA-MEO$_2$MA-EGDMA Copolymers**

The copolymers were characterized by gel permeation chromatography (GPC), $^{1}$H NMR and Fourier Transform Infrared (FTIR) spectroscopy. Weight average molecular weight ($M_w$), number average molecular weight ($M_n$) and polydispersity ($M_w$/ $M_n$) were obtained by GPC (Polymer Laboratories) with RI detector. The columns (30 cm PLgel Mixed-C, two in series) were eluted using dimethylformamide (DMF) and calibrated with poly(methyl methacrylate) (PMMA) standards. All calibrations and analysis were performed at 40 $^{o}$C and a flow rate of 1 ml/min. $^{1}$H NMR was carried out on a 300 MHz Bruker NMR with MestReC processing software. The chemical shifts were referenced to the lock chloroform ($CDCl_3$). The characteristic chemical bonds were determined by FTIR (Varian 660-IR) to affirm the vinyl functional groups in the copolymers.

**Thermoresponsive behavior of PEGMEMA-MEO$_2$MA-EGDMA Copolymers**

LCST of the copolymer solutions (0.03 % w/v) in deionized water were quantified by measuring their absorbance of 550 nm at temperatures from 20 to 55 $^{o}$C (heating rate = 0.5 $^{o}$C/sec) with a Beckman DU-800 spectrophotometer. The data were collected every 2 seconds. Moreover, dynamic light scattering (DLS) was used to analyze size and distributions of copolymers in water solution on a submicron particle size analyzer (BeckmanCoulter DLS-N5). Polymer solutions (0.01% w/v) were prepared in deionized water and filtered prior to measurements using a 0.45 μm disposable filter into a 12.5×12.5 mm polystyrene disposable cuvette.

**Preparation of photo-crosslinked gels and SEM images taken**

A LF215L UV lamp (365 nm, 2X15 W, UVitec, light intensity 2.0 mW/cm$^2$) was employed for the preparation of photo-crosslinked hydrogels. The PEGMEMA-MEO2MA-EGDMA copolymers were dissolved in 0.1% w/v Irgacure 2959 water solution to prepare 20 and 40% (w/v) copolymer solutions. Photo-crosslinked gels were formed using 200 µl polymer solutions by UV exposure of 2 hours. Scanning electron microscopy (SEM) was used to characterize the porous structure of freeze-dried gels. The samples were mounted on an aluminum stub using an adhesive carbon tab and sputter coated with gold before images were obtained using a Hitachi Field Emission SEM machine.

**Cytotoxicity assessment**

3T3 mouse fibroblast cell line was utilized for the polymer cytotoxicity assessment. 15,000 cells and $PEGMEMA_{(15)}$-$MEO_2MA_{(75)}$-$EGDMA_{(10)}$ polymer/media solution (in Dulbecco's Modified Eagle's Medium, DMEM, Sigma) were seeded into each well of a 48-wells tissue culture plate (the concentration of polymer in media = 0.5 and 1 mg/ml). After one and four days of incubation at 37$^o$C and 5% $CO_2$, alamarBlue® reduction method was used to assess cell viability. The absorbance at the lower wavelength filter (550 nm) was measured followed by the higher wavelength filter (595 nm) *via* a thermo scientific Varioskan Flash Plate Reader. The following formulae were used to calculate the percentage of cell viability:

$AO_{LW}$ = absorbance of oxidized form of alamarBlue® along at lower wavelength;

$AO_{HW}$ = absorbance of oxidized form of alamarBlue® along at higher wavelength;

Calculated correlation factor:

$$R_o = AO_{LW} / AO_{HW}; \quad \text{(eq S7)}$$

Calculated the percentage of reduced alamarBlue®:

$$AR_{LW} = (A_{LW} - A_{HW} \times R_o) \times 100 \quad \text{(eq S8)}$$

Calculated the percentage of cell viability:

$$\text{Viability} = (AR_{LW[Samples]} / AR_{LW[Cells\ along]}) \times 100 \quad \text{(eq S9)}$$

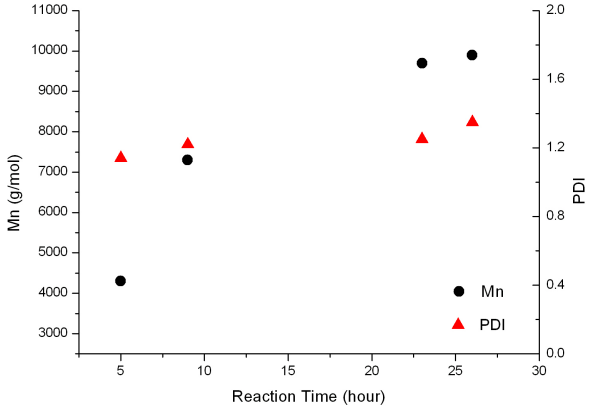


Fig. S1. Kinetic plots of the in-situ DE-ATRP polymerisation of PEGMEMA$_{(15)}$-MEO$_2$MA$_{(75)}$-EGDMA$_{(10)}$ (entry 2 in Table 1) copolymer. A relative consistent polydispersity index (PDI) at a low level confirms a controlled chain growth with the polymerization progress.

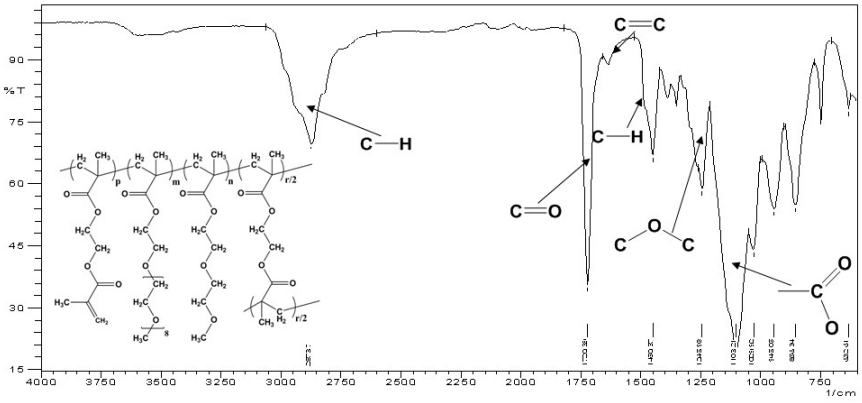


Fig. S2. FTIR analysis of PEGMEMA$_{(15)}$-MEO$_2$MA$_{(75)}$-EGDMA$_{(10)}$. The main chemical groups are characterized by a standard and labeled.

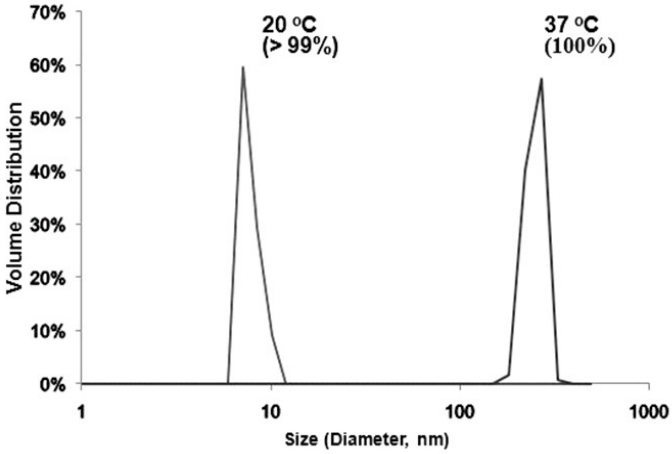


Fig. S3. Size distribution measured by dynamic light scattering. Polymer solutions (PEGMEMA$_{(15)}$-MEO$_2$MA$_{(75)}$-EGDMA$_{(10)}$, 0.01% w/v) were prepared in deionized water and filtered prior to measurements using a 0.45 μm disposable filter. Light incident angle was 90$^o$.

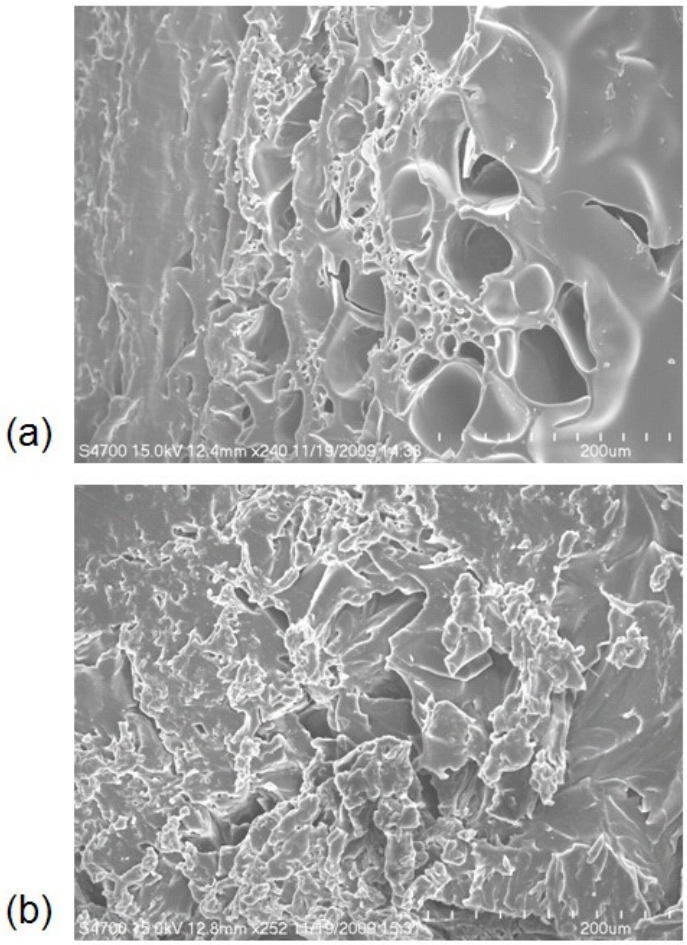


Fig. S4. SEM images of freeze-dried photo-crosslinked gels prepared from 20% (a) and 40% (b) (w/v) $PEGMEMA_{(15)}$-$MEO_2MA_{(75)}$-$EGDMA_{(10)}$ copolymer (S3 in Table 2) solution via exposing samples to UV light (365 nm). Note: the photo-crosslinked gel formed using a low polymer concentration sample (20% w/v) demonstrated more porous and looser structure than the gel formed using a high polymer concentration (40% w/v).