Supplementary Information

Stretchable and Skin-conformable Conductors Based on Polyurethane/Laser-Induced Graphene

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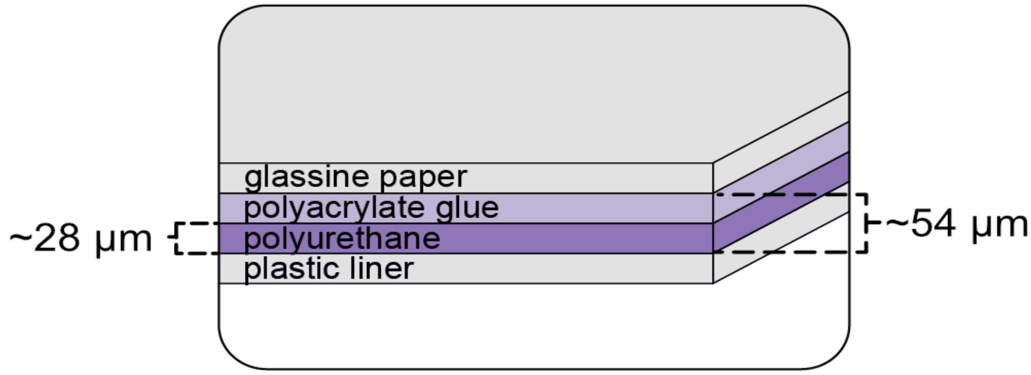

Figure S1. Schematics of MPU layers.

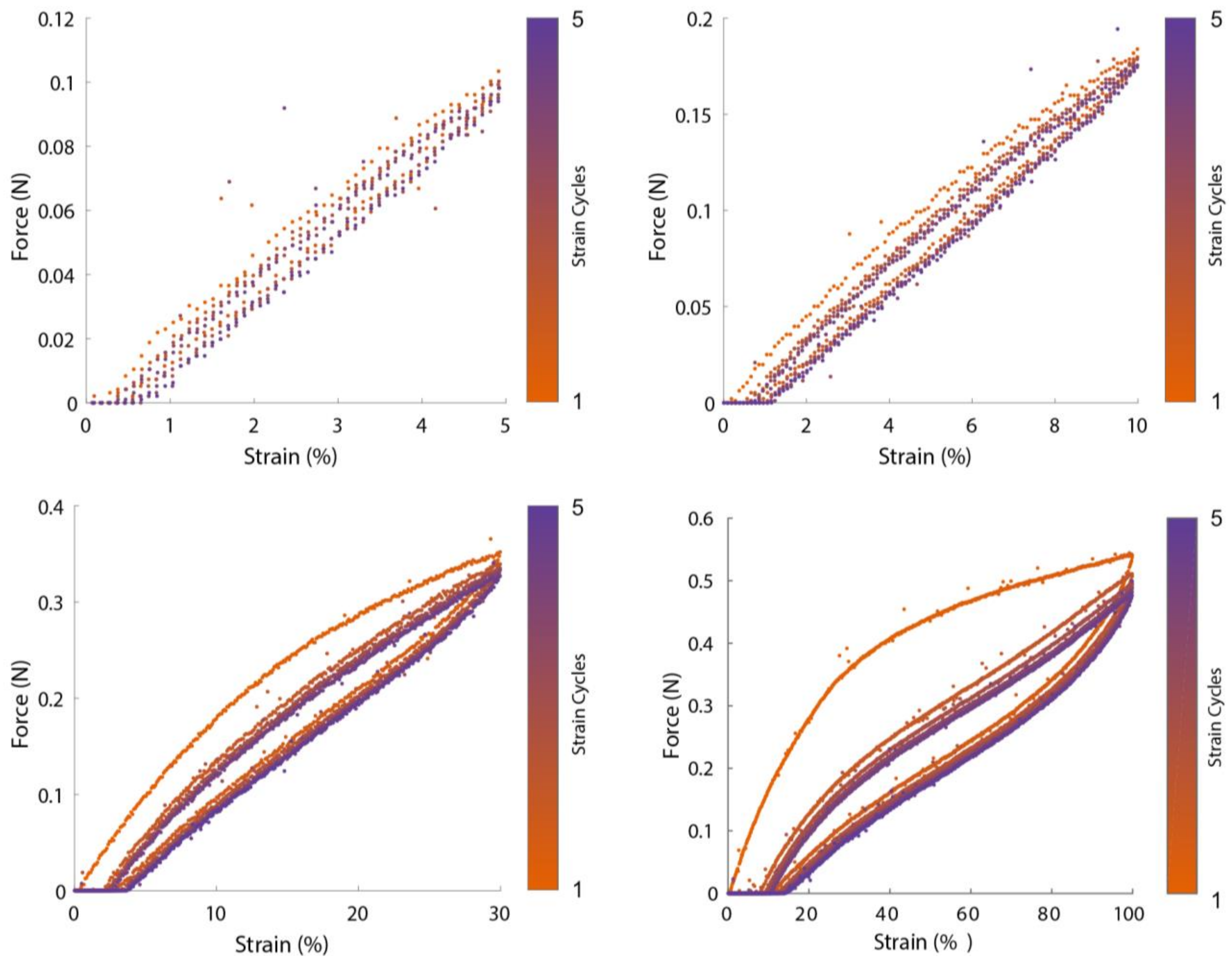

Figure S2. Force curves for MPU samples for 5%, 10%, 30% and 100% strain cycles repeated five times.

Table S1. Summary of properties of MPU.

Property	**Value**
Thickness	54±6 μm
Young's Modulus	(8.5 ± 0.3)MPa
Elongation at break	> 400%
WVTR[1]	564-648 $g/m^2/24$ h

[1] Water Vapor Transmission Rate (WVTR) provided by BSN medical.

Table S2. Summary of Raman spectra band parameters.

	LIG-F	LIG-P
G-band position/cm^{-1}	1587.3	1582.0
G-band width/cm^{-1}	56.2	55.4
G-band intensity/counts	98.8	99.4
D-band position/cm^{-1}	1344.6	1342.6
D-band width/cm^{-1}	77.7	57.8
D-band intensity/counts	85.4	105.1
D/G-ratio	0.86	1.06
2D-band position/cm^{-1}	2686.7	2682.0
2D-band width/cm^{-1}	97.7	99.9
2D-band intensity/counts	40.0	44.3

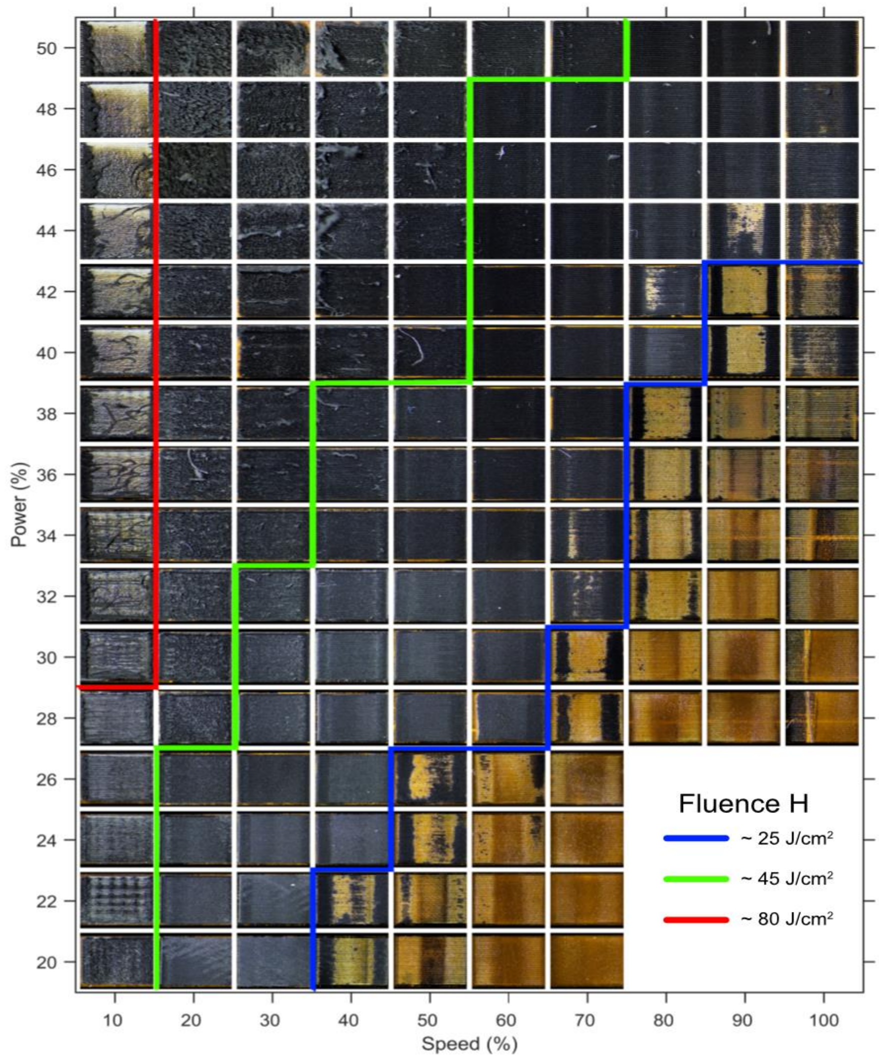

Figure S3. Map of LIG formation on PI influenced by laser power and speed parameters, resulting in different fluence H.

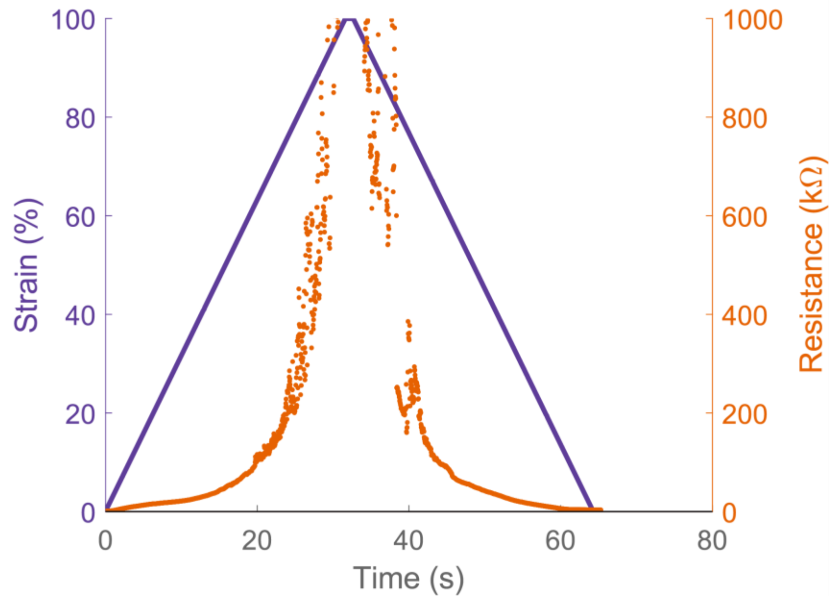

Figure S4. Stretching curve for LIG-P/MPU sample with a 100% strain/relaxation cycle and corresponding variation of electrical resistance, showing a reversible breakdown at around 60% strain (plot cut off at 1000 kΩ for better visibility).

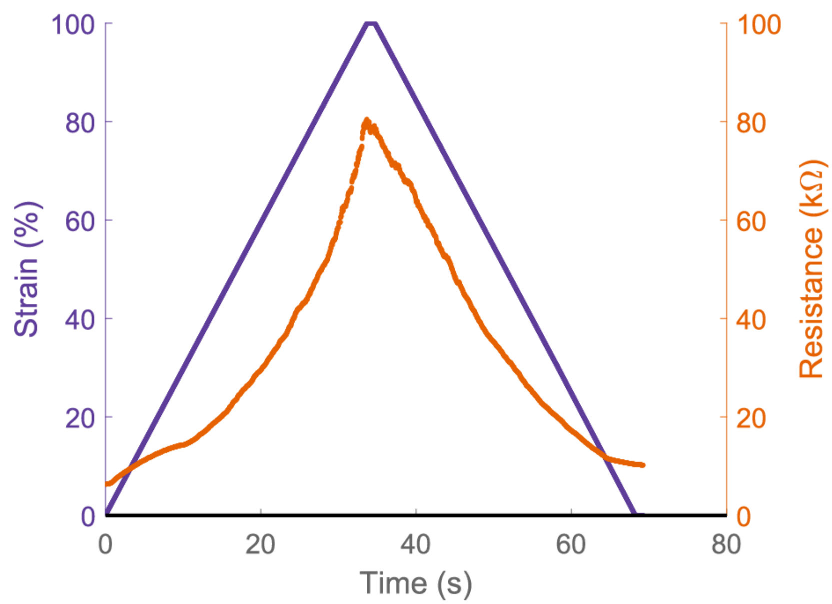

Figure S5. Stretching curve for LIG-F/MPU sample with a 100% strain/relaxation cycle and corresponding variation of electrical resistance, showing no breakdown during the full cycle.

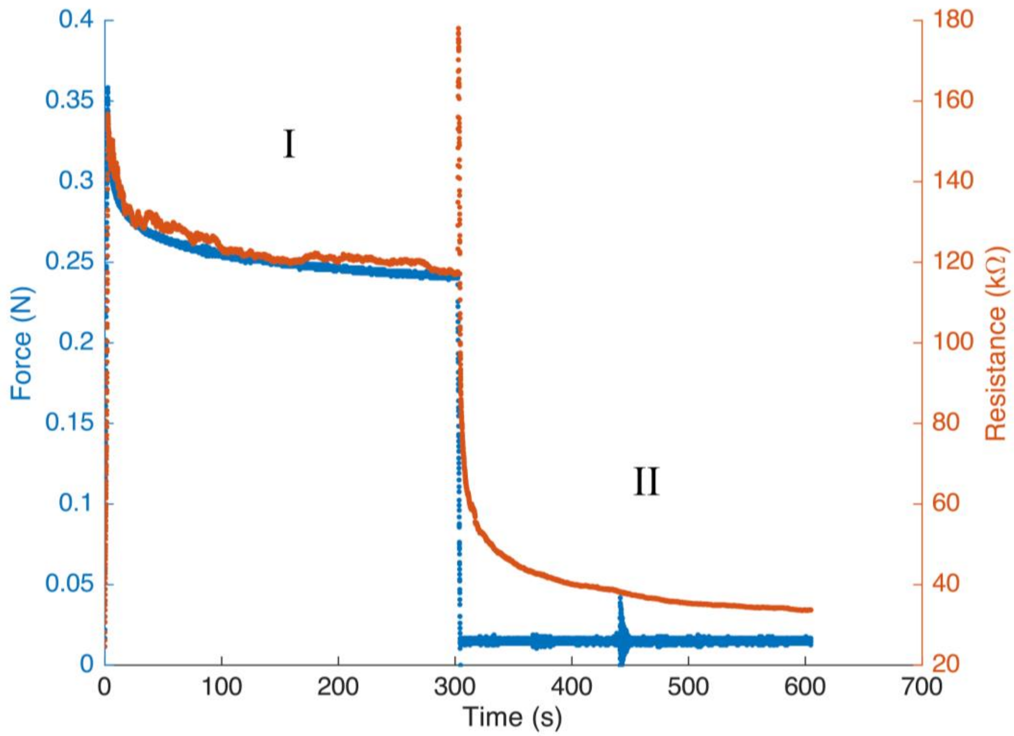

Figure S6. Stress relaxation curve from an applied 30% tensile strain on LIG-P/MPU, as used in fitting for the relaxation time constant for the I and II relaxations.

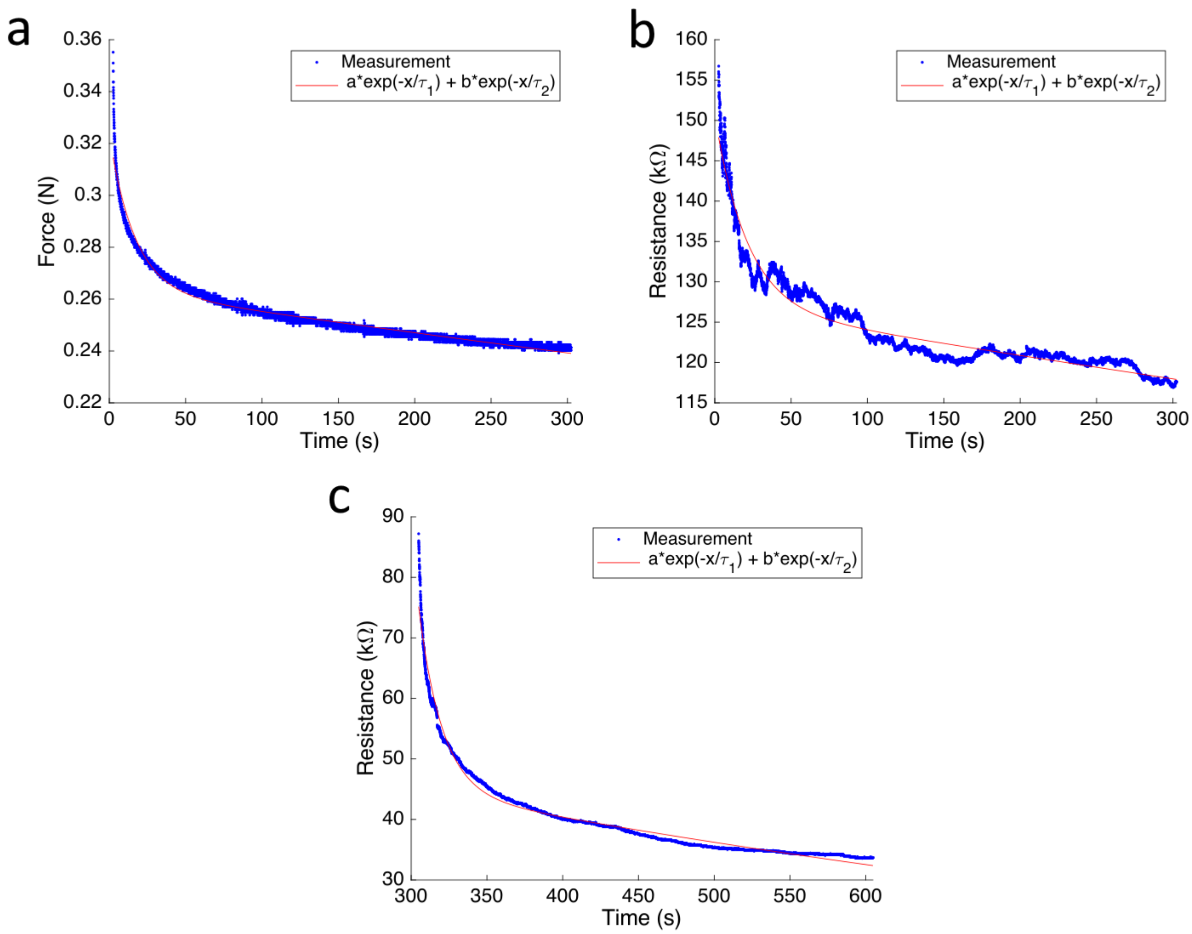

Figure S7. Fitting of (a) force and (b) resistance of I relaxation in Figure S6 and fitting of (c) resistance of II relaxation in Figure S6 with two exponential functions $(a \cdot e^{\frac{-x}{\tau_1}} + b \cdot e^{\frac{-x}{\tau_2}})$, resulting in a time constant τ_1 = 18.5 ± 2.8 s and τ_2 = 3100 ± 1400 s.

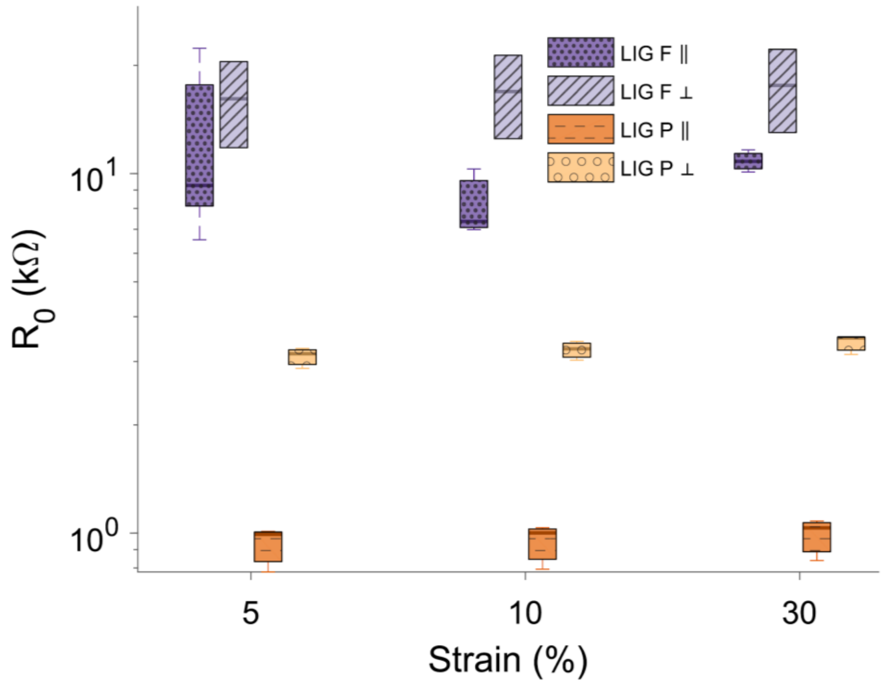

Figure S8. Starting resistance R_0 before each strain cycle for all LIG/MPU types.

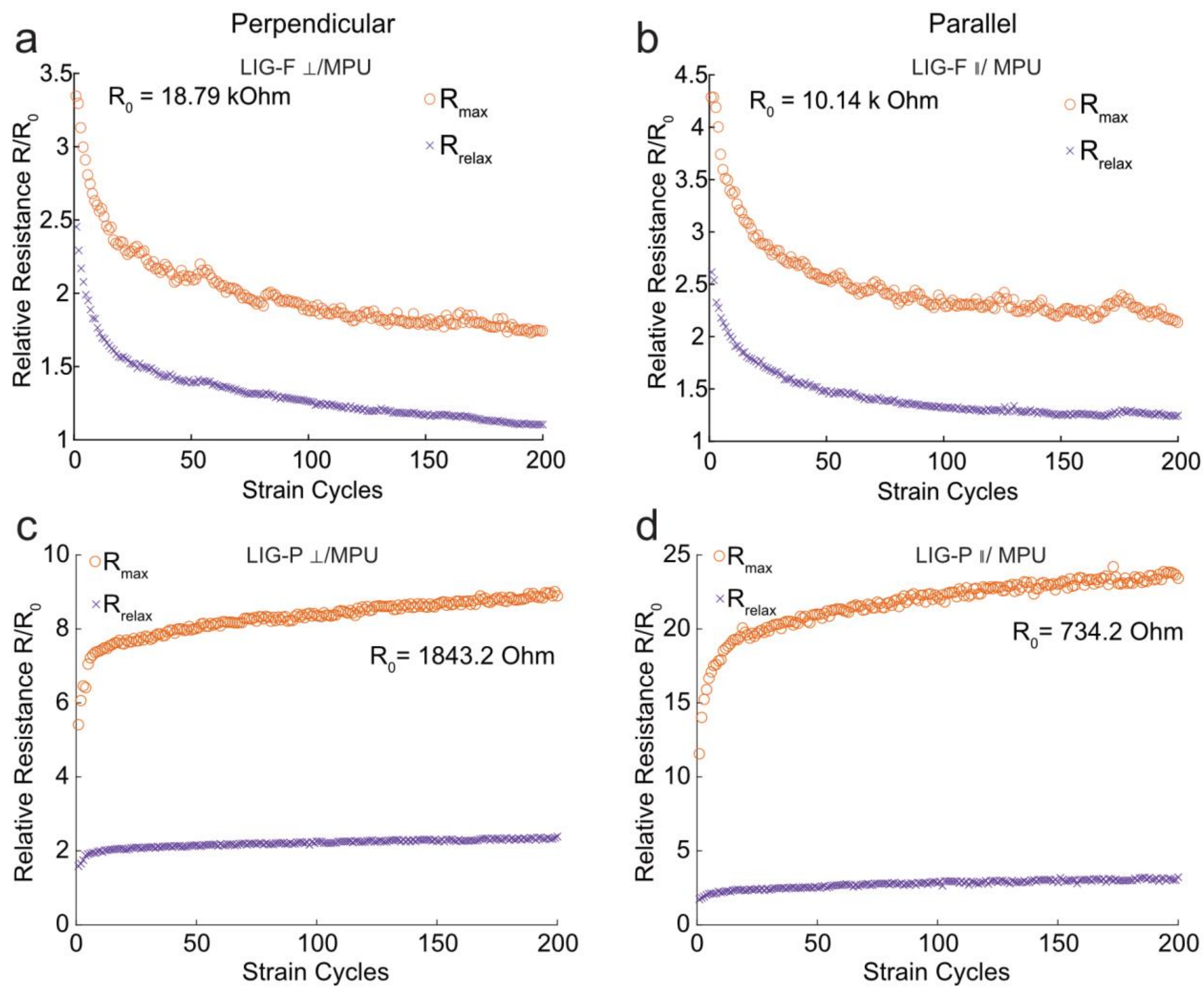

Figure S9. Change of maximum resistance R_{max} and relaxed resistance R_{relax} over 200 cycles of tensile testing at 30% strain in the case of a) LIG-F ⊥/MPU ($\phi = 90°$), b) LIG-F ∥/ MPU ($\phi = 0°$), c) LIG-P ⊥/MPU ($\phi = 90°$) and d) LIG-P ∥/MPU ($\phi = 0°$).

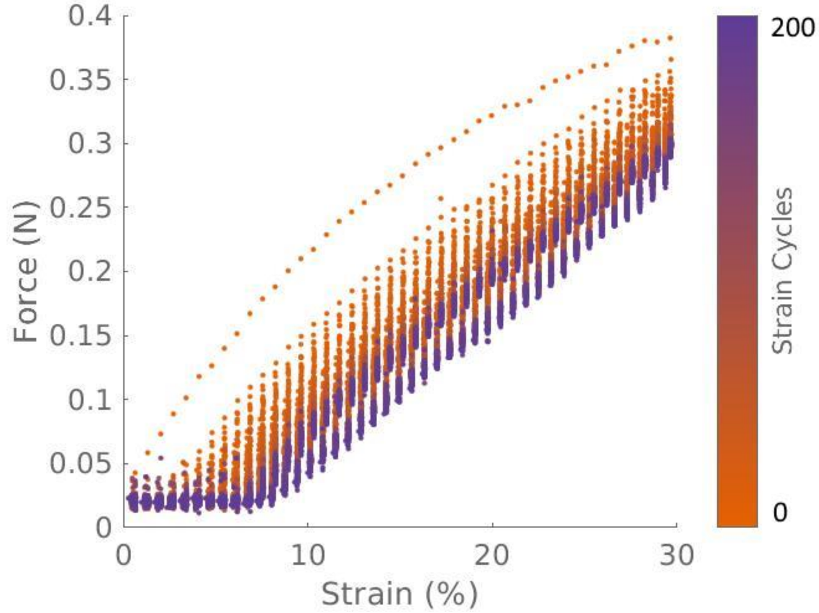

Figure S10. Force curve of MPU sample with a strain cycle of 30% imposed 200 times extracted from Figure S9.

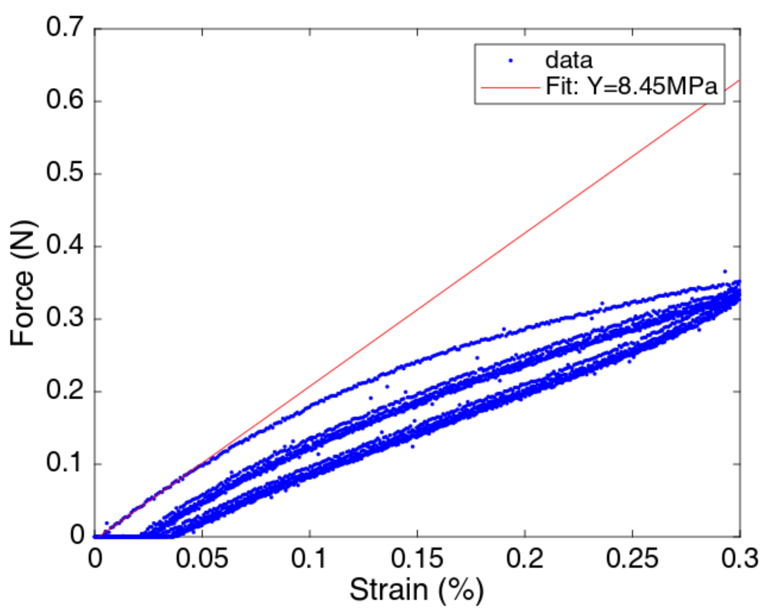

Figure S11. Fitting of Young's Modulus (Y = 8.5 ± 0.3 MPa) for LIG-F/MPU with 30% strain.

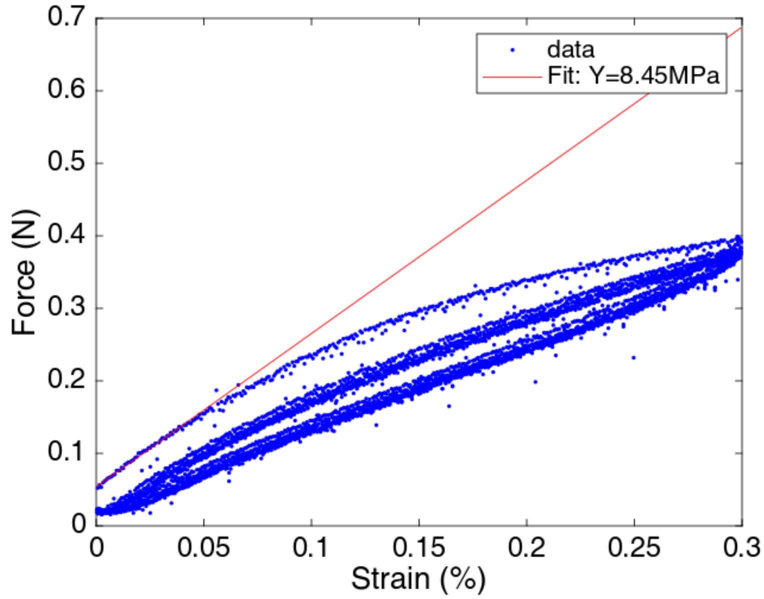

Figure S12. Fitting of Young's Modulus (Y = 8.5 ± 0.3 MPa) for MPU with 30% strain.

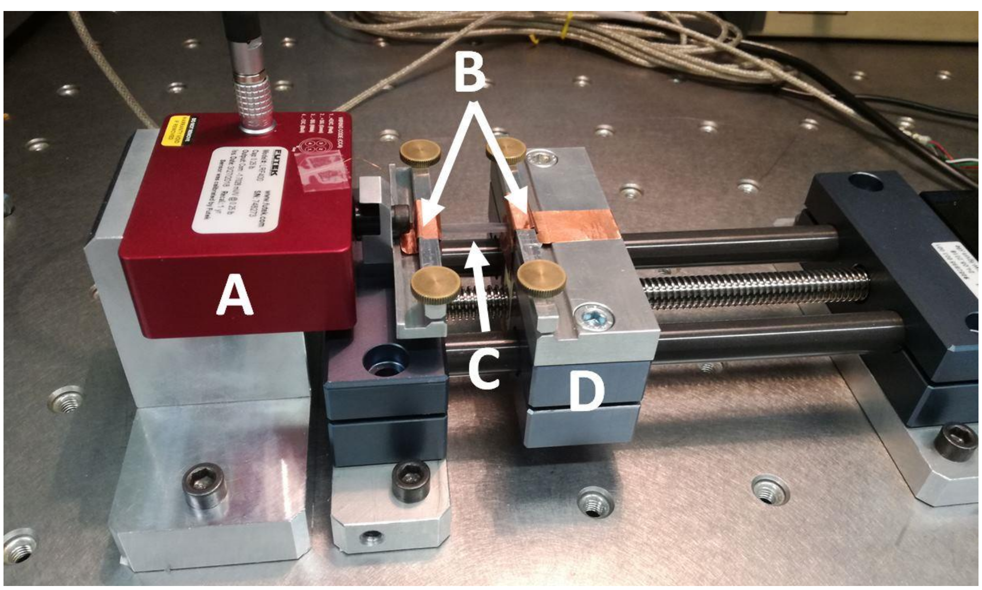

Figure S13. Custom tensile testing setup for mechanical and electrical characterization showing (A) load cell, (B) electrical contacts, (C) sample, (D) movable stage.

Calculation of laser fluence

The laser fluence H for each laser raster setting was calculated as

$$H = \frac{P \cdot P_{max}/100}{s \cdot v \cdot PPI} \qquad \text{(S1)}$$

where P is the set laser power (%) with respect to the maximal laser power P_{max}= 30 W, s is the theoretical laser spot size determined according to gaussian beam theory, v is the measured processing speed (depending on the sample size, v~ 110±10 mm/s) and PPI the raster resolution.