I. Experimental Section

Materials. Cinnamoyl chloride (98%), succinic anhydride (99%), 2,2'-azobis(2-methylpropionitrile) (AIBN, 98%), acetone (≥ 99.9%), hexanes (mixture of isomers, ≥ 98.5%), methanol (MeOH, ≥ 99.5%), chloroform ($CHCl_3$, ≥ 99.5%), dimethylformamide (DMF, anhydrous), poly(propylene glycol) bis(2-aminopropyl ether) ($M_w = 2.3 \times 10^2$ g/mol, also called Jeffamine®), triethanolamine(≥ 99.0%) and piperazine (99%) were used as received from Aldrich. Pyridine (Fisher Scientific) was refluxed and distilled over CaH_2 under argon. Tetrahydrofuran (THF, ≥ 99.0%) was refluxed and distilled over sodium under nitrogen with benzophenone as an indicator. Monomers glycidyl methacrylate (GMA, ≥ 97.0%), and 2-hydroxyethyl acrylate (HEA, 96%) were from Sigma Aldrich and re-distilled under vacuum to remove the inhibitor. Mono-methacrylate terminated polydimethylsiloxane (PDMS-MA, $M_n \sim 5000$ g/mol) was purchased from Gelest Inc. and was used as received.

Red and blue Waterman® fountain pen inks were purchased from Amazon.ca. A BarePaint conductive paint was purchased from Canadarobotix.com. According to their application notes, this paint is water-based, highly viscous, and shear sensitive and is suitable for screen printing. Our SEM and NMR analyses suggest that this paint contained carbon black as the conductor and poly(vinyl alcohol) as the dispersant and binder.

A table-top screen printing kit was purchased from Diyprintshop.com, and a screen with the mesh count of 300 per inch was purchased from Amazon.ca were used to print texts and figures for comparison purposes. In the Kit, Ryonet WBP hybrid emulsion and WBP diazo sensitizer were mixed following the user's manual as a the photocrosslinkable precursor to photo-pattern the screen.

PGMA Synthesis. Two PGMA samples were synthesized. In the first synthesis, GMA (20.0 mL), AIBN (30.0 mg), and acetone (160 mL) were charged into a 250-mL round-bottom flask. The flask was sealed with a rubber septum and N_2 was bubbled into the flask with a syringe needle to purge air. After 5 min, needles were removed and the flask was then left in an oil bath at 55 ^{o}C for 48 h. After that, the reacted mixture was poured into excess hexanes to precipitate PGMA. Finally, the white solid was filtered and dried under vacuum for 24 h to yield 19.7 g PGMA (yield 92%). The second sample was synthesized analogously except only 80 mL of acetone was used as the solvent. The final yield was 19.5 g (91%).

Hardener. A mixture of Jeffamine®, triethanolamine, and piperazine at the mass ratios of 1.000/0.106/0.034 was used as the hardener to cure PGMA fibers. Jeffamine has two primary amine groups and each of them can, in principle, open two epoxy rings. Thus, each Jaffamine molecule has four active H atoms for displacement. The Active Hydrogen Equivalent Weight (AHEW) for Jeffamine® is the 57.5 g/eq. Piperazine has two secondary amine groups, which are less reactive than the primary amine groups, and its AHEW is 43.1 g/eq. Triethanolamine does not have any active amine hydrogen. However, its three hydroxyl groups can also open epoxy rings with a lower reactivity than the former two. Based on active hydrogen atoms of the hydroxyl groups, triethanolamine has an AHEW value of 49.7 g/eq. Using the mass ratios of 1.000/0.106/0.034 for the three components, we calculated the AHEW of 56.3 g for the hardener mixture.

PGMA Mats. An 8.5 inch × 5.5 inch glass plate bearing on its back side (further away from the spraying syringe needle) a piece of aluminum foil was used as the receiver. To attach a foil, several drops of water were dispensed on the glass plate before the foil was smoothly spread on the plate by rubbing it with a lump of Kimwipe® tissue. Excess foil was cut off using a surgical knife.

For electro-spinning, a potential drop of 20 kV was used. To prepare a spinning solution, PGMA (0.60 g containing 4.2 mmol GMA units) was dissolved in 8.0 mL DMF/$CHCl_3$ at *v*/*v* = 1/2 before the hardener (0.200 g containing 0.355 mmol active hydrogen atoms) was added. The mixture was then transferred into a syringe. The distance between the metal syringe needle tip and the receiver was 15 cm and the solution was delivered at syringe pumping rate of 0.028 mL/min. To ensure mat uniformity, the syringe position was changed once every 30 min.

The thickness of the mat was controlled by changing the amount of polymer solution sprayed. To use the final patterned mat as stencil for screen printing, ~ 4.5 h was used to electrospin the thicker mat. For other applications, the thinner mat was prepared using an electrospinning time of ~ 1.7 h.

To cure the fibers, the spun mats were left at room temperature for 12 h to evaporate the solvent. The partially cured fibers were further cured at 120 ^{o}C for 4 h and then at 150 ^{o}C for 4 h. After curing, the mat was peeled from the glass plate by a razor blade and cut into sections of the targeted sizes for use.

PCEA-*g*-PDMS Synthesis. The polymer was synthesized in two steps. In step 1, PHEA-*g*-PDMS was prepared. This involved mixing PDMS-MA (6.0 mL), HEA (2.0 mL), AIBN (50 mg), distilled THF (80 mL) in a round flask. The flask was sealed after air was purged with N_2 for 5 min and then immersed in an oil bath at 60 ^{o}C for 12 h before another batch of AIBN (50 mg in 1.0 mL THF) was added. The polymerization was left going for another 12 h.

In step 2, one third of the polymerized mixture was mixed with 2.0 g of cinnamoyl chloride and 3.0 mL pyridine. After stirring overnight, the mixture was poured into excess MeOH to precipitate the polymer. The precipitate was dissolved in 20 mL of THF and added into excess methanol to precipitate the polymer again. The protocol was repeated another time. The final precipitate was vacuum dried for 12 h to yield 3.1 g of a waxy polymer.

Carboxylation of Fiber Surfaces. The electrospun and crosslinked fibers were hydrophilic already due to the presence of surface hydroxyl groups. To further increase the hydrophilicity, we converted the surface hydroxyl groups to carboxyl groups. To achieve this, a mat was soaked in a THF solution of succinic anhydride (50 mg/mL) for 4 h. It was then withdrawn. After solvent evaporation, it was heated in a 60-^{o}C oven for 1 h. The heated mat was soaked in methanol to remove the unreacted succinic anhydride and dried at room temperature for 1 h.

Fiber Coating by PCEA-*g*-PDMS. Coating the carboxyl-bearing fibers with PCEA-*g*-PDMS involved first the preparation of micellar solutions from PCEA-*g*-PDMS at different concentrations in THF/hexanes at a hexanes volume fraction of 80%, in which PCEA was insoluble. To prepare a coating solution at a copolymer concentration of 10.0 mg/mL, PCEA-*g*-PDMS (100 mg) was dissolved THF (2.00 mL). Hexanes (8.0 mL) was then slowly added under stirring. A mat was soaked in this micellar solution for 4 h, removed, and annealed at 60 ^{o}C for 30 min.

Mat Patterning. The patterns for transfer were first printed on Arkwright transparencies using an HP 1020 laser printer and HP Q7553X black toner. The printed side of the transparency was then placed on a PCEA-*g*-PDMS-coated mat. The two were subsequently sandwiched by a top quartz plate and a bottom glass plate using a pair of binder clips. This was followed by shining a focused beam that was from 500-watt Hg UV lamp and had passed through a 274-nm cut-off filter on the quartz plate. Depending on the targeted application, the thickness of the mat and the photolysis time were varied. To use the final patterned mat as stencil for screen printing, ~ 4.5 h was used to electrospin the thicker mat. The photolysis time used was 10 min. For other applications, the mat was prepared using an electrospinning time of ~ 1.7 h and a photolysis time of 40 min. The photolyzed mats were soaked in THF for 10 min to remove the un-crosslinked PCEA-*g*-PDMS from the regions where PCEA-g-PDMS was not securely crosslinked. The final mat was dried in 40 ^{o}C oven for 30 min before use.

SEM and EDS Analyses. Scanning electron microscopy (SEM) images were obtained for samples that were not coated by metal in the environmental SEM mode using a FEI-MLA Quanta 650 FEG-ESEM instrument. The acceleration voltage used was 10 kV. The secondary electron detector used was of an Everhart-Thornley model and the used beam spot size setting was 4.0 (corresponding to 4.0 nm in beam diameter). Energy dispersive spectroscopy (EDS) analysis was performed at a beam spot size setting of 8.0. While the SEM image was formed using back scattered primary electrons, the X-ray detector was a Bruker XFlash 5010 model. To construct the binary silicon distribution maps, the Kα X-ray emission band of silicon was used. A “positive” or “negative” detection was assigned to a pixel when the peak to background signal ratio was above or below 7, respectively, where 7 was the default cut-off value set by the instrument manufacturer.

For cross section analysis, a mat was cut to yield a stripe of the size of 10 × 3.0 mm^2. One end of the rectangularly-shaped stripe was then glued to the side of a SEM pin stub (sample holder) using a double-sided adhesive tape, leaving the other end suspended in air. The free end of the vertically standing stripe was used for EDS analysis and mat thickness analysis.

NMR Analyses. ^{1}H NMR spectra were recorded on a Bruker 300 MHz spectrometer using a relaxation delay of 3 s. The used solvent was deuterated chloroform ($CDCl_3$).

Contact and Sliding Angle Measurements. A DataPhysics OCA 15 Pro Optical instrument was used to measure the water static contact angles. The measurements were performed at room temperature (21 – 23 ^oC). The droplet size for all contact angle measurements is 5 μL.

Size Exclusion Chromatography (SEC). A size exclusion chromatograph (SEC) system with a Wyatt Optilab rEX refractive index (RI) detector was used to characterize the synthesized polymers. Chloroform (containing 2.5 v% triethylamine) was used as the eluent at a flow rate of 1.000 mL/min. The columns used were of MZ-Gel SDplus packed with beads possessing nominal pore sizes of 500, 10000 and 100000 Å and were calibrated with narrowly dispersed PS standards.

ATR-IR Measurement. An ALPHA-Bruker Attenuated Total Reflectance Infrared (ATP-IR) spectrometer was used to confirm the surface modification of mats with -COOH and PDMS. Before analysis, mat samples were cut with a surgical blade into 5 mm × 5 mm pieces. These samples were directly placed on the ATR-IR instrument diamond sample holder to gather spectra.

Circuit Fabrication. A printed transparency and the thinner mat were used in this case. After pattern transfer and development on the mat, the mat was attached to a microscope slide using a double-sided tape. Since the circuit pattern was small and the lines were thin, it was challenging to dispense a conductive ink following the lines. Instead, we dispensed a line of the BarePaint conductive paint after it was diluted with water by 10 times at one end of the pattern. Another microscope slide was then used to drag the diluted ink across the pattern (the original ink was too viscous to move with the microscope slide). While the ink was absorbed by the hydrophilic regions, it was mostly rejected by the hydrophobic regions and excess ink was scrapped away by the dragging microscope slide. The water was allowed to evaporate for 5 min before another batch of paint was loaded. This process was repeated for 10 times until the carbon black content was high enough in the hydrophilic regions to allow conductivity. To complete the circuit, the two legs of a LED bulb dissembled from a toy was glued to the two hollow circles in the circuit using the thick original BarePaint conductive paint. Two conductive wires were glued to the solid circles in the circuit (Figure 2c) and then to a stack of battery at a total voltage 5.2 v.

Screen Printing. Due to the thickness of the mat and the short photolysis time of 10 min, a mat used as a printing screen was Janus. Onto the side close to the light source the desired hydrophilic pattern was duplicated in a hydrophobic matrix. Since no significant light reached the far side, that side was not patterned but remained hydrophilic.

To print, a red or blue ink was dropped on the back side of the patterned mat. Around 0.15 mL ink was loaded per square inch mat, and the excess ink was wicked away by tissue paper. The mat was then placed on a glass slide with the patterned side facing up. A piece of paper was subsequently placed on the mat and rotating a paint roller on the paper enabled the permeation of the ink through the hydrophilic pattern and its deposition onto the paper.

For comparison, we also made prints using a commercial screen printing kit. All the materials mentioned below were from the kit, except the 300-mesh screen purchased from Amazon.ca. In a light safe environment, a scooper coater was used to evenly spread a thin layer of the photosensitive emulsion onto the screen, and the emulsion coated screen was dried in air for at least 4 h. A laser printer printed transparency was fixed on the screen using adhesive tape before the screen was irradiated the provided light source. Then the screen was brushed away with cold water to remove the uncured emulsion in the masked region. After drying in the air, the patterned screen was hold on a printing paper tightly. The black ink from the kit was loaded on the screen and the squeegee was used with little pressure to flood ink over the patterned area. After that, the screen in the kit was lifted from the paper.

Ag Nanoparticle Synthesis and Ink Formulation. Water-borne Ag particles with diameters less than 10 nm were synthesized following a literature method.[1] For this, $AgNO_3$ (3.40 g, 200 mmol), octanoic acid (2.02 g, 140 mmol) and DI water (300 mL) were mixed in a 500 mL round flask. Under vigorous stirring, 30 mL of an aqueous ammonia solution (30 wt% of NH_3) was slowly added into the flask at 70 ^{o}C to yield a clear and colorless solution. Then, an aqueous sodium hypophosphite hydrate solution (2.00 g in 20 mL water) was added in one shot. The solution turned yellow initially and light brown after 45 min. Rota-evaporation 50 ^{o}C to remove volatile components yielded a brown wax with light metallic appearance.

To prepare an Ag ink, 2.0 g of the brown solid was dispersed into water (16 mL), diethylene glycol (3.0 mL), and the aqueous ammonia solution (2.8 mL) to form a viscous brownish liquid. The Ag ink was prepared freshly for screen-printing circuits.

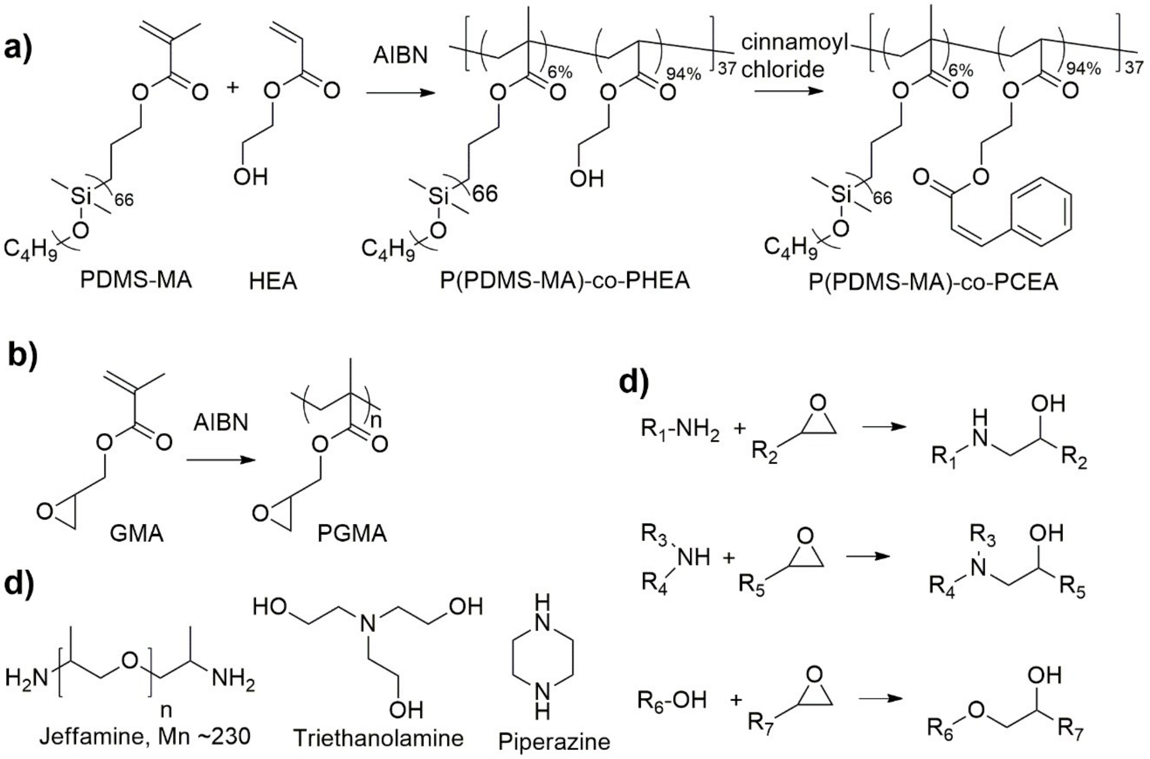
Patterned Mats for Sensing Applications. The photomasks for generating patterned mats for sensory applications were cut from aluminum foil. The final patterned hydrophilic region assumed the shape a 2-D dumbbell, where the two end semi-circles were used for reagent dispensing and the middle rectangle was used for reagent transport and mixing.

To make a pH sensor, Hydroion® pH paper, 20 cm long, was soaked in 15-mL water to extract out the pH indicator. The indicator solution was then condensed to 5 mL and dropped on the hydrophilic region of the mat until it was saturated. After 4 h of drying at room temperature, a drop of an aqueous H_2SO_4 solution (5×10^{-3} M) and a drop of an aqueous NaOH solution (1×10^{-2} M) were dispensed into the opposite semi-circles. A picture was taken of the mat 1 min later.

In another demonstration experiment, two drops of an aqueous NaOH solution (10 wt%) was added into a silver nitrate solution (1 mL, 2.0 wt%). An ammonia solution (2.0 wt%) was then added until the solid just dissolved, yielding a fresh Tollen reagent. A drop of the Tollen's reagent and a drop of a glucose solution (0.20 wt%) were subsequently added to each of the two semi-circles of a 2-D dumbbell-shaped hydrophilic pattern on a mat that was glued onto a piece of glass by double side tape. The sample were placed onto a 50-^{o}C hot plate and picture was taken 8 min later.

II. Results and Discussion

Scheme S1 gives the pathways for synthesizing the targeted polymers and the chemical structures for the hardeners. It also shows the chemical reactions between the hardeners and the glycidyl groups.



Scheme S1. Synthetic pathways for a) PCEA-*g*-PDMS and b) PGMA. c) Chemical structures for the hardeners, d) typical reactions involved in the PGMA curing.

PGMA Synthesis and Characterization. Two PGMA samples, PGMA1 and PGMA2, were prepared for this study. The lower molecular weight sample PGMA1 was prepared using a lower GMA concentration for polymerization. Figure 1 shows ^{1}H NMR spectra for PGMA1 and PGMA2 and their peak assignments. The spectra agree with those reported in the literature.

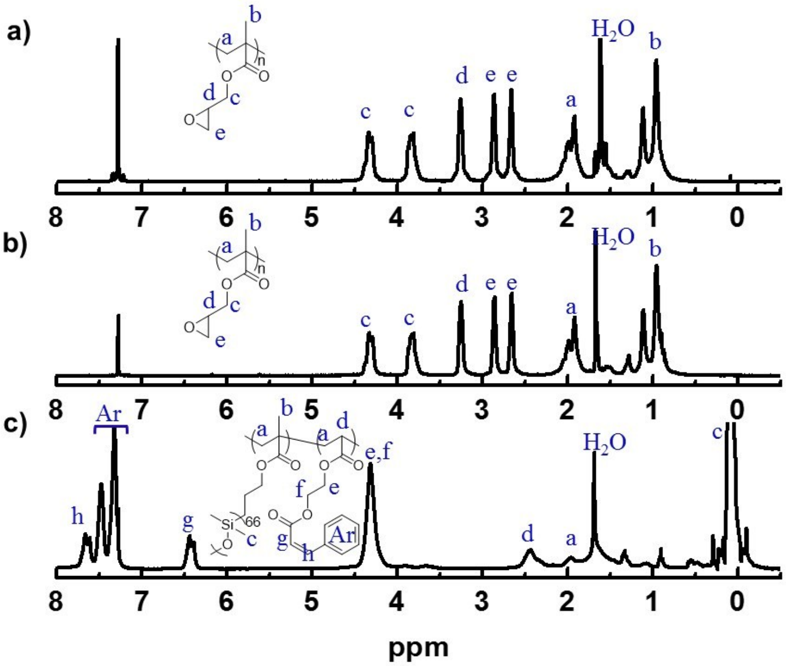


Figure S1. ^{1}H NMR spectra and peak assignments for a) PGMA1, b) PGMA2, and c) PCEA-*g*-PDMS.

SEC analyses yielded the PS-equivalent number-average molecular weights M_n of 77 × 10^3 and 124 × 10^3 Da for PGMA1 and PGMA2. Their polydispersity indices were 2.41 and 3.36, respectively.

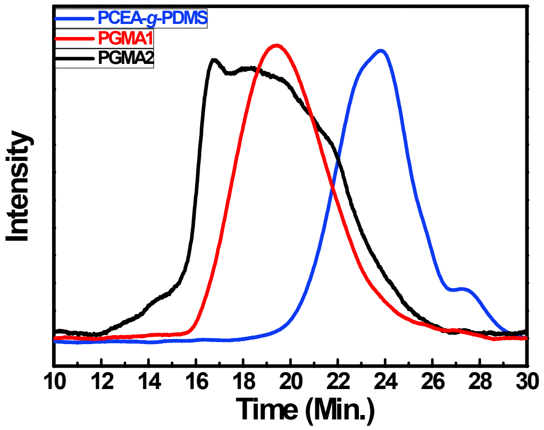


Figure S2. SEC traces for PGMA1, PGMA2, and PCEA-*g*-PDMS.

The polydispersity index was abnormally high for PGMA2 because it was prepared at a higher GMA concentration. At the end of the polymerization, the system became highly viscous and an auto-acceleration event probably had occurred.

PCEA-*g*-PDMS Synthesis. The first step involved copolymerization of PDMS-MA and HEA copolymerization, where PDMS-MA denotes a PDMS macromer bearing a terminal methacrylate unit. The targeted polymer was obtained in step 2 after the HEA hydroxyl groups were reacted with cinnamoyl chloride in pyridine. While a ^{1}H NMR spectrum of PCEA-g-PDMS is shown in Figure S1, its SEC trace is shown in Fig. S2. The polymer has a PS-equivalent M_n of 20 × 10^3 Da. Since the monomer conversions were essentially quantitative, the molar fractions of PDMS-MA and CEA as calculated from the feed rations should be 6.2% and 93.8%. These values were confirmed from the NMR spectrum.

Hardeners for ENM Fibers. The hardener used to cure with PGMA is mixtures of Jeffamine®, triethanolamine, and piperazine at the mass ratios of 1.000/0.106/0.034 (molar ratios of 1.000/0.163/0.091). This recipe was used to tune curing rate of PGMA. At room temperature, the mixture of the hardeners together with PGMA did not gel even after 24 h. Once the solvent evaporated, the curing was very fast. For example, the fibers 5 min after they were spun could not re-dissolve in THF.

The Amine Hydrogen Equivalent Weight (AHEW, g/eq) of Jeffamine®, triethanolamine, and piperazine were calculated analogously and were 57.5, 49.7, and 43.1 g, respectively. So, the calculated hardener AHEH is 56.3 g. PGMA has an epoxy equivalent weight of 142 g. Based on our PGMA/hardener mass feeding ratio (3/1), we calculated the epoxy:active hydrogen molar ratio 1.19/1.00.

Electrospinning. PGMA/hardener was elcetrospun using conditions described in the Experimental Section. All the mats used were prepared from PGMA1, which yielded beaded rather than pure cylindrical fibers (Figure S3). We note that mats made of pure fibers could be prepared from PGMA2. However, these PGMA2 mats did not feature water contact angles as high as those on the PGMA1 mats.

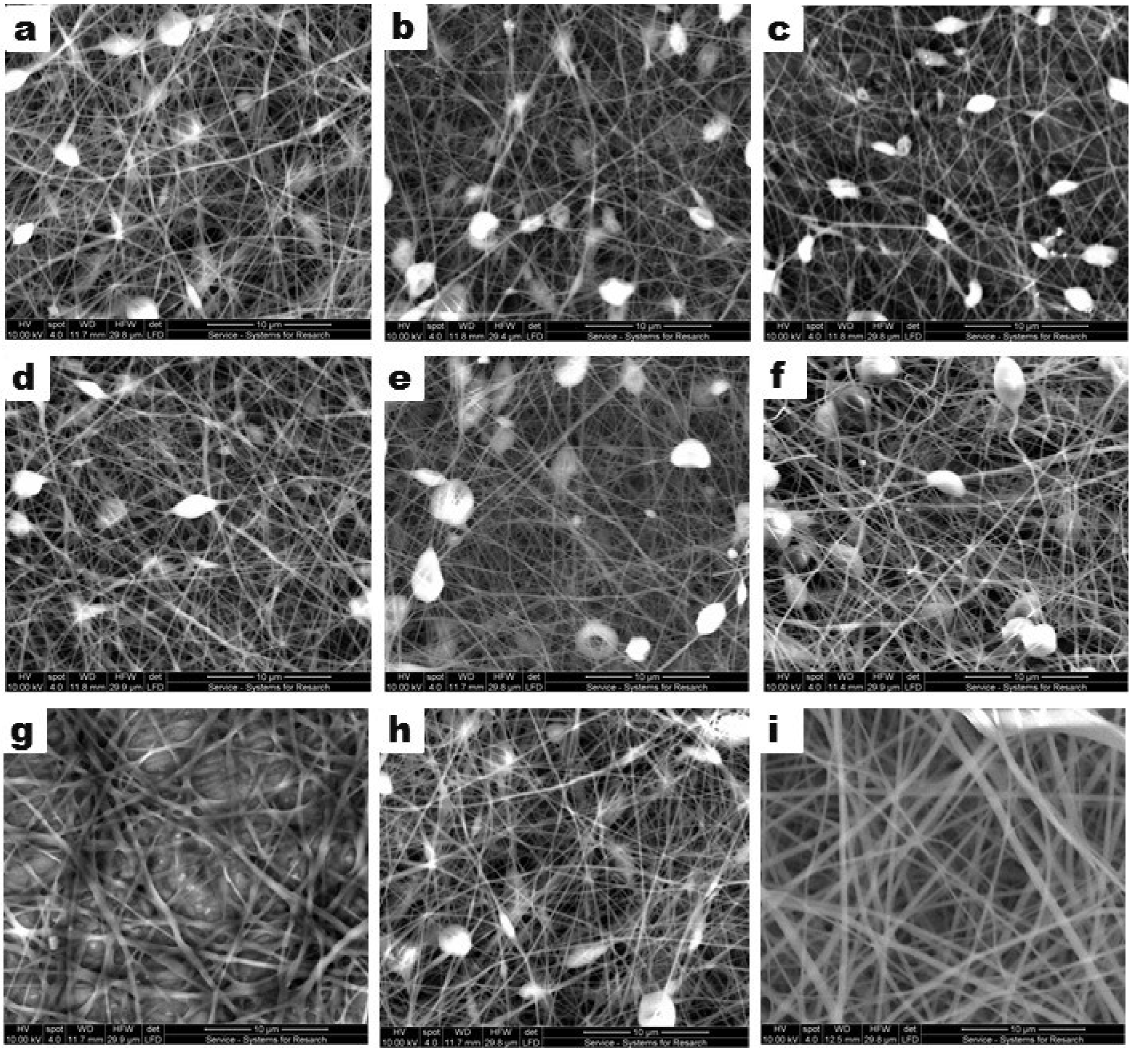


Figure S3. SEM images of mats spun from solutions that were aged for a) 0, b) 1, c) 2, d) 4, e) 6, f) 8, and g) 24 h, respectively. Figure h) shows an image of a cured mat that had been soaked in THF overnight. Figure i) shows an image of a mat prepared from PGMA2.

According to literatures, the viscosity of the spinning polymer solution influences the morphology and diameter of the electrospun fibers. Since a mixture of PGMA/hardener was electrospun over several hours to make a mat, we investigated how the fiber shape and diameter changed with the aging time of the spinning solution, which involved leaving a spinning solution in the syringe for different times before it was spun for 5 min to generate a thin mat. Figures S3 a-f show the SEM images of the top-surfaces of mats fabricated using solutions aged for 0, 1, 2, 4, 6, 8 and 24 h, respectively. The morphology and diameters of the fibers barely changed within 8 h, which was the longer than 4.5 h used to prepare the thicker mat used in this study.

After 24 h, the PGMA/hardener mixture appeared to be more viscous than a freshly-prepared solution. Electrospinning this solution yielded fibers with their SEM image shown in Fig. S3 g. The fibers were not beaded anymore and had a larger width of ~ 500 nm.

That increasing solution viscosity reduces beading and increases fiber diameter is well known. We confirm this by electrospinning a PGMA2 solution. This polymer had a higher molecular weight than PGMA1 and its solution at an equal mass concentration had a higher viscosity. Figure S3i shows an SEM image of the fiber mat prepared. The fibers are purely cylindrical and thick.

The fibers were crosslinked after thermal curing. Figure S3h shows an SEM image of a mat that had been soaked THF overnight. The fibers retained their integrity even after this harsh treatment.

Further Characterization Results for Nanofiber Mats. The thinner nanofiber mat was also characterized by SEM. Figure S4a shows a top-down and a cross-sectional SEM image for the thinner mat.

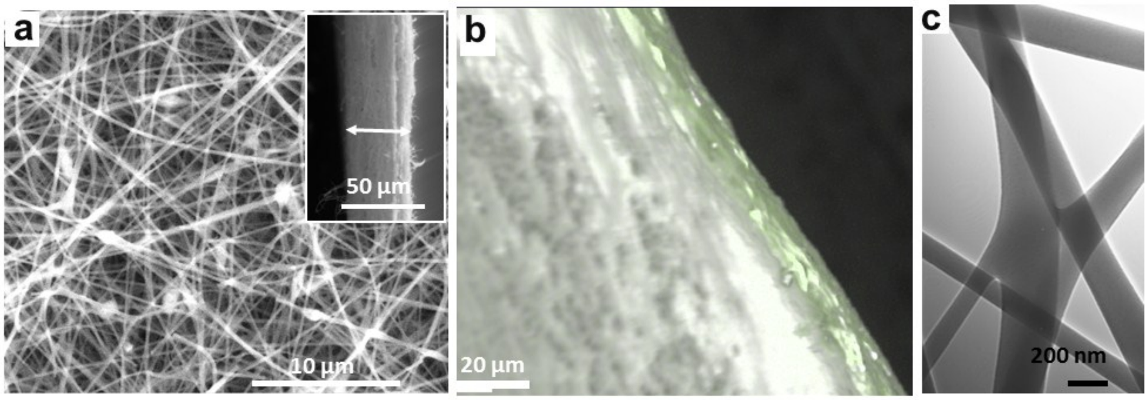


Figure S4. SEM a) top-down and b) cross-sectional images for the thinner nanofiber mat. c) TEM image of nanofibers that were not coated by PCEA-*g*-PDMS.

SEM/EDS were used in combination to determine the thickness of the mat layer bearing securely crosslinked PCEA-*g*-PDMS. For this experiment, the thicker mat was used. It was irradiated on one side for 10 min before extraction with THF to remove PCEA-*g*-PDMS that was not securely attached to the fibers. A sample was then prepared so that its cross section could be analyzed by SEM and EDS. The experiment involved the formation of an SEM image of the ENM's cross section using back-scattered primary electrons and the simultaneous construction of a binary Si distribution map based on "positive" or "negative" detection of the characteristic Si Kα X-ray at different pixels. Figure S4c shows an overlap of an SEM image and its corresponding silicon map. The green dots indicative of positive Si detection occurred mostly on the irradiated side within a depth of ~ 10 μm. Thus, this was the thickness of the mat bearing securely crosslinked PCEA-*g*-PDMS.

Fiber Surface Modification. The mat before surface modification was hydrophilic already and these hydroxyl groups show a broad absorption peak 3430 cm^{-1} as shown in Figure S5. To further increase the hydrophilicity, the surface was modified with succinic anhydride, to introduce -COOH groups. The introduction of carboxyl groups was witnessed by the appearance of a new peak at 1660 cm^{-1} in Figure S5.

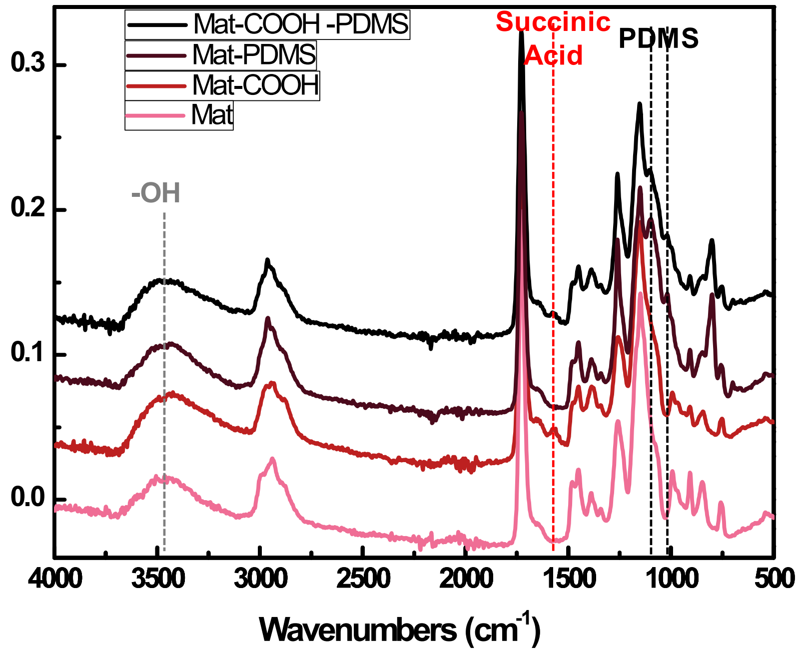


Figure S5. ATR-IR spectra of mat, carboxylated mat, PDMS coated mat, and carboxylated and PDMS coated mat.

Coating the fibers with PCEA-*g*-PDMS turned the mat superhydrophobic. The coating solution was prepared by dissolving PCEA-*g*-PDMS in THF first and then adding hexanes to 80% by volume. In this solvent mixture, the graft copolymer existed as micelles. We photocrosslinked the micelles and then aero-sprayed the crosslinked micelles on mica for AFM analysis. Figure S6 shows an AFM image of the crosslinked micelles and the diameter distribution of the micelles. The polymer seemed to have formed unimolecular micelles in the solvent mixture. This was desirable for coating fibers as surface adsorption did not have to compete with formation of inter-chain micelles.

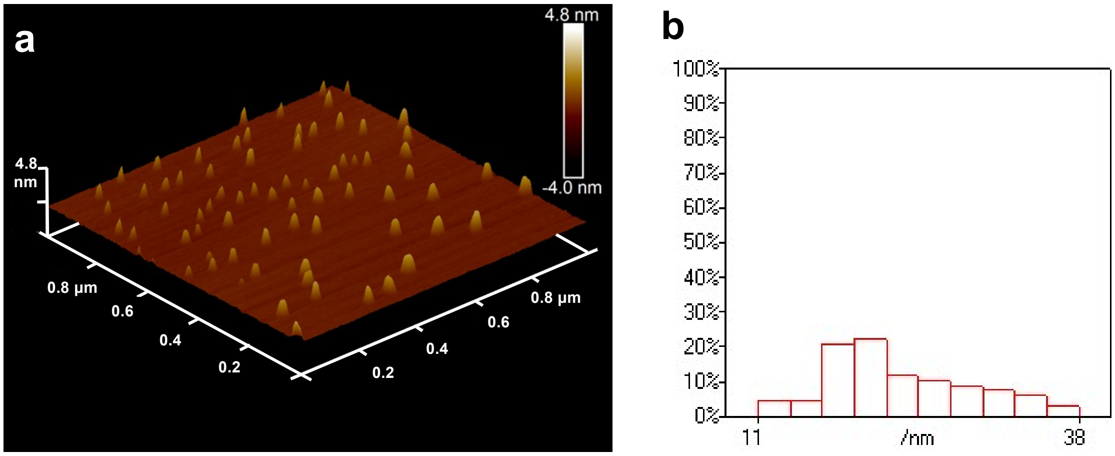


Figure S6. a) 3-D AFM topography image and b) diameter distribution of PCEA-*g*-PDMS micelles from the AFM image.

Figure S4 also shows an ATR-IR spectrum for hydroxy-bearing mat that was coated by PCEA-*g*-PDMS as well as one for the carboxylated mat that was coated by PCEA-*g*-PDMS. After coating, the PDMS characteristic peaks at 1020 and 1120 cm^{-1} appeared.

Effect of Varying Mat Thickness and Photolysis Time. While the thicker mat was photolyzed under a mask for only 10 min to produce patterned ENMs for printing stencils, the thinner mat was photolyzed for 40 min to yield patterned ENMs for other applications. The mats were then extracted with THF to develop the patterns. Figure S7 compares properties of the two sides of mats prepared under the two sets of conditions.

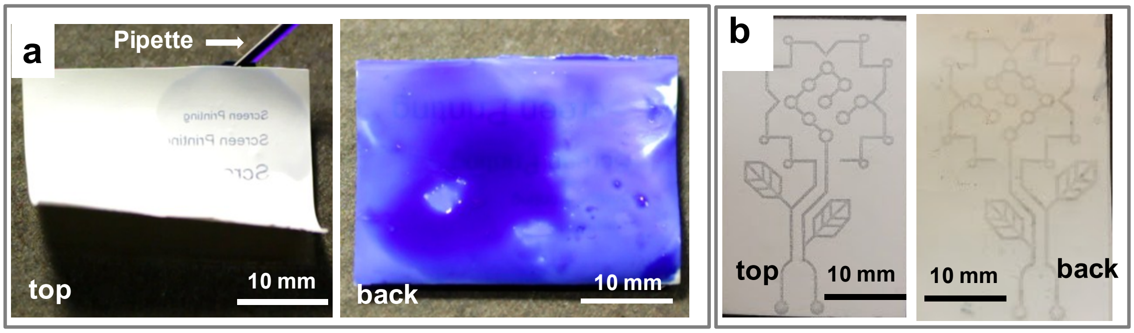


Figure S7. a) Pictures showing front and back side of a patterned stencil that was prepared from the thicker mat using a photolysis time of 10 min. b) Pictures showing the front and back side of a patterned mat after it was impregnated with water. The mat was prepared from the thinner mat using a photolysis time of 40 min.

Dispensing ink on the back side (further away from the irradiation source) of a stencil is followed by the quick spreading of the ink through all hydrophilic regions including the through the hydrophilic pattern. However, the ink was blocked by the hydrophobic regions on the front side. Figure S7a compares the statuses of the mat on the front and back side after ink dispensing.

Forty-minute irradiation of the thinner mat under a pattern allowed secure crosslinking of PCEA-*g*-PDMS on all fibers across the mat thickness. Figure S7b compares front-and back-side pictures taken of a mat bearing the partial electric circuit after its impregnation with water. The pattern was recognized even on the back side, confirming permeation of the mat across the mat thickness in this case.

Effect of Varying PCEA-g-PDMS Coating Solution Concentration. To optimize the mat coating conditions, we immersed mats in PCEA-*g*-PDMS coating solutions of the concentration c of 1.0, 5.0, 10.0, 20.0, and 30.0 mg/mL. After drying and PCEA-*g*-PDMS crosslinking, water contact angles were measured on the different mats. Figure S8 plots the variation of the water contact angle as a function of PCEA-*g*-PDMS coating solution concentration c. The water contact angle plateaued after $c = 10.0$ mg/mL.

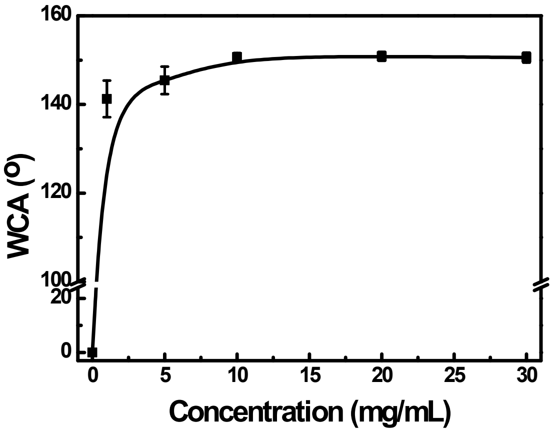


Figure S8. Plot of water contact angle variation on coated and crosslinked mat as a function of PCEA-g-PDMS coating solution concentration.

Factors Affecting Screen-Printed Images. Figures S9a and S9b compare a flowery pattern that was originally on a transparency and later screen-printed onto a piece of paper using a carboxylated and patterned ENM. Focusing on the regions enclosed by the ellipses, one sees how the details were reproduced with high fidelity in the screen-printed picture despite the use of the commercial unmodified ink. The picture was also reproduced on a piece of paper with the commercial screen printing kit (Figure S9c). The printed pattern was far inferior, lacking many details in the region enclosed by the ellipse.

Lastly, we draw attention to the need to carboxylate the mat fibers. Figure S9d shows the picture screen-printed with a mat that had not been carboxylated. The picture was higher in quality than that printed with the commercial kit but was inferior to that shown in Figure 4b. The inferiority should not be due to the use of the red ink because the use of the red ink with a carboxylated mat produced a print with quality identical to that seen in Figure S8b. Thus, the carboxylation facilitated ink permeation through the finer regions of a hydrophilic pattern and enhanced the details in a print.

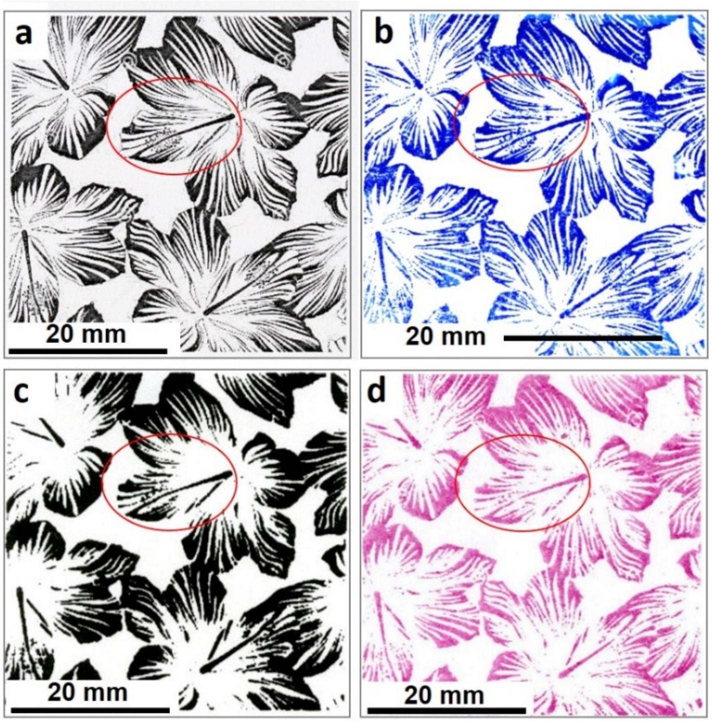


Figure S9. Figure printing: a) An image printed on a transparency. Images screen-printed using b) an optimized ENM, c) a commercial kit, and d) a non-carboxylated mat.

[1] Y. Tai, Z. Yang, *ACS Appl. Mater. & Interf.* **2015**, *7*, 17104-17111.