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Supporting Information

Facile Fabrication of Highly-Stretchable, Low-Hysteresis and Notch-Insensitive Ionogels for Strain Sensors

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EXPERIMENTAL METHODS

Characterization. Microscope photography was conducted using an Olympus BX-53M instrument, and subsequent image analysis was performed with Image J. Fourier transform infrared (FT-IR) spectra were acquired employing a Nicolet 670 spectrometer equipped with an attenuated total reflectance accessory. Thermal gravimetric analysis (TGA) was executed using a TG 209 F1 under an N_2 atmosphere, ramping from room temperature to 600 °C at a heating rate of 10 °C min^{-1}. The electrical conductivity of the ionic conductive elastomer was assessed through a four-point probe resistivity test using the 4-Point probe resistivity measurement system (RTS-8).

The mechanical properties of the samples were assessed using an electronic universal testing machine (SUNS UTM2000) at room temperature. Tensile measurements involved stretching strip-shaped ionogel samples (100 × 10 × 1 mm^3) at a strain rate of 50 mm min^{-1}. Rheological measurements were conducted employing an advanced rotary rheometer (Anton Paar, MCR302, Austria) at room temperature. The investigation was conducted over a range of angular frequencies (ω) from 0.1 to 100 rad s^{-1} while maintaining a constant oscillatory strain of 1%. Additionally, the temperature-dependent rheological characteristics were examined from 5 to 100 °C, with a heating-cooling rate of 10 °C min^{-1}. These measurements were performed at fixed angular frequency and oscillatory strain values of 10 rad s^{-1} and 1%. The dynamic mechanical behavior of the DMCl samples was also studied at various temperatures, employing angular frequencies ranging from 0.1 to 100 rad s^{-1} and a fixed oscillatory strain of 1%.

Dissipated energy (ΔU) for DMCl was calculated as:

$$\Delta U = \int_{loading} \sigma d\varepsilon - \int_{unloading} \sigma d\varepsilon$$

Loss coefficient (η) of the DMCl was evaluated as:

$$\eta = \frac{\Delta U}{U} \times 100\%$$

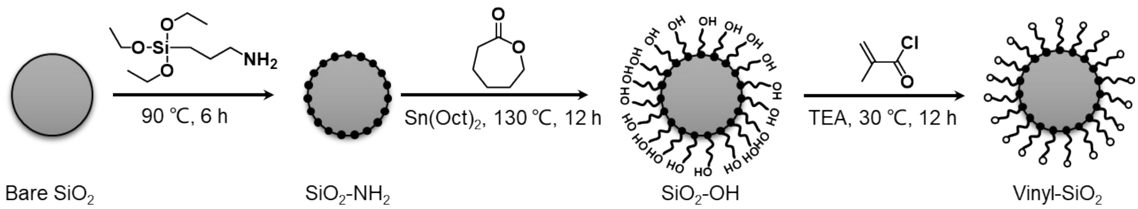
Fabrication and characterization of the DMCI-based sensor. The DMCI-based sensor was constructed using a strip-type ionogel (100 × 10 × 1 mm^3) affixed with two pieces of copper foil (each measuring 10 × 5 mm^2) at both ends of the ionogel, functioning as collectors. Simultaneously, copper wires were connected to the copper foil to establish the link between the sensor and the source meter. Sensing performance was evaluated through the collaboration of a universal testing machine and the source meter (Keithley, 2612B). The relative resistance changes and gauge factor (GF) of the sensor were calculated using the following formulas:

$$\Delta R/R_0\ (\%) = \frac{R - R_0}{R_0} \times 100\%$$

where R_0 and R were the resistance without strain and the real-time resistance under the stretch, respectively.

$$GF = \frac{R - R_0}{R_0} \Big/ \varepsilon$$

where ε was the applied strain.



Scheme S1. Synthesis of surface vinyl modified silica Vinyl-SiO_2.

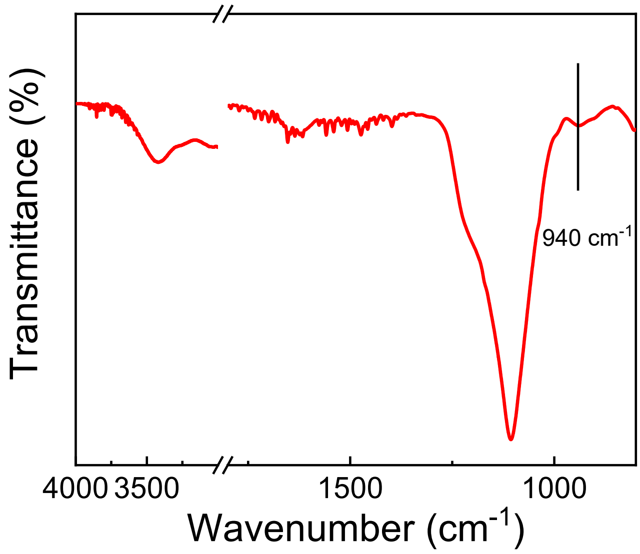


Fig. S1 FT-IR spectra of Vinyl-SiO_2.

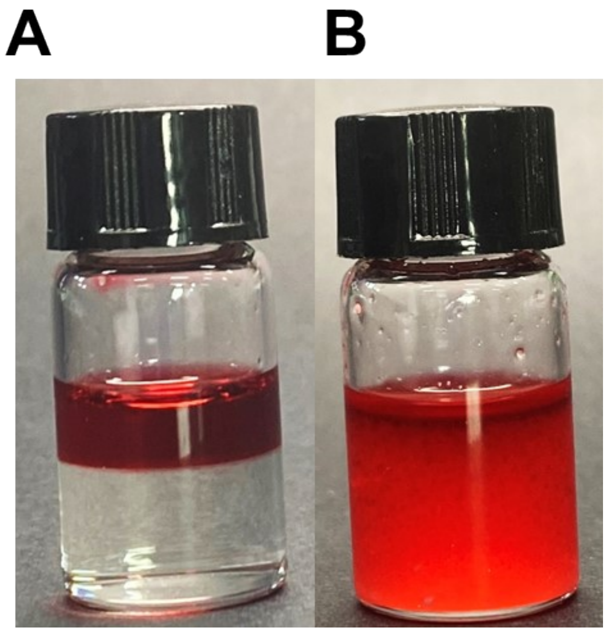


Fig. S2 Digital photos of the **(A)** layered mixture and the **(B)** pickerling emlusion.

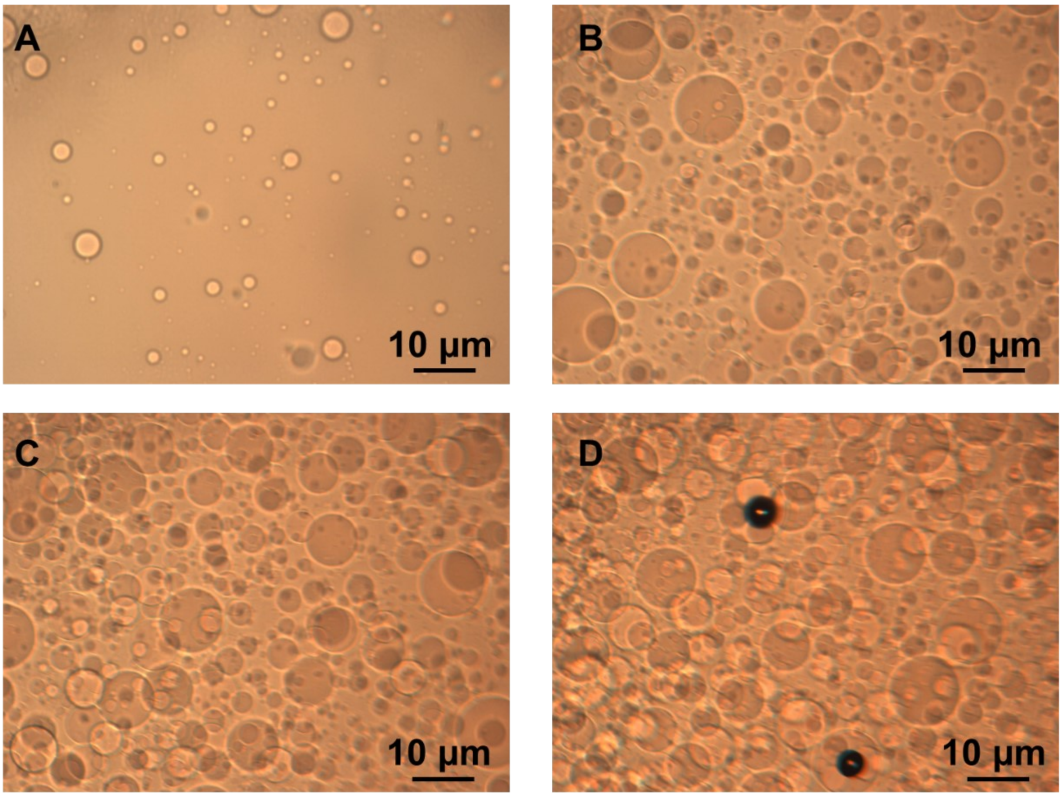


Fig. S3 Optical micrographs of Pickering emulsions with **(A)** DMCl-0%, **(B)** DMCl-1%, **(C)** DMCl-2% and **(D)** DMCl-3% after 30 minutes.

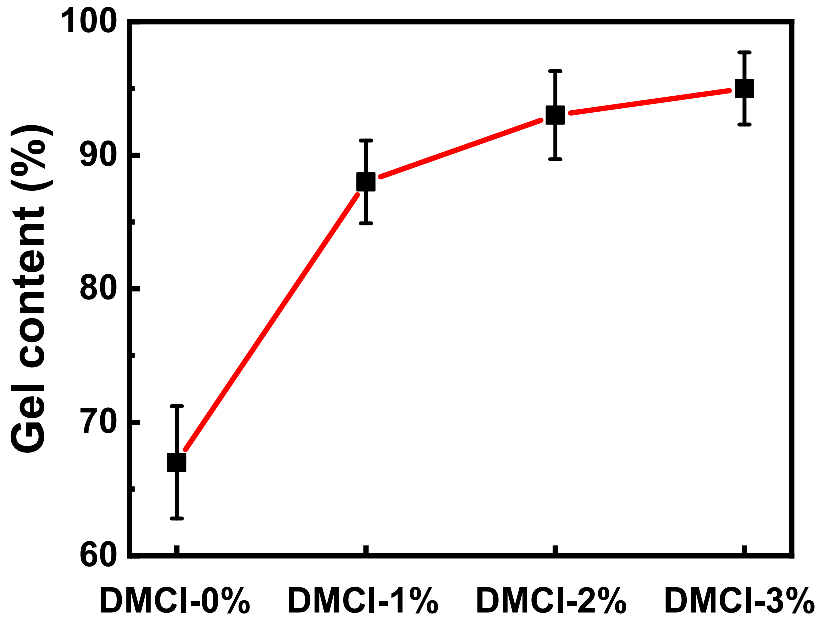


Fig. S4 The gel contents of the polymer networks with different Vinyl-SiO2 contents.