A resistive sensor for humidity detection based on cellulose/polyaniline

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Supporting Information

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S1. COST ANALYSIS AND SET-UP

Table S1: cost analysis to produce 310,8 cm^2 of modified cellulose

material	Cost for batch (310.8 cm^2, USD)
Water	0.45
Bare cellulose fibers	negligible
Aniline	0.80
Cloridic acid (37%)	3.27
Ammonium persulphate	9.49
Citric acid	41.32
Aluminium sulphate	1.46
Tot	56.8

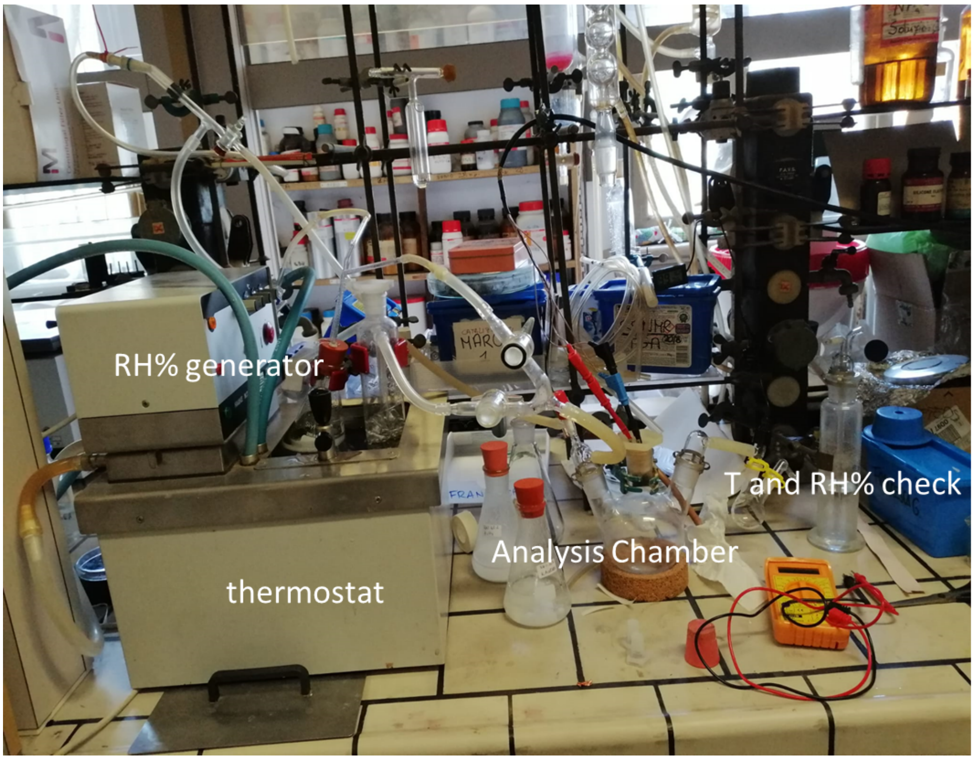

Fig. S1. Homemade set-up for humidity sensing. Analysis chamber of 500 cm^3.

S2. SENSOR CHARACTERIZATIONS

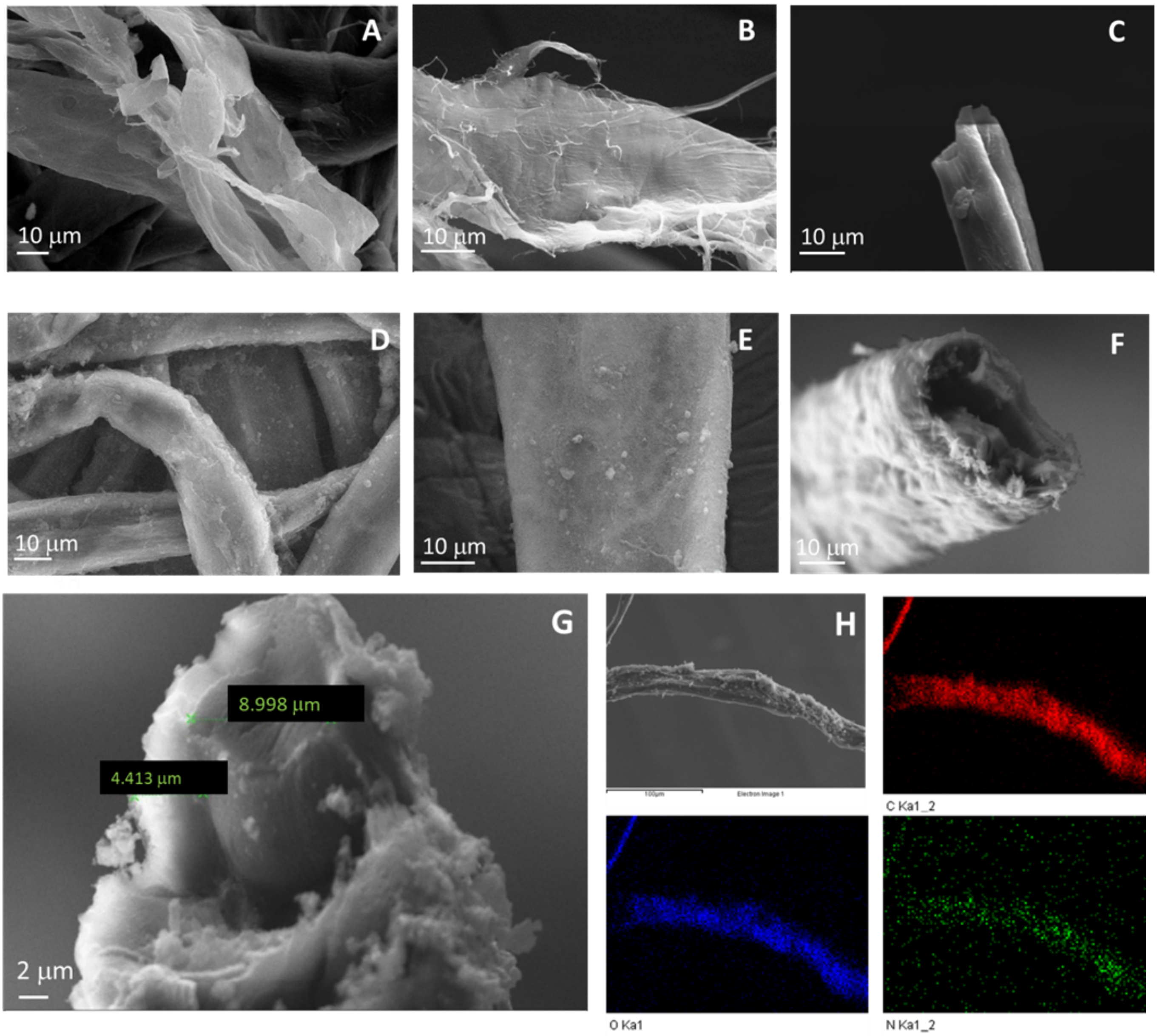

Fig. S2. Scanning electron microscopy (SEM) of: A-C) bare Cellulose and D-F) Cell/PANI fibers at different X magnifications; G) Cross-section of Cell/PANI fiber at 10000 X magnification and H) EDX elemental maps of a Cell/PANI fiber (C red, O blue, N green).

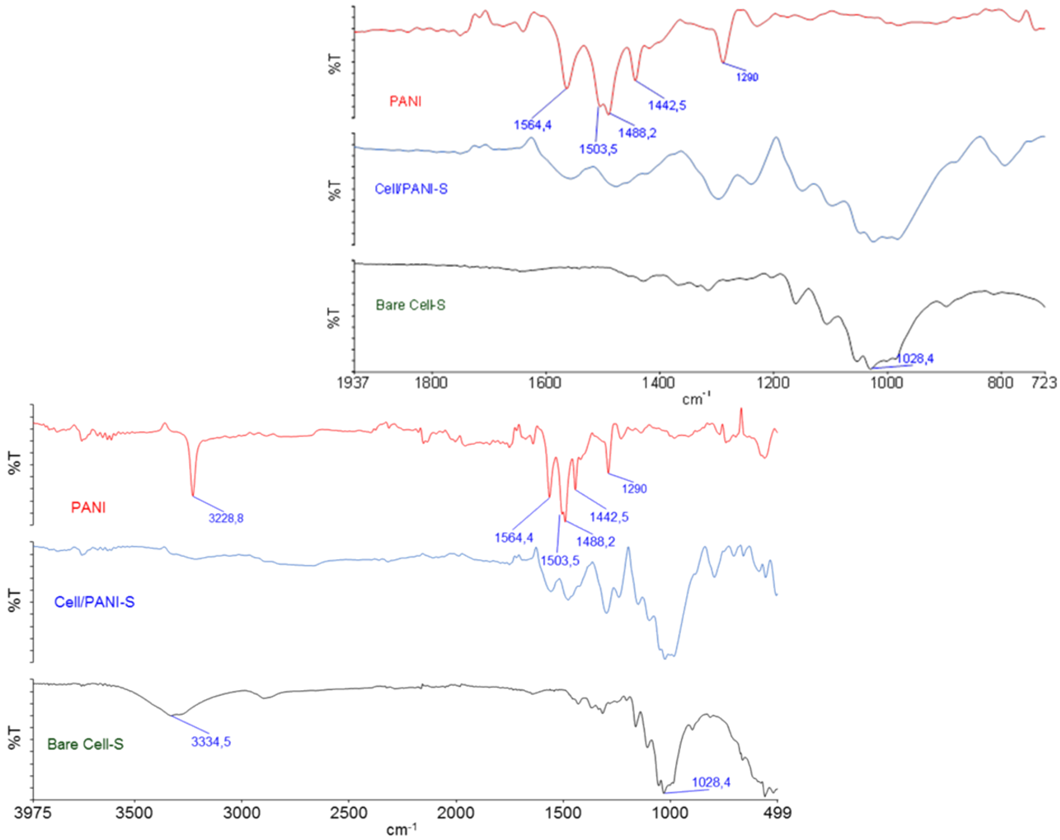

Fig. S3. ATR-FTIR spectra of bare Cellulose (black), PANI (red) and Cell/PANI-S (blue); inset: enlargement in the range 1900-700 cm^{-1}.

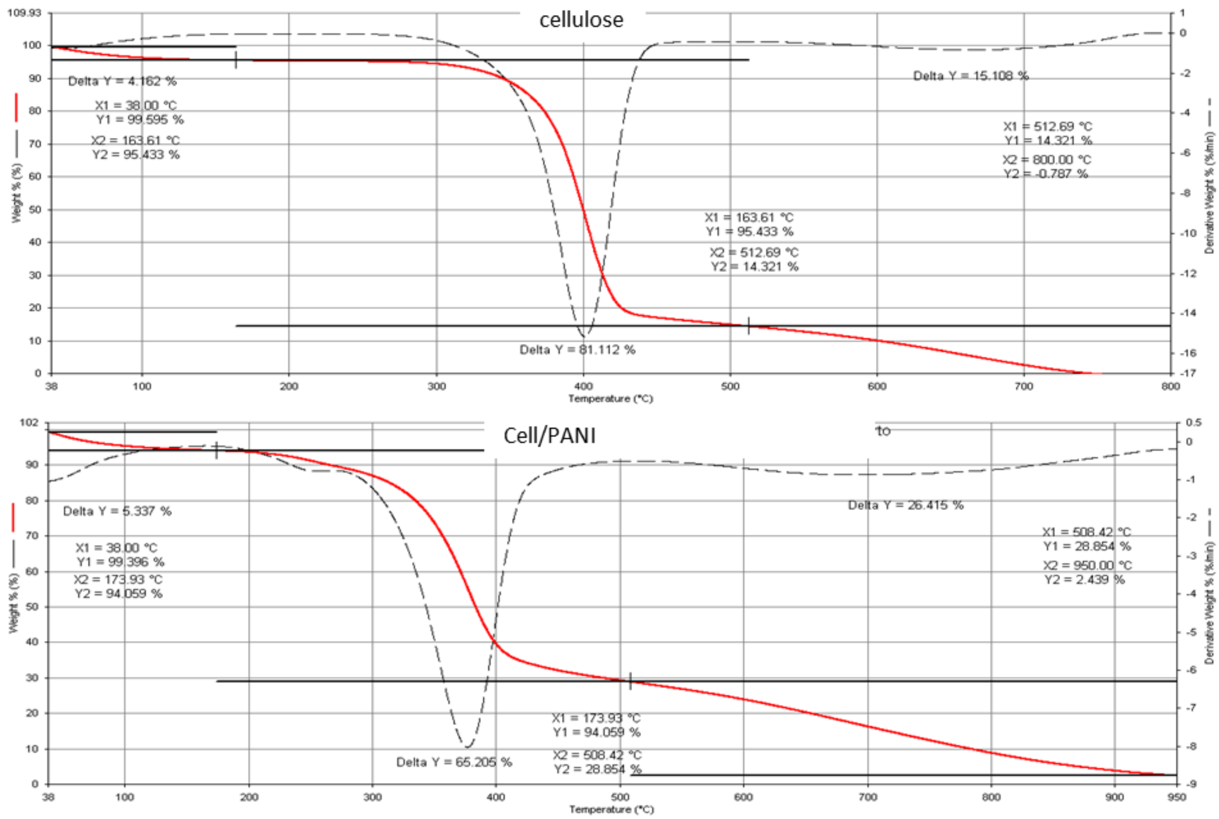

Fig. S4. TGA curves for Cellulose and Cell/PANI.

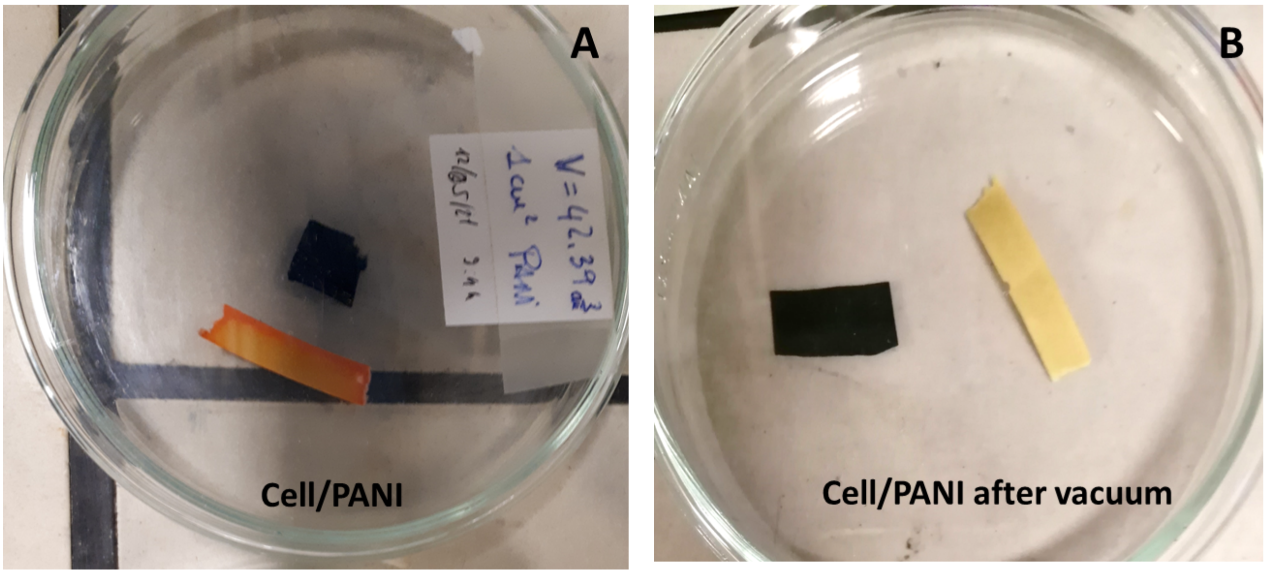

Fig. S5. Acid release tests: A) Cell/PANI, B) Cell/PANI after 67 h under vacuum.

S3. ELECTRICAL MEASUREMENTS

Resistance measurements were made with a Keysight B2902A source meter units in a 4-line-probe configuration. The sample was prepared with a rectangular shape and was held down with an insulating material by exerting a uniform pressure on all the surfaces. The inner electrodes measure the difference of potential while a constant current flow was forced between the two outer electrodes (Fig. S6).

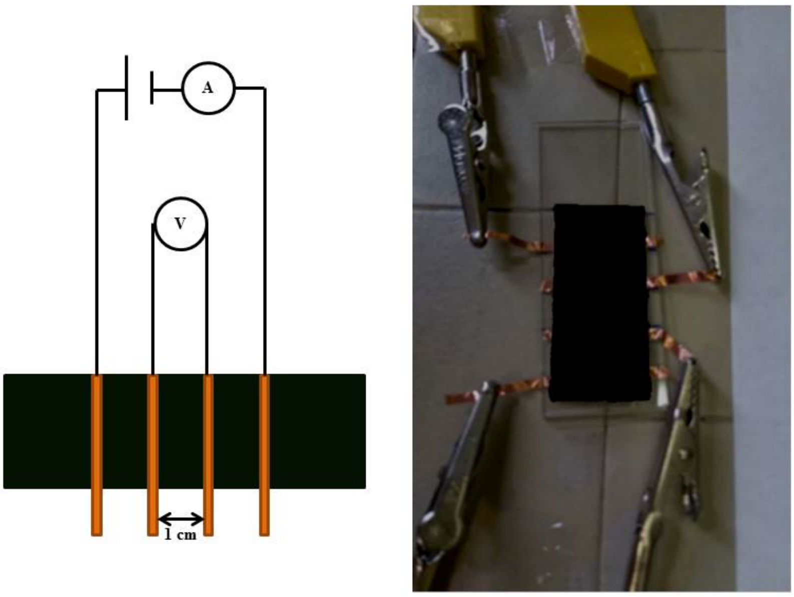

Fig. S6. Sample holder for resistance measurements.

The measurements were performed at different current values (100, 200, 300 μA) and a line passing from the origin was always obtained. The resistance (R) was calculated with the Ohm's law and the sheet resistance ($R_{■}$) is equal to:

$$R_{■} = R\frac{W}{L}$$

Where W and L are the width and the length, respectively.

The specific resistance (ρ) can be calculated by:

$$\rho = R_{■}\, t$$

Where t is the thickness. The specific conductance (κ) is calculated by:

$$\kappa = \frac{1}{\rho}$$

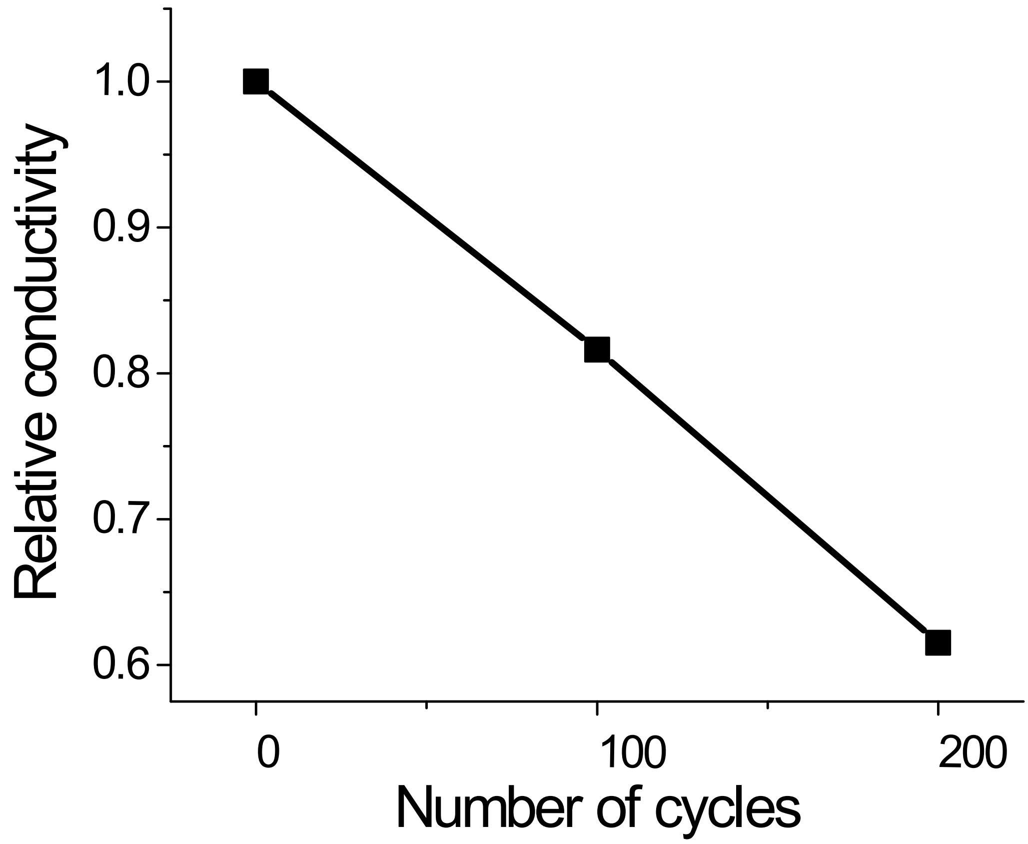

Fig. S7. Cell/PANI conductivity after repeated bending cycles (angle = 30°).

S4. HUMIDITY SENSING STUDIES

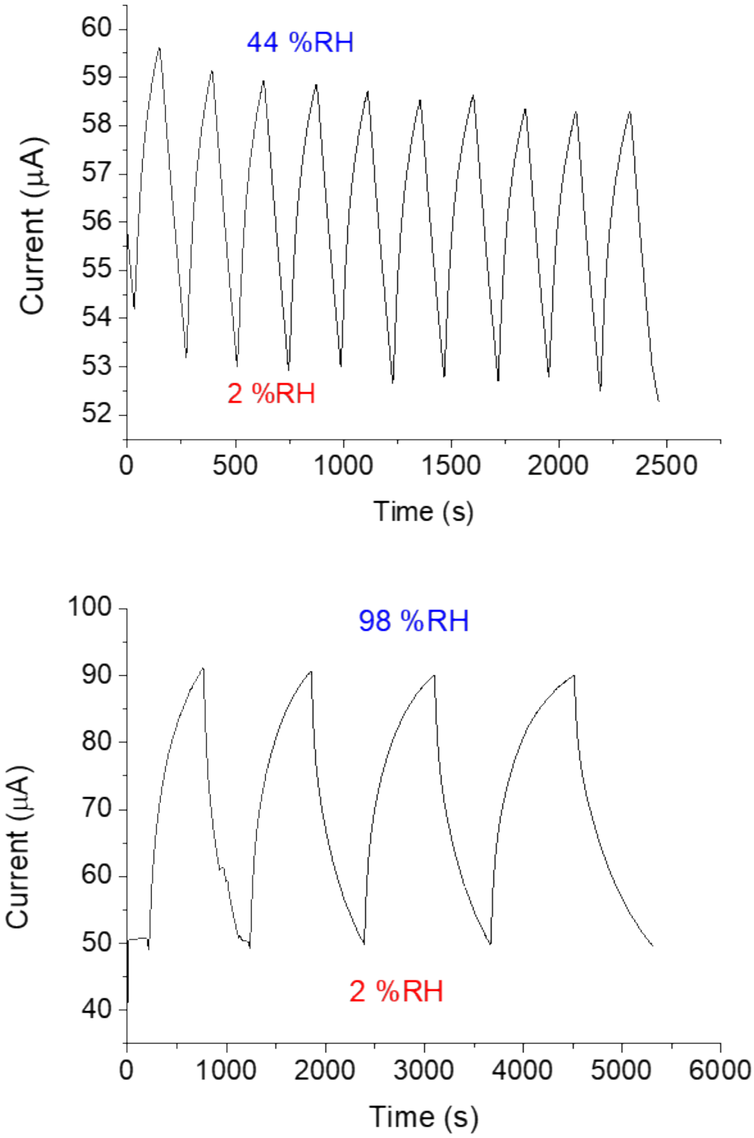

Fig. S8. The cycling behaviour of the Cell/PANI sensor under pulse stimuli obtained by switching at different %RH obtained with potassium carbonate saturated salt solution (44 RH%) or under wet or dry N_2 flow (3 mL s^{-1}, 2-98 RH%) at short cycling time. The tests were conducted under an applied voltage of 0.100 V at 25±1 °C with the homemade set-up.