

Supporting Information

Novel Biopolymer Pectin-based Hydrogel Electrolytes for Sustainable Energy Storage

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Notes on “Homogenous” Gel Formation

Gels were determined to be “homogenous” by the following process:

1. While stirring the alcohol + pectin solution, add the aqueous salt solution.
2. After heating above 50 degrees Celsius, the small pectin particles begin to disappear into the liquid (they do not dissolve, but absorb, the water) and it becomes significantly more viscous.
3. While there is typically a noticeable color change, the pectin particles should almost fully disappear into the liquid, creating a translucent fluid.
4. Manual stirring with a glass stir rod may be needed to fully combine the two solutions as the viscosity can increase dramatically on combination and heating.

The time (depending on temperature, heating rate, salt content, and mixing) to full gelation is typically anywhere from mere seconds to 15 minutes.

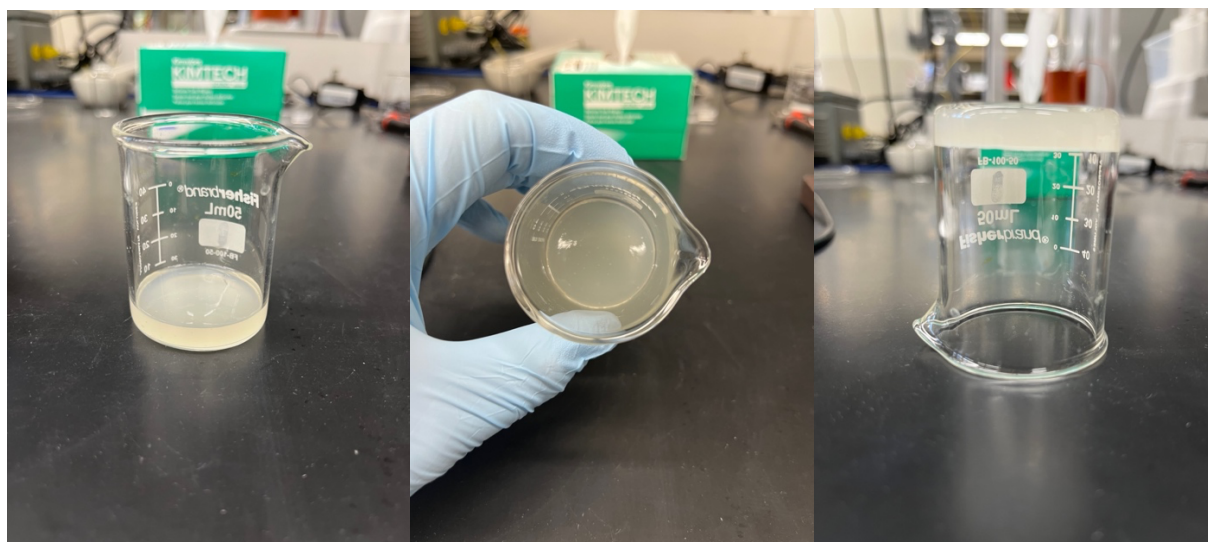


Figure S1. The three pictures included show both the homogenous nature of the gel and that the definition of a “gel” is fulfilled (the container being inverted does not allow the substance to flow).

Notes on Electrochemical Test Cell Setup

The electrochemical cells were housed by a rectangular, polystyrene, open top, 10 mm pathlength and 3.5mL volume cell (Agilent Technologies). Each gel was formed in a new cell, and nickel blocking electrodes were cleaned with isopropanol between uses.

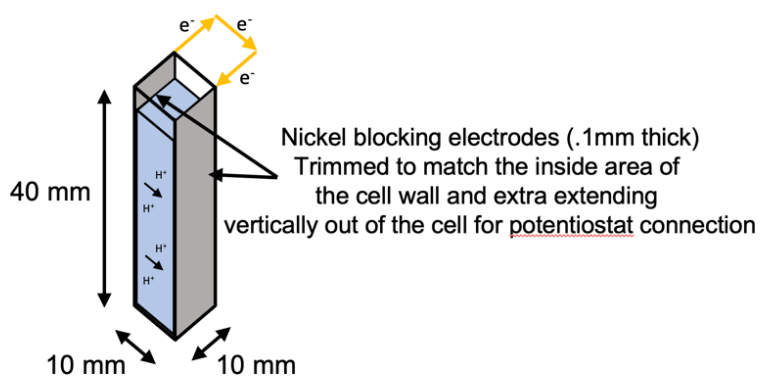


Figure S2. Schematic representation of the electrochemical cell setup. Alligator clips connected each electrode to the potentiostat for electrochemical measurements.

Notes on Supercapacitor Coin Cell Setup

Activated carbon, acetylene black (CB, purity >99.9%, Alfa Aesar), and polyvinylidene difluoride (PVDF, HSV900, MTI corporation), were each dried at 80 °C for one day (Across International oven) and carbon was ground into a fine powder by zirconia spheres (1/4 in., Uxcell) at 1500 rpm for 5 minutes in a Speed Mixer (FlackTek, Inc., DAC150.1FVZ) before mixing as a slurry. The slurry was spread on Nickel foil (0.01 mm thick, MSE supplies) with a doctor blade (KTQ-II, LianDu-US), and dried at 60 °C and 25 inHg gauge pressure overnight (about 24 hr). Details on the fabrication of the supercapacitor are proved by Jafari and Botte¹.

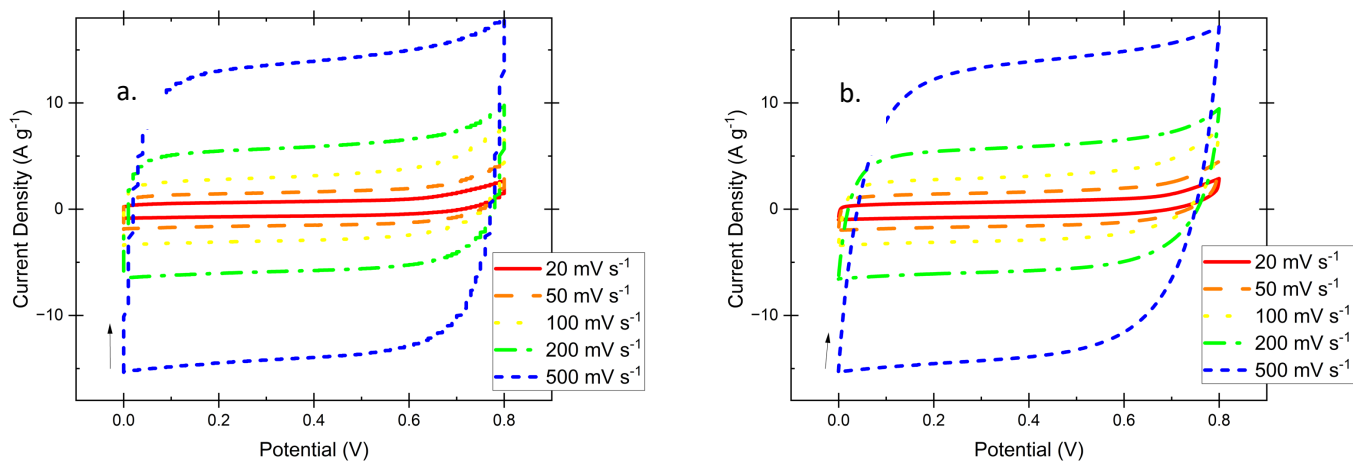


Figure S3. Cyclic voltammetry measurements at a range of measurement speeds before (a) and after (b) 5000 GCD cycles at 10 A g^{-1} displaying the less-ideal deviation from a box shape as well as a small amount of area lost under the curve, translating to lost current efficiency over that cycling range. Each curve represents a relaxed periodic state on the 5th cycle of each when measured from 0V to 0.8 V.

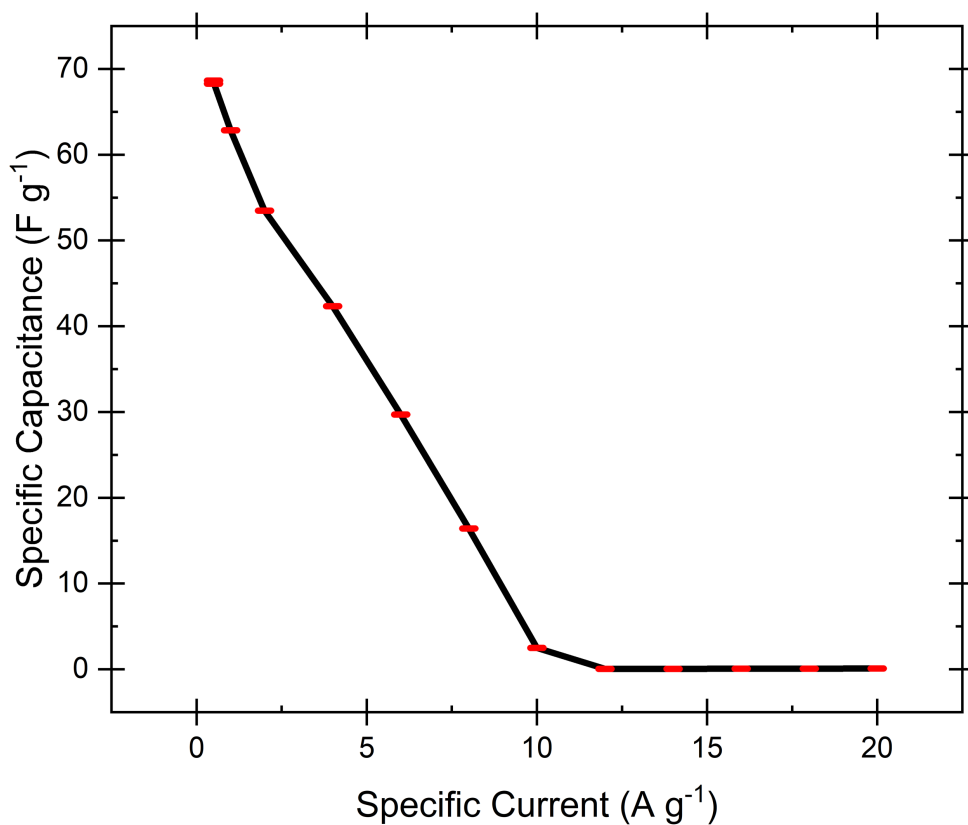


Figure S4. Represents the calculated specific capacitance of the supercapacitor by GCD testing over a range of specific currents with error bars representing the deviation between each of the first 5 charge-discharge cycles. This was calculated from GCD measurements before the 5000 cycle test.

References

1. M. Jafari and G. G. Botte, *ACS Omega*, 2024, **9**, 13134-13147.