Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics

Field effect transistors and RC filters from pencil-trace on paper

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Electronic Supplementary Information (ESI)

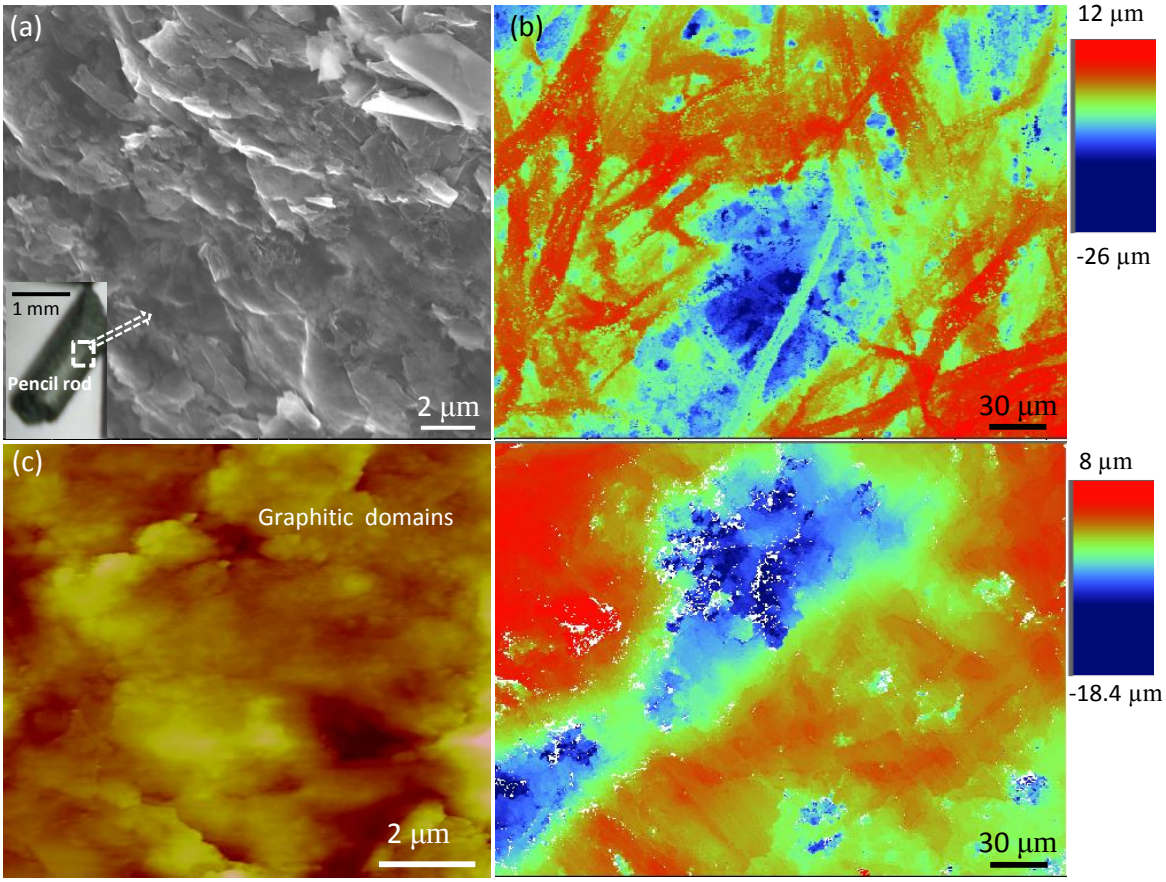

Fig. S1 (a) SEM image showing the surface morphology of the pencil rod (inset shows the optical micrograph of the pencil rod). (b) Optical profilometric image showing the cellulose fibres of the plane paper surface (c) AFM topography and (d) optical profiolometric images of the pencil trace on the paper.

Surface profiling of the paper and pencil-trace was performed using Wyko NT1100 optical profiler (Veeco, USA). AFM imaging was done on a diInnova SPM (Veeco, USA) using Si probes (model, RTESPA, spring constant 40 N/m) in tapping mode.

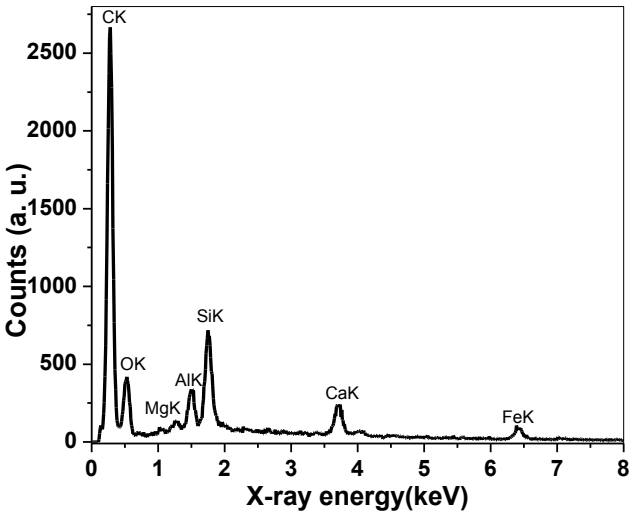

Fig. S2 Energy dispersive x-ray spectrum (EDAX) of the pencil trace on paper, showing the presence of inter mixed metal oxide particles in the form of (Si, Al, Mg, Ca, Fe, O) clay in the graphite matrix.

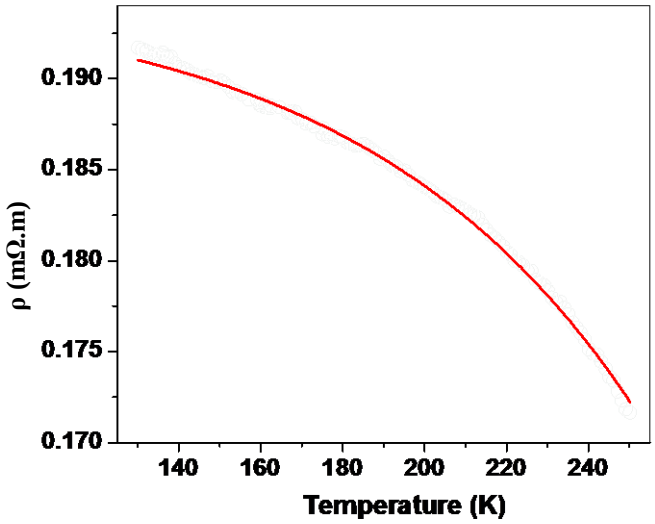

Fig. S3 Resistivity of the pencil-trace varying as $\rho \sim \exp((-T_0/T))$ above 100 K, where T_o is constant, T is the temperature.

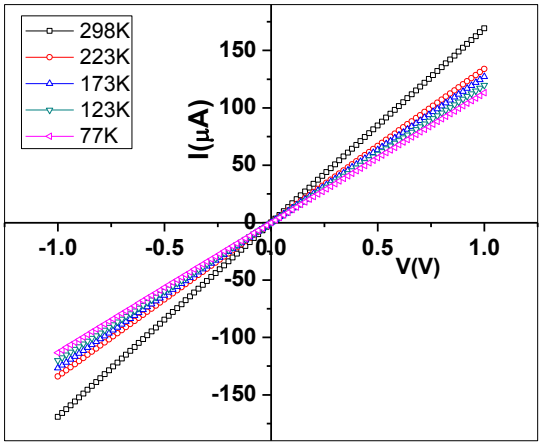

Fig. S4 I-V of the pencil-trace at different temperatures.

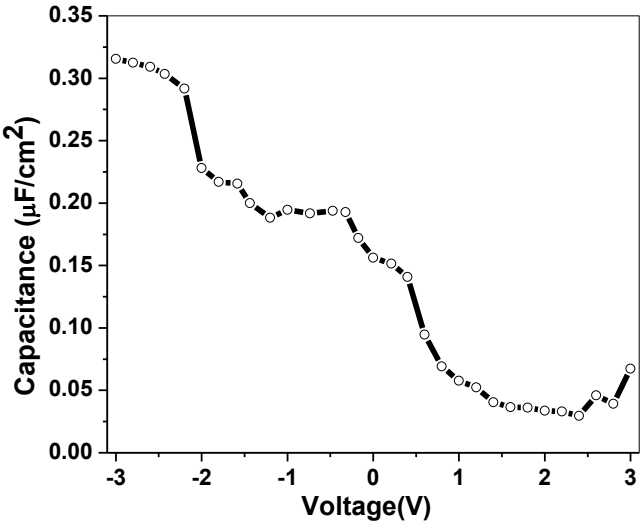

Fig. S5 Specific capacitance-voltage characteristics of the ion gel at frequency of 1 Hz.

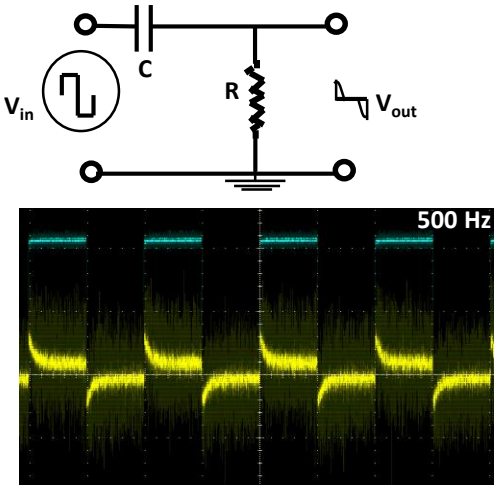

Fig. S6 RC differentiator circuit and the voltage response at 500 Hz. Sky blue curve is the input signal and yellow curve is for the output signal.

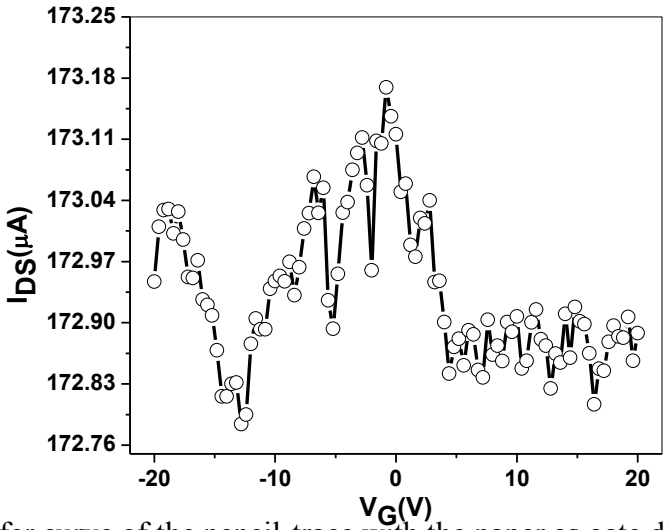

Fig. S7 Transfer curve of the pencil-trace with the paper as gate dielectric, no field effect was observed.

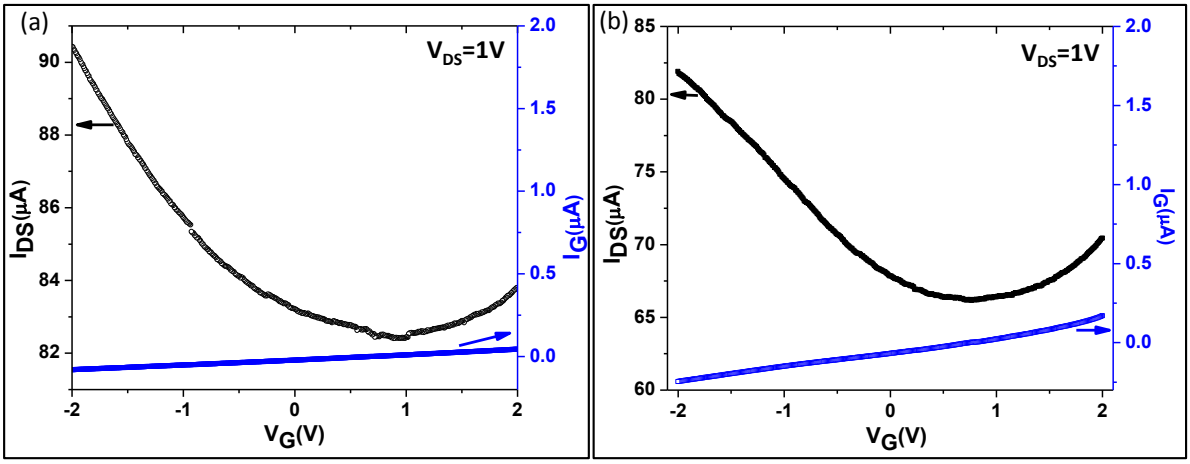

Fig. S8 (a) and (b) Transfer curves of the pencil traces on the paper with ion gel as top gate dielectric. (hole and electron mobilities are found to be $\mu_h \sim 81$, 112 and $\mu_e \sim 63$, 69 cm^2/Vs for (a) and (b) respectively).

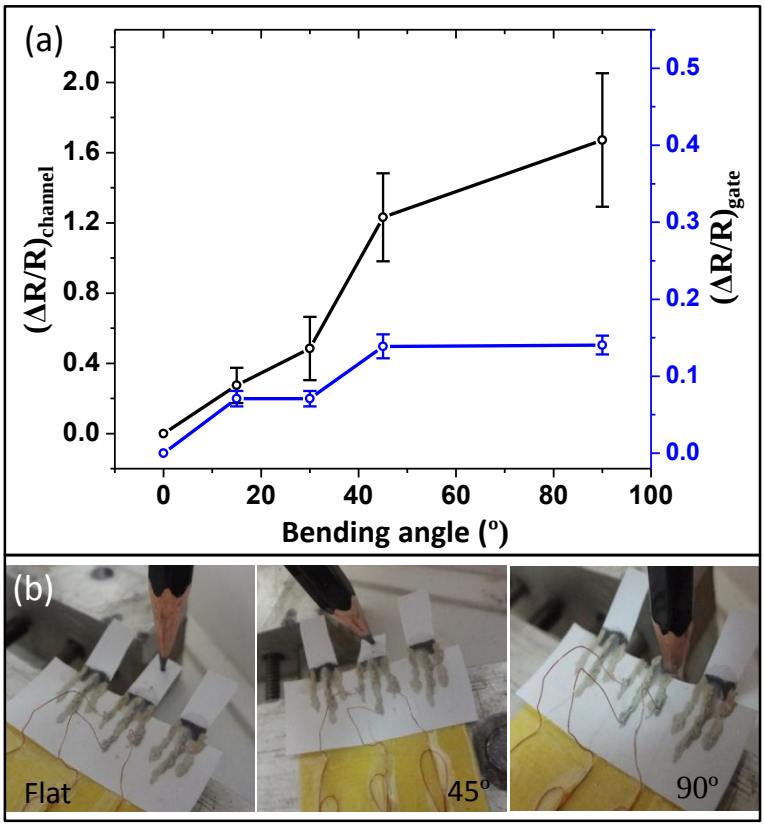

Fig. S9 (a) Normalised resistance changes in the channel and the gate with respect to bending. The associated error bars are included. (b) Photographs showing the extent of bending.

The changes in the resistance of the channel and gate are normalised and plotted with respect to the bending angle in Fig. S9(a). It is observed that the resistance of the pencil mark changes significantly up to 160% at a maximum bending angle of 90º (see Fig. S9(b)). The gate resistance, however, changes only up to 15% at a bending angle of 90º. Clearly, the ion gel dielectric is stable against substrate bending. Thus, the flexible ion gel based dielectrics can be explored as components for fabricating flexible electronic devices.