SUPPORTING INFORMATION

Polyurethane-Grafted Graphene Oxide from Repurposed Foam Mattress Waste

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SUPPLEMENTAL DATA AND FIGURES

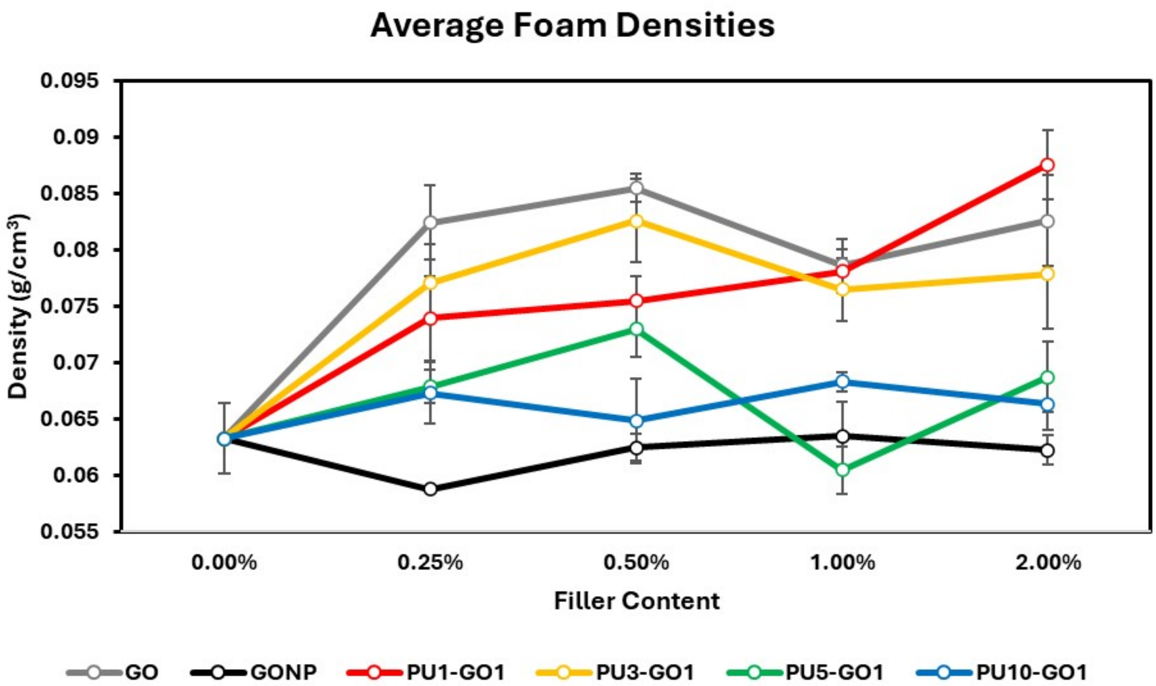

Figure S1. Average foam densities of each PU foam, taken in triplicate from cut and manufactured foam disks. Density was determined by weighing each foam disk and volume was determined by calculating surface area from averaged diameter measurements taken in triplicate and multiplied by the height of the foam sample.

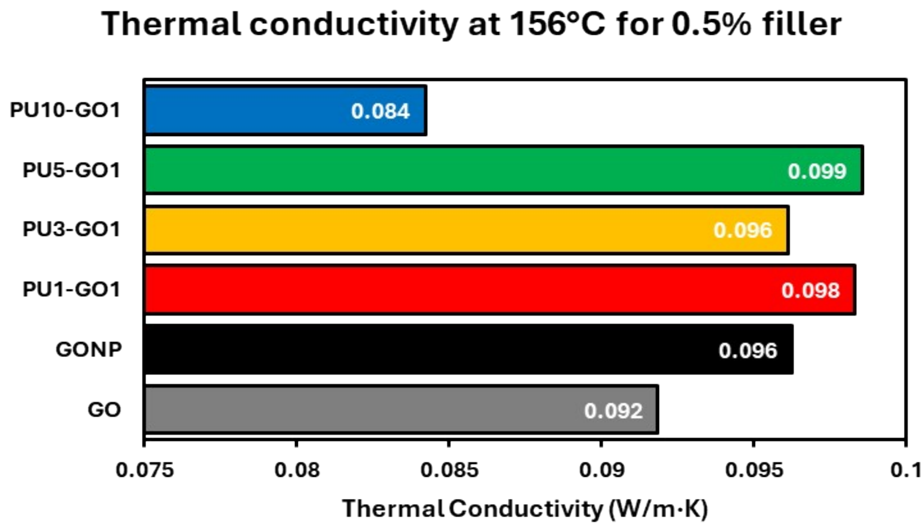

Figure S2. Thermal conductivity of PU foams at 0.5% filler loading.

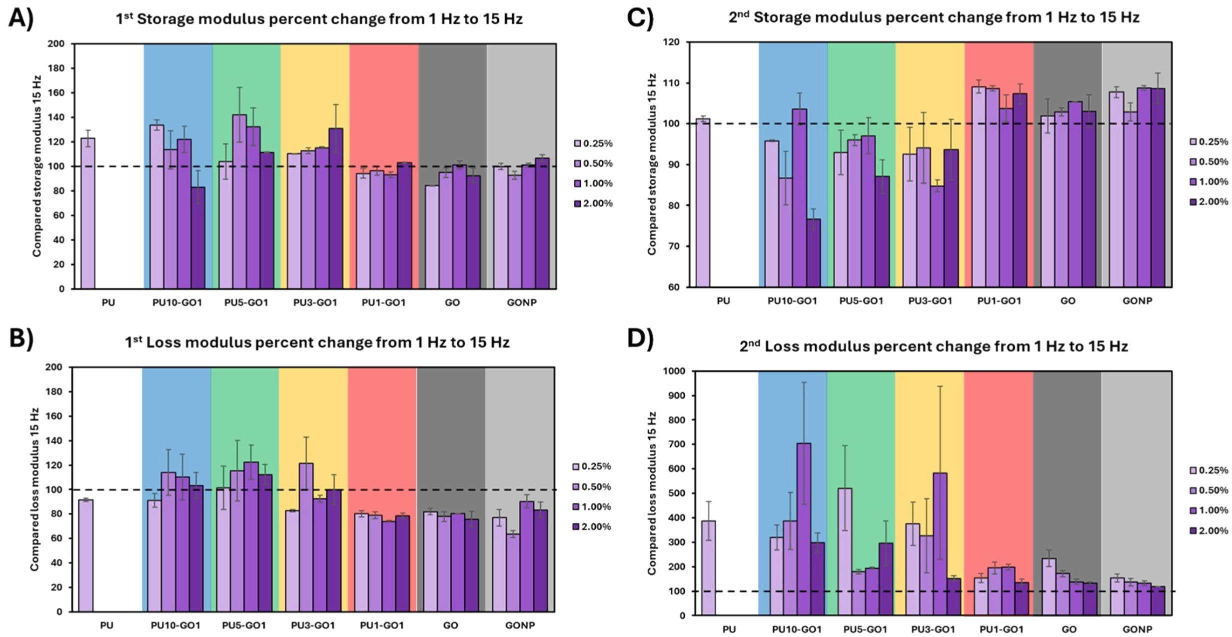

Figure S3. The storage modulus (A & C) and loss modulus (B & D) at 15 Hz as a percentage of the modulus at 1 Hz. With regard to storage modulus, percent above 100% exhibits a stiffening effect when a higher frequency application of force occurs, while measurements below 100% exhibit reduced energy required to deform the sample.

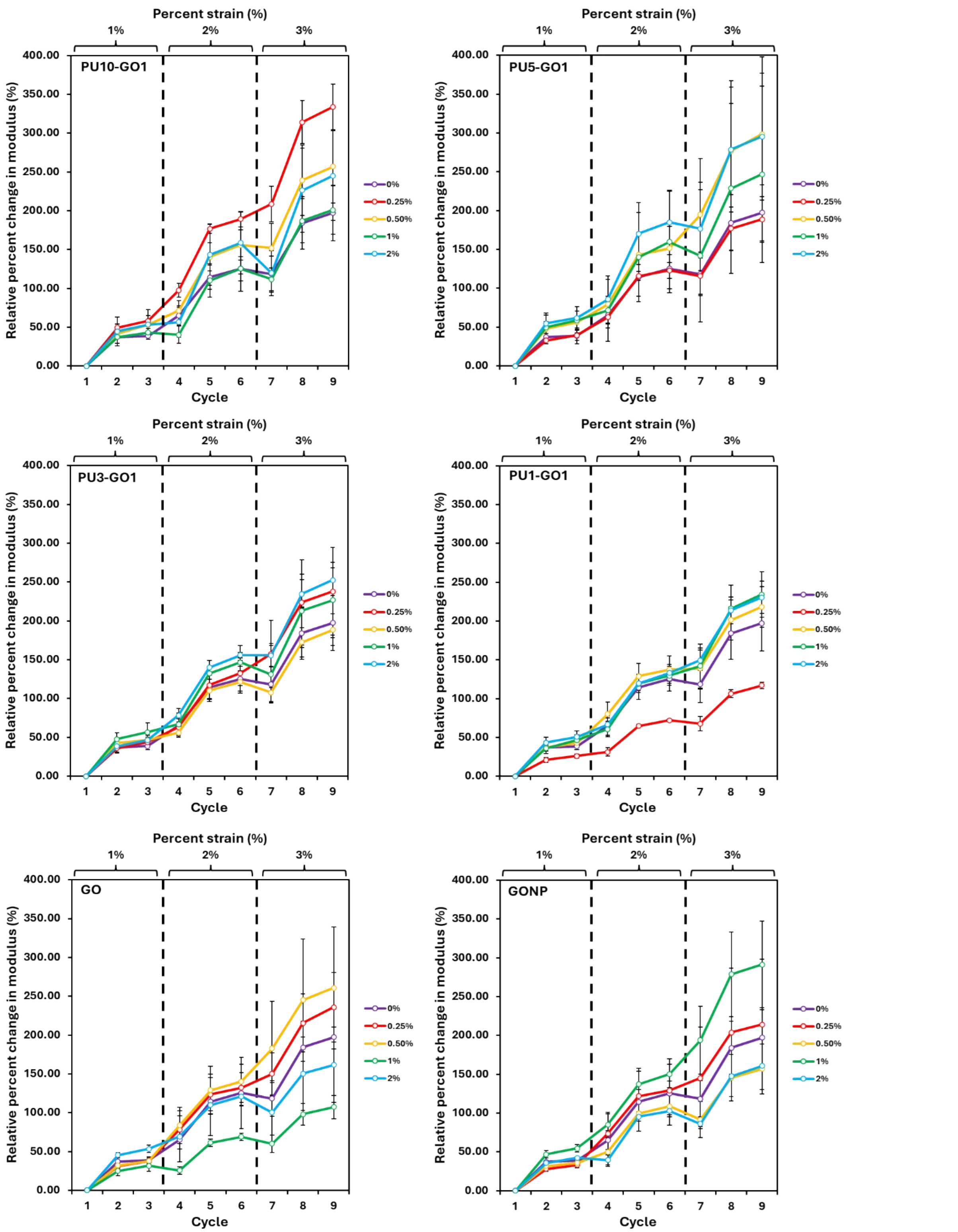

Figure S4. Percent change of Young's modulus of PU foam composites with cyclic loading at different weight percents. Samples above PU neat have a greater stiffening effect with respect to neat PU as cyclic loading occurs, likely due to compaction from microfracturing.

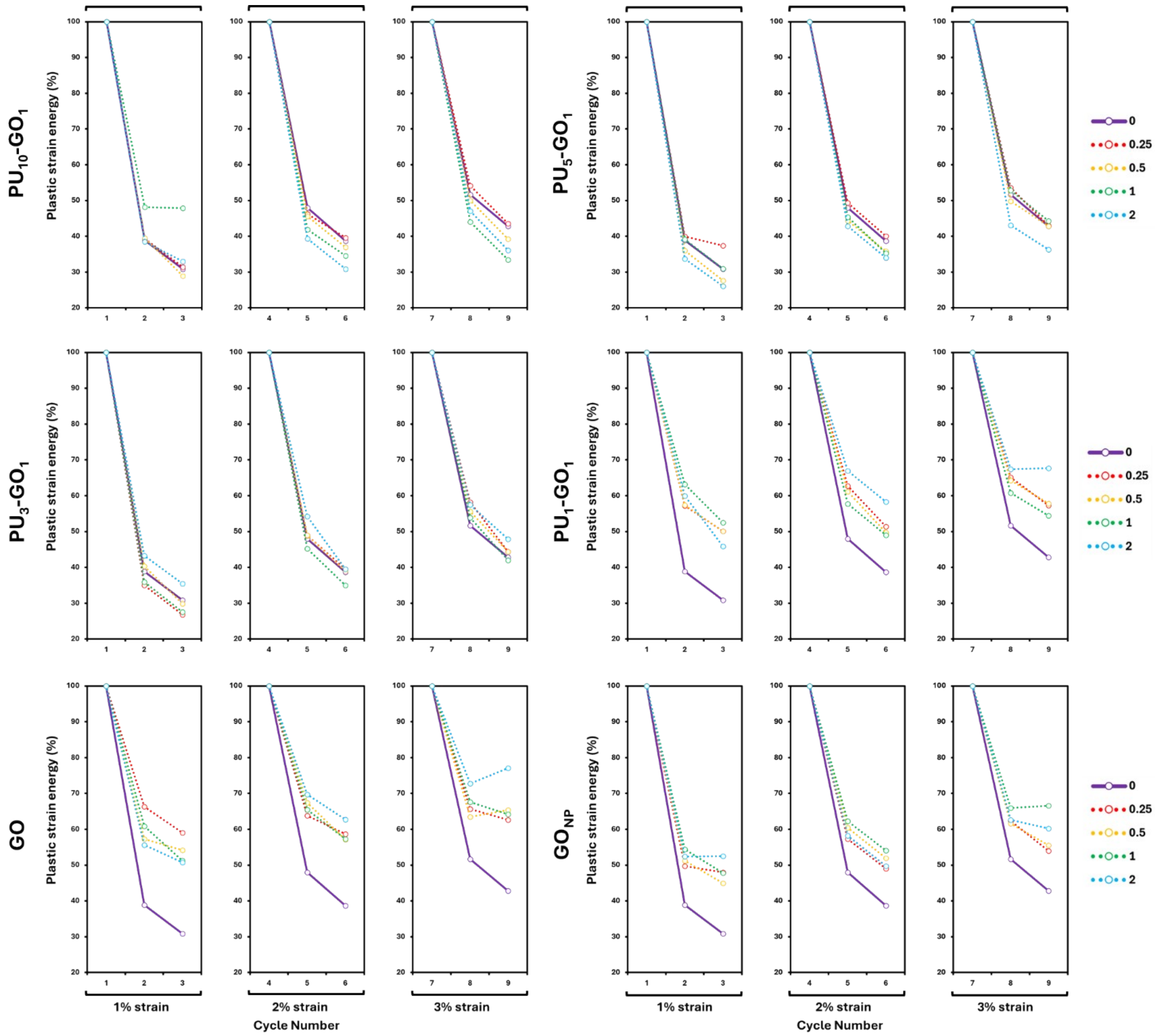

Figure S5. Change in plastic strain energy as a percentage of the original plastic strain energy of the first run in a cycle at a 1%, 2%, and 3% strain.

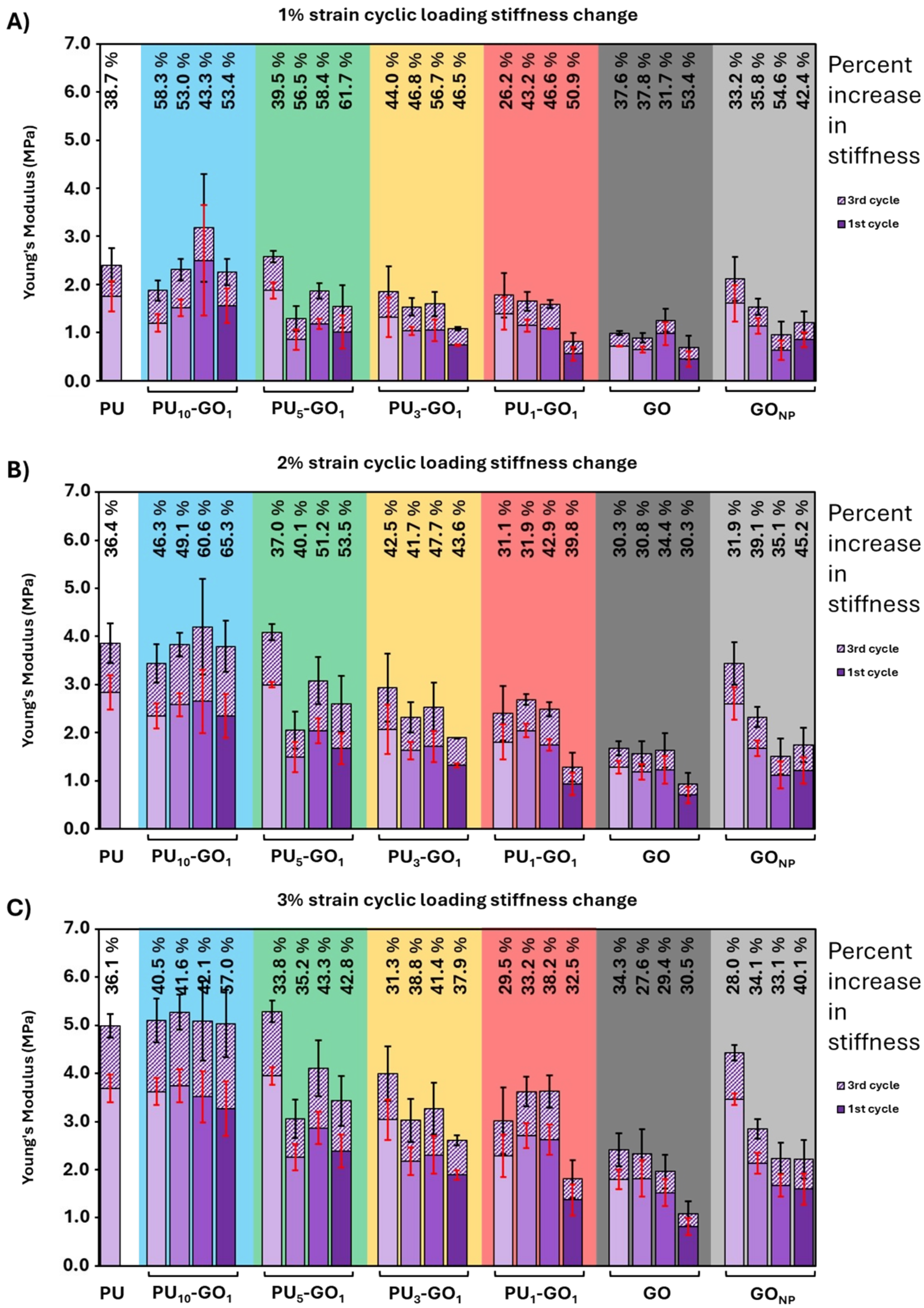

Figure S6. Cyclic stiffening of foam materials demonstrated by Young's modulus change with cyclic loading. Stiffening occurs with cyclic loading due to fracturing and compacting of the foams over time.

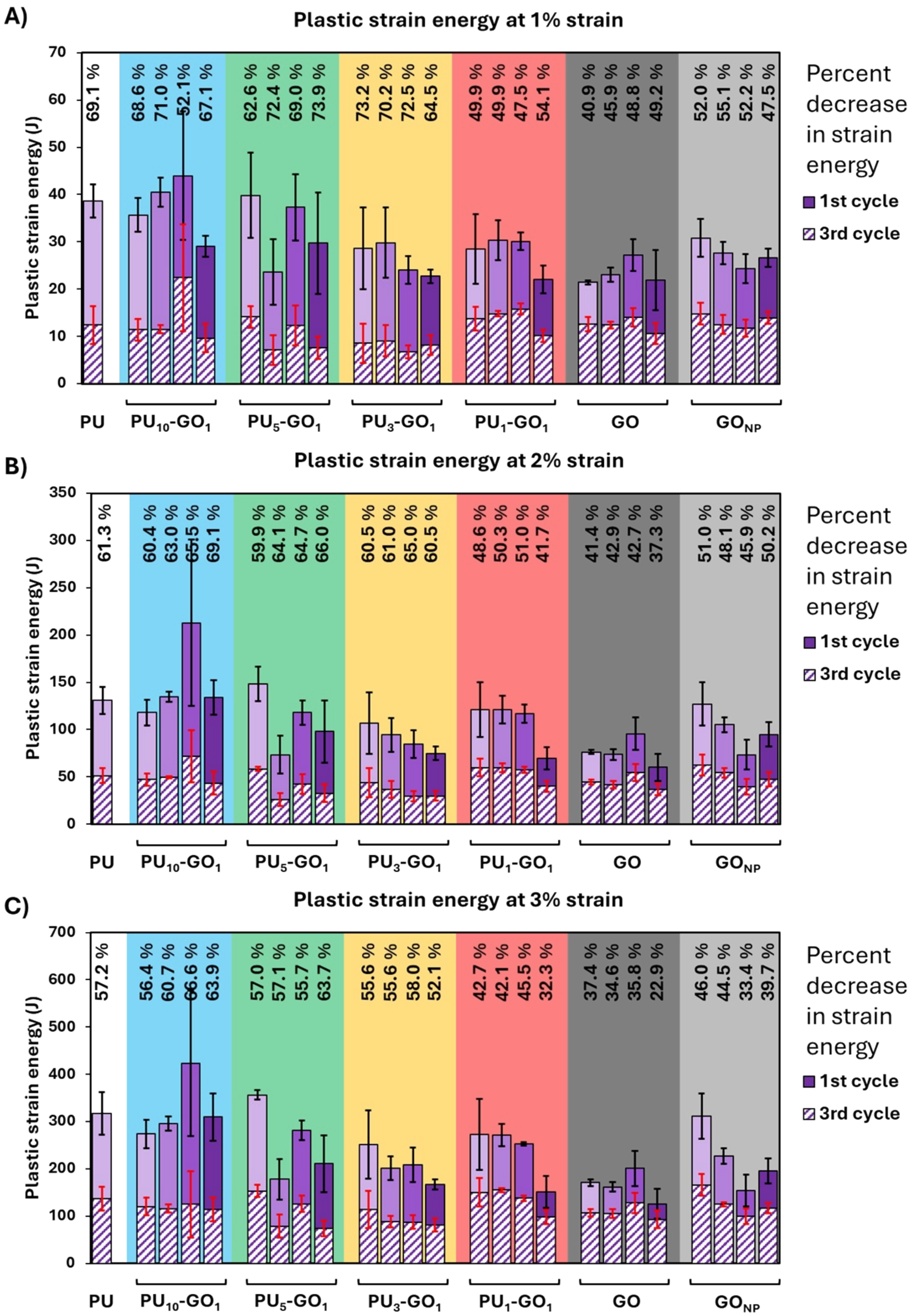

Figure S7. Plastic strain energy loss for each material as a percentage of the initial plastic strain energy for various cyclic loading strains. Runs 1-3 are at 1% strain, runs 4-6 are at 2% strain, and runs 7-9 are at 3% strain.

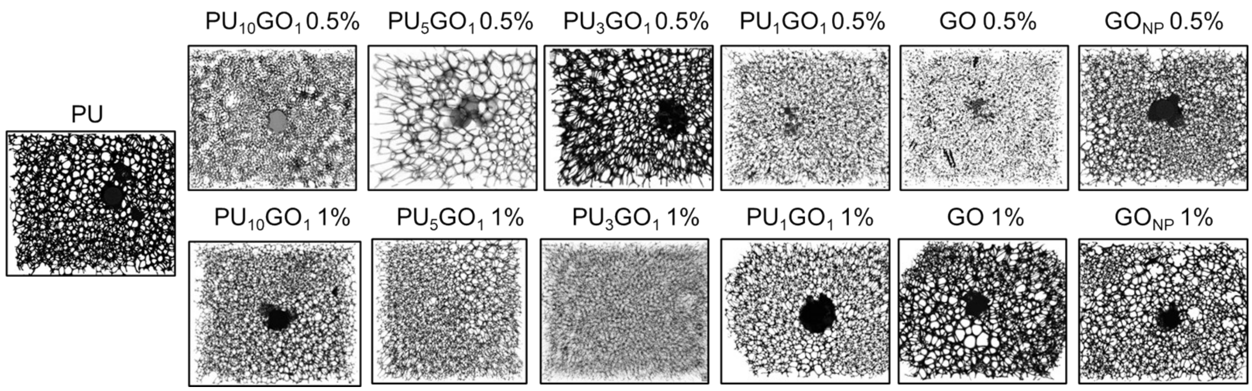

Figure S8. Micro-CT images of PU foam and composites of 0.5 wt. % and 1.0 wt. % provide a 3D rendering of the foam pore structures.

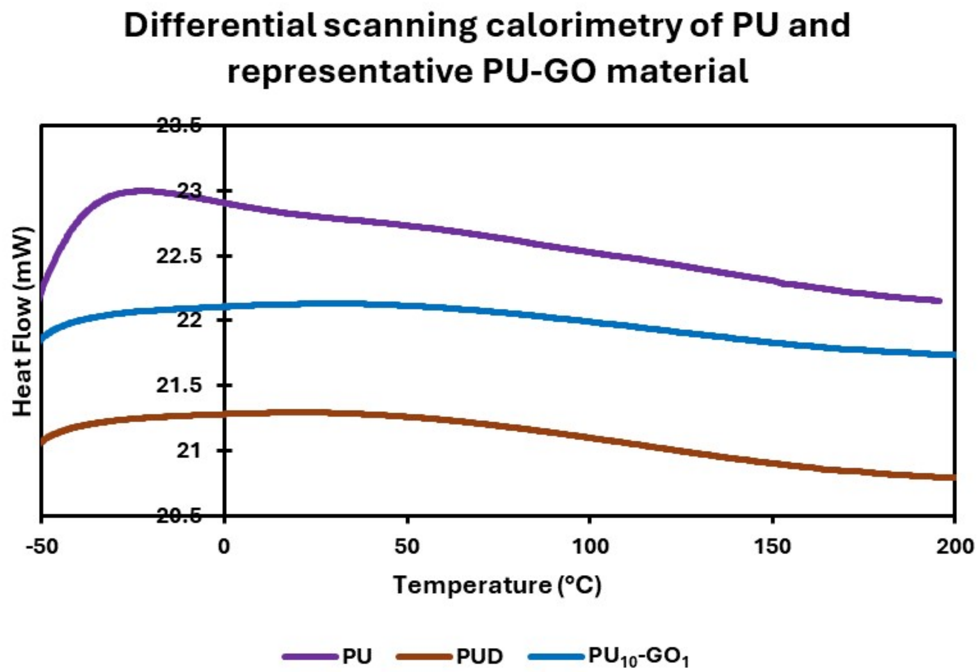

Figure S9. Differential scanning calorimetry (DSC) conducted over -50 to 200 °C to determine any thermal transitions present in PU waste foam of PU-GO materials. As is expected of a highly crosslinked foam there are no strong thermal transitions present in the PU waste foams. Additionally, no strong thermal transitions were noted in the PUD or PU_{10}-GO_1 material

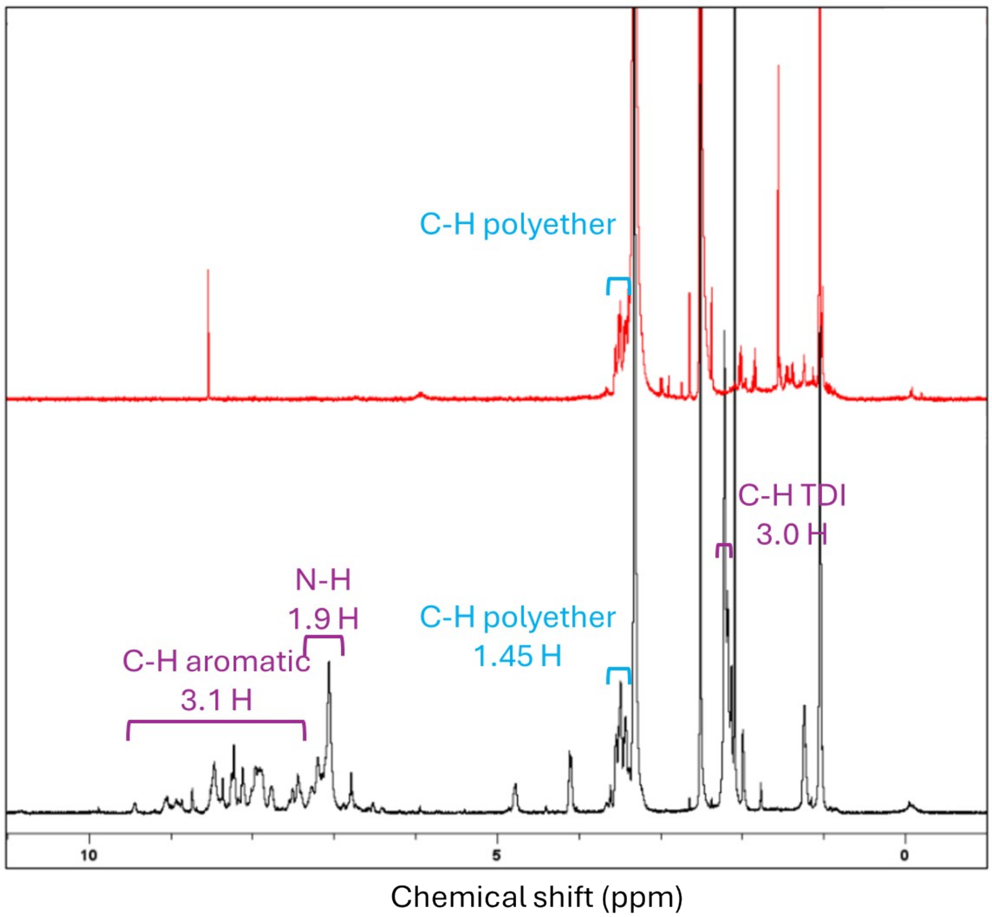

Figure S10. [1]H-NMR of PUD residue from the washes (top) and PUD (Bottom). PUD contains C-H aromatic, C-H aliphatic, and N-H peaks with shifts and integrations that are strongly characteristic of TDI based polyurethanes. Polyether is present in PUD and the residue from the washes. The polyether segment that is fragmented can be retrieved from the washes and isolated easily through centrifugation for further processing if it is desirable to retrieve the valuable polyether segment for further chemical processing.

Calculations to assess loading efficiency by TGA char weights.

A system of equations was set up to predict the loading efficiency of PU onto GO based on the char weights of each material. Several assumptions were made to produce these estimates: 1) the component parts of each PU-GO material, PUD and GO_{NP}, retain the relative char weights of their isolated forms, and 2) PUD and GO_{NP} components make up the entirety of the PU-GO composites.

(Eq S1) $$X_G + X_P = 1.0$$

(Eq S2) $$C = 0.783(X_G) + .152(X_P)$$

Where X_G and X_P are the mass percent components of GO_{NP} and PUD in the PU-GO composite, respectively. C is the char weight percent of the PU-GO material. 0.783 and 0.152 are constants obtained from the char weight percentages of GO_{NP} and PUD, respectively. The final equation for mass percent of GO_{NP} is:

(Eq S3) $$X_G = -0.241 + 1.585(C)$$

Which can be used to find the mass percent of PU:

(Eq S4) $$X_P = 1 - X_G = 1.241 - 1.585(C)$$

Bragg's Equation.

(Eq S5) $$2d \cdot \sin(\theta) = n\lambda$$

Where d is the interplanar spacing of crystalline structures, θ is the incident angle of the x-ray beam, and λ is wavelength of the incident x-rays. λ is 1.528 angstroms for the Cu probe used in this study.

References

(1) Mettler Toledo. Simple Determination of the Thermal Conductivity of Polymers by DSC.
(2) Hummers, W. S.; Offeman, R. E. Preparation of Graphitic Oxide. *J. Am. Chem. Soc.* **1958**, *80* (6), 1339–1339. https://doi.org/10.1021/ja01539a017.
(3) Holt, B. D.; Arnold, A. M.; Sydlik, S. A. In It for the Long Haul: The Cytocompatibility of Aged Graphene Oxide and Its Degradation Products. *Adv. Healthcare Mater.* **2016**, *5* (23), 3056–3066. https://doi.org/10.1002/adhm.201600745.