Supporting Information

## Thiol-click chemistries for responsive neural interfaces

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Voit*
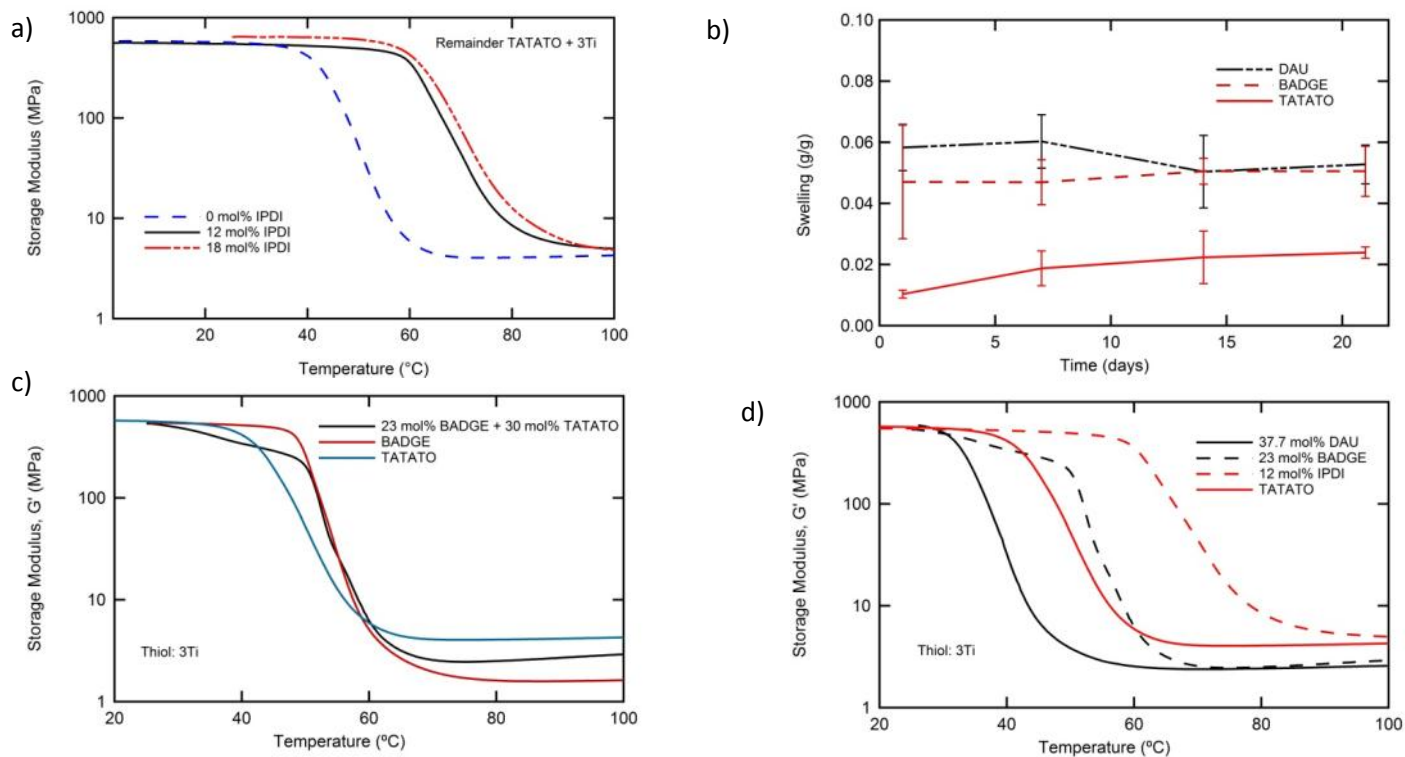
Supplemental Figure 1 – DMA of thiol-ene/thiol-isocyanate networks (a). Swelling of three networks from Figure 1. DMA of thiol-epoxy/thiol-ene hybrid network compared to the thiol-ene and thiol-epoxy networks presented in the main text (c). Interestingly although covalent crosslink density changes the glass transition remains relatively unaffected. Large versatility can be obtained using thiol-ene, thiol-isocyanate, and thiol-epoxy networks. Two examples of networks that share the same covalent crosslink density but have T_gs separated by over 20 °C are shown (d).
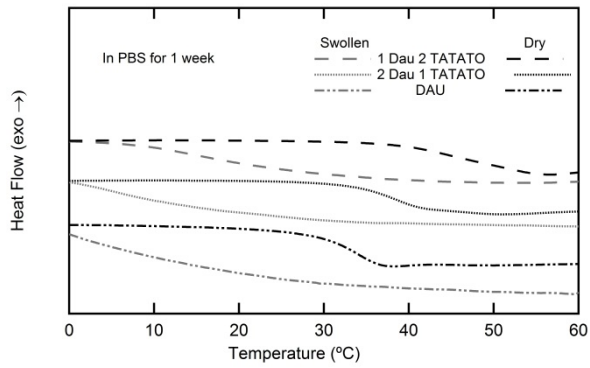
Supplemental Figure 2 – DSC of samples exposed to physiological conditions for 1 week as compared to the dry sample of the same composition. The degree of plasticization after 1 week is roughly equivalent to the degree plasticization measured after 1 day of exposure.
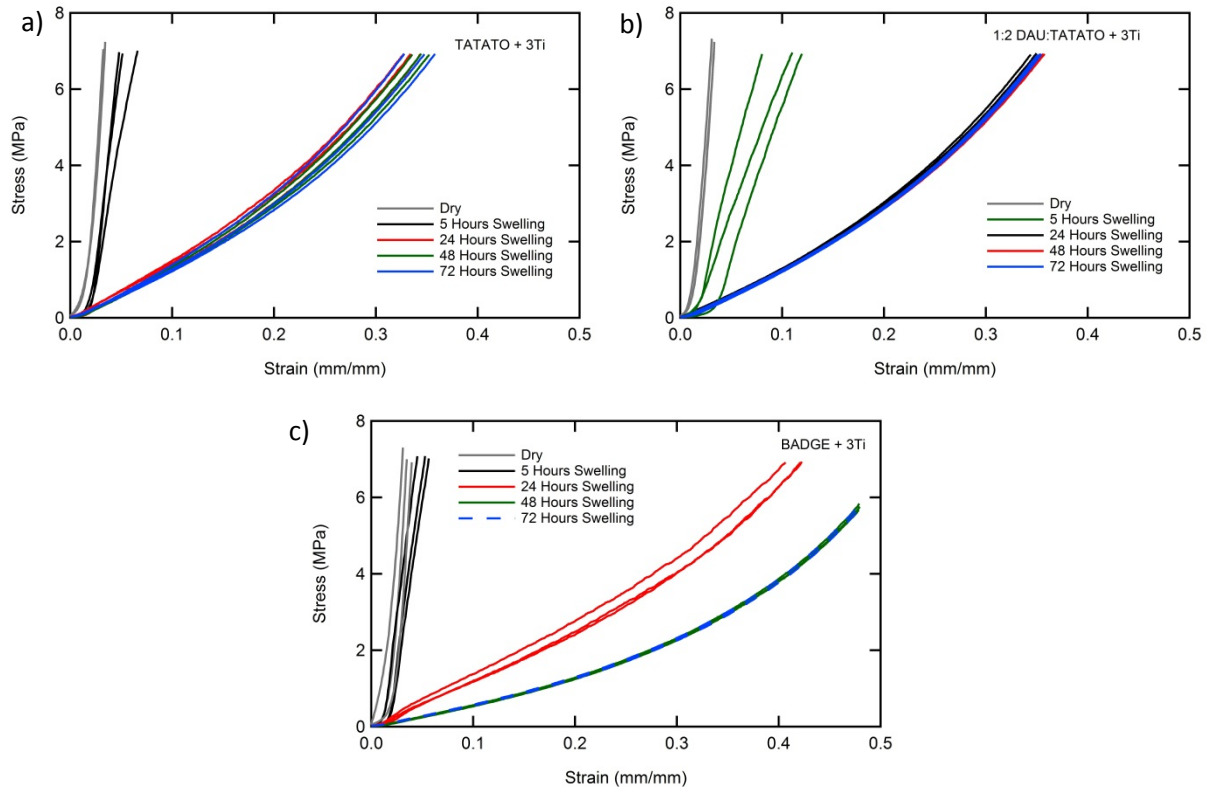
Supplemental Figure 3 – Compression stress-strain response of samples in physiological conditions over 2 days. All three curves that were obtained for each composition at each time point are displayed. A significant drop in modulus is observed with each sample over the period of 72 hours. After 24 hours no change was observed in the behavior of the TATATO (a) and TATATO+DAU (b) networks. No change was observed after 48 hours for the BADGE network. The stress-strain response was measured either until the load maximum of the instrument was reached (45 N) or until 500 μm displacement was reached.
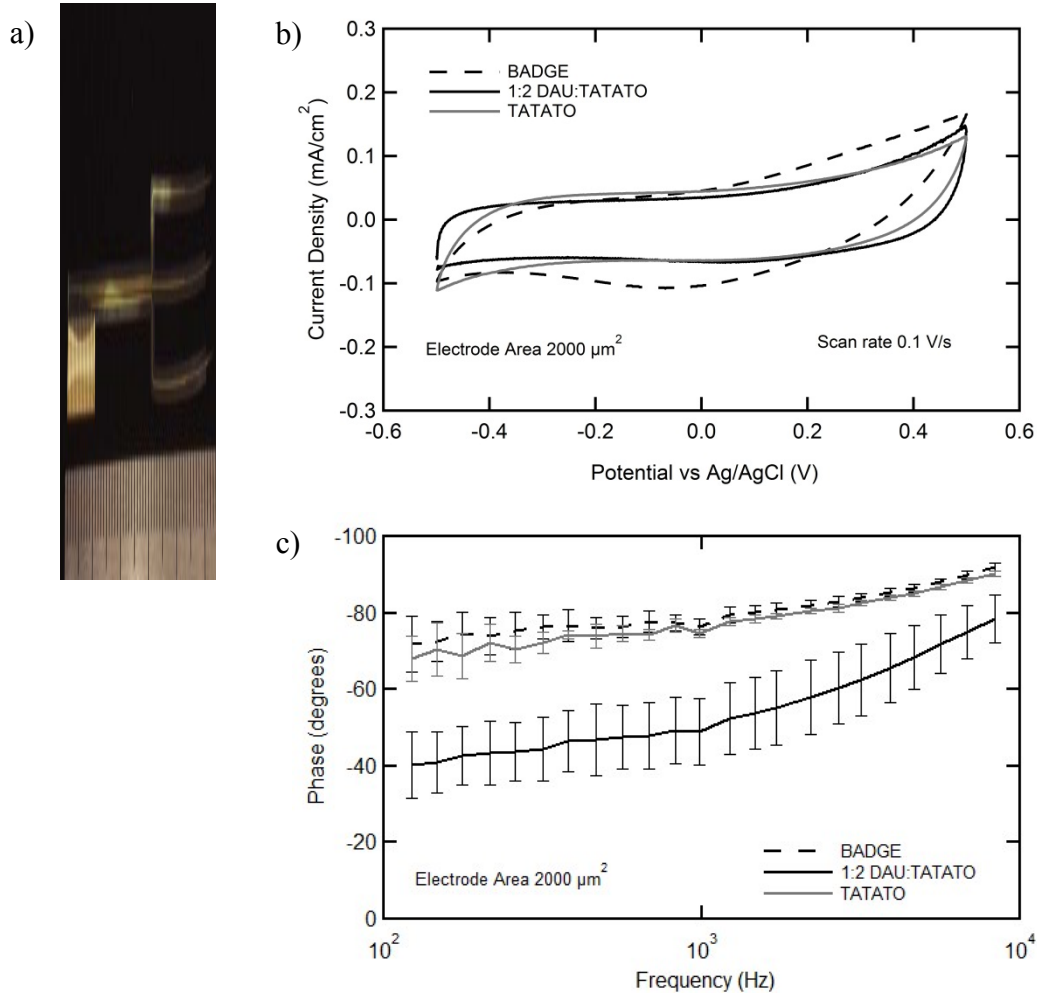
Supplemental Figure 4 – Photograph of an intrafascicular electrode array after micromachining and removal from the supporting substrate The device consists (from top to bottom) of a connector, gold leads and three implantable shanks (150 μm wide) each with 4 microelectrodes (each scale line is a millimeter) (a). Representative cyclic voltammetry measurements of a gold electrode on each of the three substrates selected for device fabrication (b). Average phase angle from impedance spectroscopy for electrodes(n=8) fabricated on each substrate (c)

Experimental Methods

Polymer synthesis: All networks were made by polymerizing 1:1 molar ratio of either alkenes or epoxides to thiols. Thiol-ene networks were synthesized by first dissolving 0.1 wt % DMPA of total monomer concentration into 3Ti. The vial was covered in aluminum foil to prevent incident light from contacting the monomer solution. In the covered vial the appropriate amount of DAU was added and heated to 90 °C to melt the DAU and subsequently vortexed to obtain a clear liquid. The resulting homogenous mixture is then cooled to room temperature; precipitation of the DAU was not observed. The appropriate quantity of TATATO, depending on the desired composition, was then added to the solution. Without exposing the solution to light, the vial was mixed through vortexing and sonication until the solution was visually homogenous and without air bubbles. The monomer solution was cast between two glass slides (75 × 50 mm) that were previously coated with a silicone mold release (Rain-X™) separated by a glass spacer, 1.2 mm or 35 μm thick. Polymerization was performed using a crosslinking chamber with five overhead 365 nm UV bulbs (UVP via Cole-Parmer) for 15 minutes.

Thiol-epoxy networks were synthesized by first melting BADGE at 50 °C and cooling to room temperature. The monomer did not crystallize over the course of the experiment. 5 wt% tritethylamine was added to the epoxide and subsequently mixed. To this mixture 3Ti was added, vortexed and sonicated until a homogenous and bubble-free solution was obtained. The monomer solution was cast between two glass slides (75 × 50 mm) that were previously coated with a silicone mold release (Rain-X™) separated by a glass spacer, 1.2 mm or 35 μm thick. The polymerization occurred over approximately an hour at room temperature in the dark.

All samples were postcured for 24 hours at 120 °C under vacuum (125 mm of Hg) and subsequently stored in a dark, desiccated container.

Simulated Physiological Conditions: Samples consisted of ~10 mg laser machined cylinders 3 mm in diameter and 1.2 mm tall. The dry mass of each sample was measured and recorded with a balance with 0.01 mg precision. Swelling was measured by weight change after immersion in phosphate buffered saline (PBS pH 7.4) at 37 °C at several time points over one month. At each desired time point each sample was removed from the PBS, and the surface of the polymer was gently dried using an absorbent wipe. The swollen mass was then recorded. Swelling is calculated as the mass change from dry to swollen normalized to the dry mass. Data reported are the average of 5 samples. At several time points swollen samples were characterized by DSC and uniaxial compression.

Substrate preparation for photolithography: 75 × 50 mm glass microscope slides were cleaned by subsequent steps of scrubbing in an Alconox solution, sonication in acetone, sonication in isopropanol and repeated as necessary until free of optically visible unwanted material. 300 nm of Au was deposited at 0.2 nm/s by physical vapor deposition (electron-beam). Metal transfer was accomplished by using the sacrificial substrate with unpatterned film as the bottom slide for the mold with the metal surface facing inward. The top side of the mold was a cleaned glass slide coated in silicone mold release. Due to the comparatively poor adhesion of the gold to the sacrificial glass slide the metal was transferred to the SMP substrate via a process previously described. After polymerization the substrate adheres sufficiently well to the top glass slide that delamination does not occur throughout processing; silicone mold release ensures that the polymer substrate will release from the carrier slide after processing.

Metal Patterning: Electrodes were then patterned by standard photolithography using S1813 photoresist (Microposit). The positive resist was spun onto the metal coated polymer at 2000 rpm with an acceleration of 3000 rpm/s. The resist was then soft-baked at 85 °C for 10 minutes. A

pattern was transferred to the resist using UV light at a dose of 150 mJ/cm^2. The resist was developed using MF-319 developer and subsequently hard-baked at 85 °C for 10 minutes. Metal was then etched using gold etchant (AU-5 Cyantek Corporation) diluted in a 1:1 volume ratio.

Parylene-C Deposition and Patterning: 500 nm of Parylene-C was deposited using a Labcoter 2 (SCS Systems). Patterning of the photoresist was accomplished through similar methods described during metal patterning. Parylene-C was etched using a Technics reactive ion etching (RIE) tool using oxygen plasma. A pressure of 100 mTorr and power of 50 W was used. Each sample was etched for 9 minutes. After RIE the photoresist was removed using a flood exposure and subsequent developing.

Device definition and electrical bonding: Micromachining was performed using a 355nm diode-pumped solid-state Nd:YAG laser connected to a μFab workstation (Newport). Devices were removed from the carrier glass slide by lifting gently with a moistened razor blade. Probes were electrically bonded to a custom printed circuit board using a zero insertion force connector.

Dynamic Mechanical Analysis: DMA was performed on a Mettler Toledo DMA 861e/SDTA. Samples were cut into cylinders approximately 1.2 mm thick and ~3 mm in diameter. The mode of deformation was shear, and strain was limited to a maximum of 0.08%. Samples were tested at a heating rate of 2 °C/min and over the range of 0 °C – 100 °C. The frequency of deformation was 1 Hz. Tests were conducted in a nitrogen atmosphere. Tg by DMA is denoted as the peak of tan δ. Each composition was tested at least twice.

Differential Scanning Calorimetry: DSC on both dry and swollen samples was performed on a Mettler Toledo DSC 1 with an intracooler option. Dry samples were heated from room temperature to 125 °C, cooled to -30 °C and subsequently heated to 200 °C. Data shown are of only the second heating ramp. Swollen samples were loaded at 25 °C, cooled to -30 °C and

subsequently heated to 100 °C. Data shown are of only the heating ramp. For both types of samples heating and cooling rates were fixed at 10 °C/min. Tests were conducted in a nitrogen atmosphere. T_g by DSC is denoted as the midpoint of the transition.

Compression testing: The quasi-static compressive stress-strain response was measured using a TA instruments Discovery HR-3 rheometer with a Peltier plate heating accessory. Samples were exposed to simulated physiological conditions for between 0 hr and 72 hr. Each sample was loaded between parallel plates and preloaded to 0.03 MPa and the gap flooded with PBS. After allowing equilibration at 37 °C, the sample was deformed in compression with a strain rate of .06 s^{-1}. Modulus was calculated as the slope in the linear regime of the stress-strain response. Three identical samples were tested for each composition at each time point.