Supplementary Information for: Conducting Hydrogels for Edible Electrodes

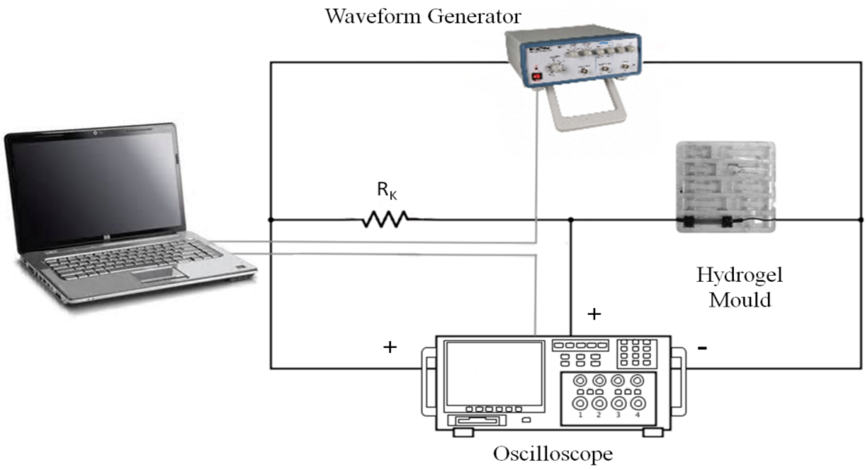

Figure S1 Schematic representation of the custom designed impedance analyser, R_k is a known resistor.

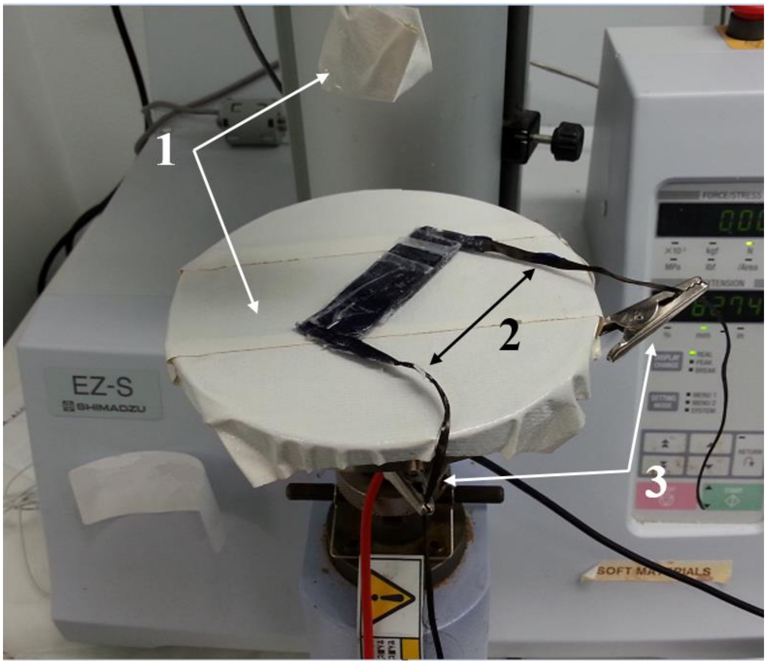

Figure S2 Setup for analysis of capacitive pressure sensor. **1.** Duct tape is used to insulate compressive plates. **2.** Carbon fibre used to connect hydrogel to multimeter clips. **3.** Alligator clips to connect the device to digital multimeter.

Table S1 Mechanical and electrical properties for gellan gum/gelatin ICE gels using different %w/w concentrations of Ca^{2+} crosslinkers at 21 °C. σ_c, ε_t, E_c, U and σ indicate compressive stress at failure, compressive strain at failure, secant modulus (20%-30%), strain energy to failure and conductivity, respectively.

Ca^{2+} (%w/w)	*0.4*	*0.8*	*2*	*4*	*8*	*20*
σ_c (MPa)	0.3 ± 0.1	0.5 ± 0.1	1.0 ± 0.2	0.9 ± 0.2	0.5 ± 0.1	0.11 ± 0.01
ε_t (%)	78 ± 6	79 ± 2	84 ± 3	82 ± 2	69 ± 4	36 ± 1
E_c (MPa)	0.16 ± 0.01	0.15 ± 0.02	0.15 ± 0.02	0.14 ± 0.01	0.29 ± 0.03	0.33 ± 0.04
U ($kJ.m^{-3}$)	70 ± 20	90 ± 10	130 ± 30	130 ± 20	100 ± 20	18 ± 2
σ (mS/cm)	1.2 ± 0.1	1.3 ± 0.1	1.5 ± 0.1	1.8 ± 0.1	4.4 ± 0.6	13.0 ± 0.4

Table S2 Mechanical and conductive properties for gellan gum/gelatin ICE gels using different %w/w concentrations of Na^+ crosslinkers at 21°C.

Na^+ (%w/w)	*25*	*50*	*70*	*80*	*100*
σ_c (MPa)	0.5 ± 0.1	0.27 ± 0.02	0.17 ± 0.03	0.19 ± 0.05	0.15 ± 0.03
ε_t (%)	75 ± 1	59 ± 5	45 ± 3	47 ± 5	44 ± 3
E_c (MPa)	0.32 ± 0.03	0.40 ± 0.03	0.38 ± 0.03	0.39 ± 0.08	0.31 ± 0.06
U ($kJ.m^{-3}$)	110 ± 10	65 ± 5	35 ± 5	40 ± 10	29 ± 4
σ (mS/cm)	10 ± 1	22 ± 1	31 ± 2	34 ± 3	83 ± 7

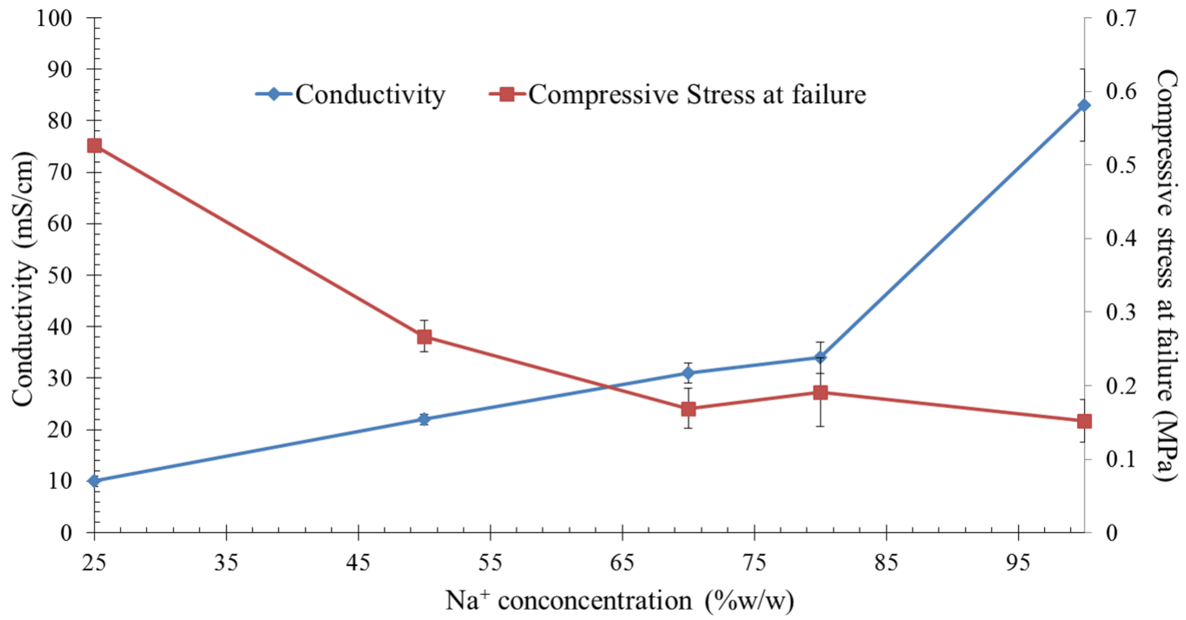

Figure S3 Summary of conductivity and compressive stress at failure as a function Na^+ %w/w concentration at 21°C. Data from Table 5.

Statistical modelling of noise

Limit of detection (*LOD*) is the reduced value at which the signal is roughly three times the noise.[51] An increase in capacitance above the *LOD* is said to be a result of external pressure and not from background fluctuations. Calculation of *LOD* for the capacitance pressure sensor was determined as follows:

$$LOD = 3 \times RMSD, \qquad (1)$$

where *RMSD* is the root mean square deviation, and is determined by comparing experimental noise to a modelled noise. Modelled noise was calculated by fitting a 5th order polynomial function to experimental data.[1] The *RMSD* was calculated using equation 2.

$$RMSD = \sqrt{\frac{\sum_{t=1}^{n}(y-\bar{y})^2}{n}}, \qquad (2)$$

where, *RMSD* is the root mean square of deviation, *y* is the experimentally recorded capacitance at time (*t*), $\bar{y}$ is the model's capacitance at time (*t*) and *n* is the number of data points used.

Using equations 1 and 2 to analyse the generated data, Figure S4, the average LOD for three different pressure sensors was established as 7 ± 2 pF. This capacitance change corresponds to an average pressure of 1.3 ± 0.4 kPa.

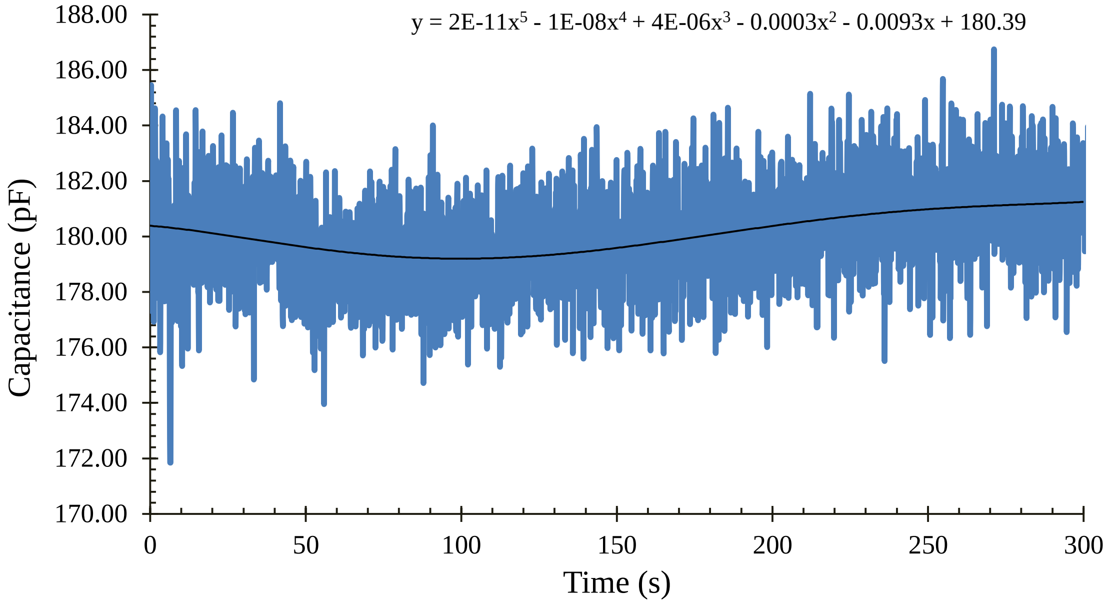

Figure S4: Capacitance reading of a typical sensor under ambient conditions with no applied force. Solid line is a fifth order polynomial fit to the data.

Supplementary References:

1. Small, W. R. & in het Panhuis, M. Inkjet Printing of Transparent, Electrically Conducting Single-Walled Carbon-Nanotube Composites. *Small* **3**, 1500–1503 (2007).