

## Detailed Calculations

The content of MC-derived carbon (%<sub>C</sub>) in the MC-recovered carbon mixture can be obtained with Equation 1

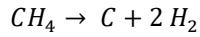
$$\%_C = \frac{m_C}{m_C + m_s} \quad \text{Equation 1}$$

where  $m_C$  is the mass of MC-derived carbon and  $m_s$  is the mass of the carbon support (which is 4.5 g)

$m_C$  can be obtained with Equation 2

$$m_C = n_C M_C \quad \text{Equation 2}$$

where  $M_C$  is the molar mass of carbon (12.011 g/mol) and  $n_C$  is the amount of carbon obtained during the methane cracking reaction:



The amount of obtained carbon is stoichiometrically identical to the total amount of methane that has reacted ( $n_{rCH_4}$ ), as expressed in Equation 3:

$$n_C = n_{rCH_4} \quad \text{Equation 3}$$

$n_{rCH_4}$  depends on the efficiency of the reaction ( $\eta_r = 0.9$ ), as expressed in Equation 4:

$$n_{rCH_4} = \eta_r n_{CH_4} \quad \text{Equation 4}$$

where  $n_{CH_4}$  is the total amount of methane that was fed into the system and which can be obtained with Equation 5:

$$n_{CH_4} = \frac{V_{CH_4}}{V_{mol}} \quad \text{Equation 5}$$

where  $V_{mol}$  is the molar volume of an ideal gas (22.4 dm<sup>3</sup>) and  $V_{CH_4}$  is the total volume of methane that was fed into the system and which can be obtained with Equation 6:

$$V_{CH_4} = f_{CH_4} \Delta t_r \quad \text{Equation 6}$$

where  $f_{CH_4}$  is the methane flow rate at the inlet (12.5 ml/min) and  $\Delta t_r$  is the total reaction time (360 min).

Replacing these values in Equation 6, one obtains  $V_{CH_4} = 4500 \text{ ml} = 4.5 \text{ dm}^3$

Replacing this value in Equation 5, one obtains  $n_{CH_4} = 0.2 \text{ mol}$

Replacing this value in Equation 4, one obtains  $n_{rCH_4} = 0.181 \text{ mol}$  and thus, by Equation 3,  $n_C = 0.181 \text{ mol}$

Replacing this value in Equation 2, one obtains  $m_c = 2.17 \text{ g}$

And finally, replacing this value in Equation 1, one obtains  $\%_c = 0.325$  (ca. 33%)

## Electrochemistry Data

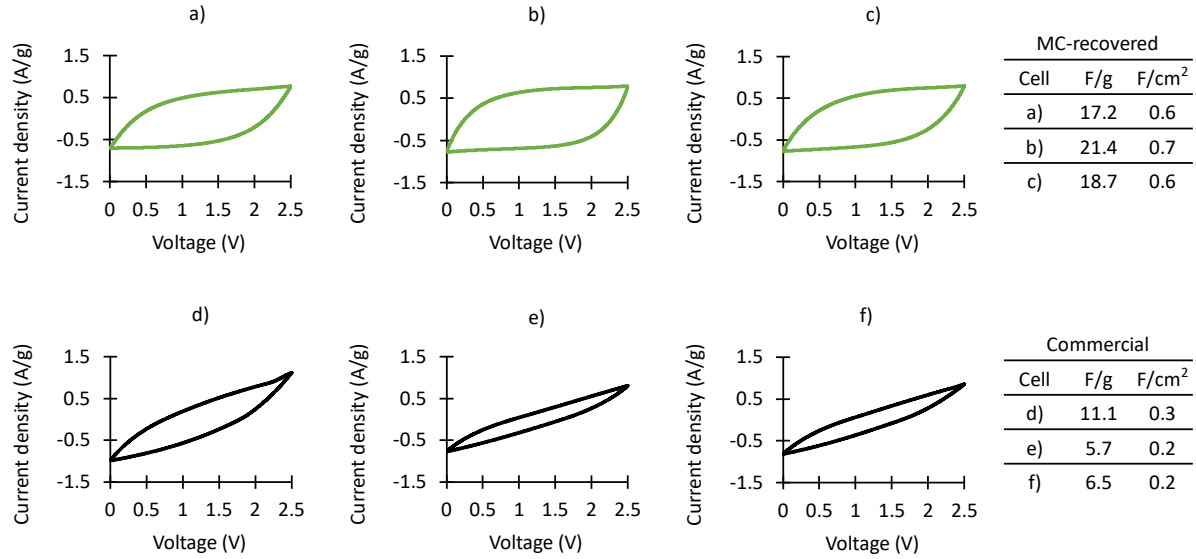


Figure S1- Cyclic voltammograms at 100 mV/s obtained for supercapacitors fabricated with MC-recovered carbon (a), b) and c)) and with commercial activated carbon (d), e) and f)). The tables on the right show the areal and gravimetric capacitance obtained for each cell.

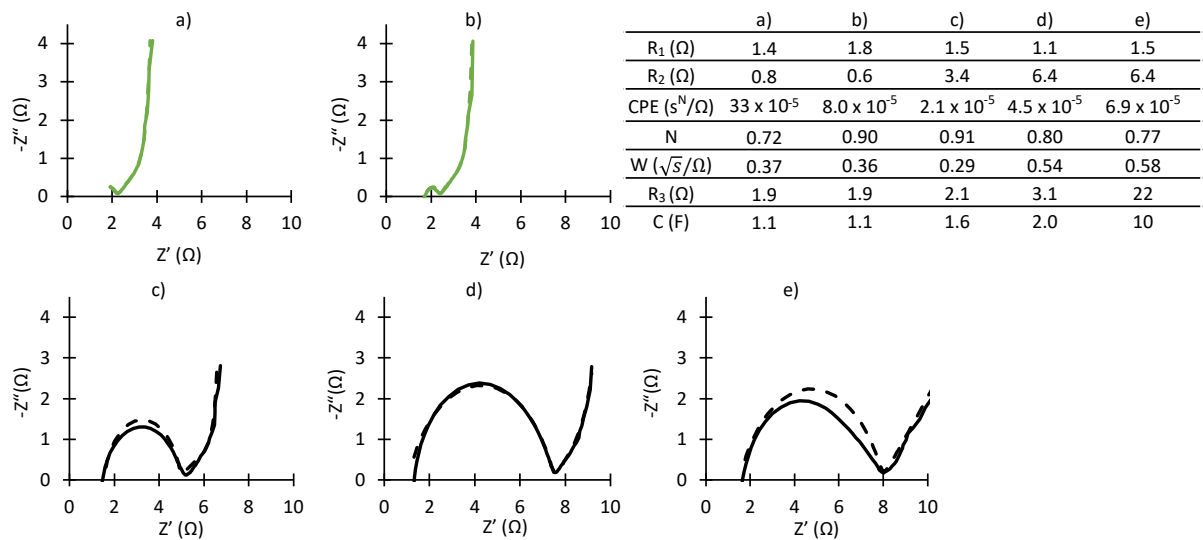


Figure S2- Nyquist plots (solid) and respective fittings (dashed) obtained for MC-recovered (a) and b)) and for commercial carbon (c, d) and e)). The inset table contains the resultant fitting values for the equivalent circuit elements (see Figure 4).

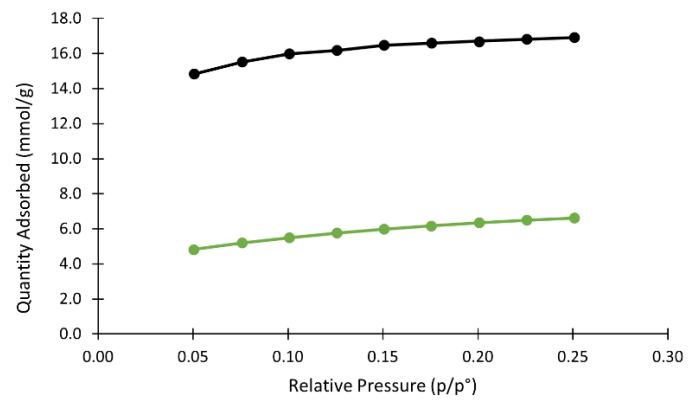


Figure S3 - Adsorption isotherms obtained for commercial (black) and for MC-recovered (green) carbon electrodes

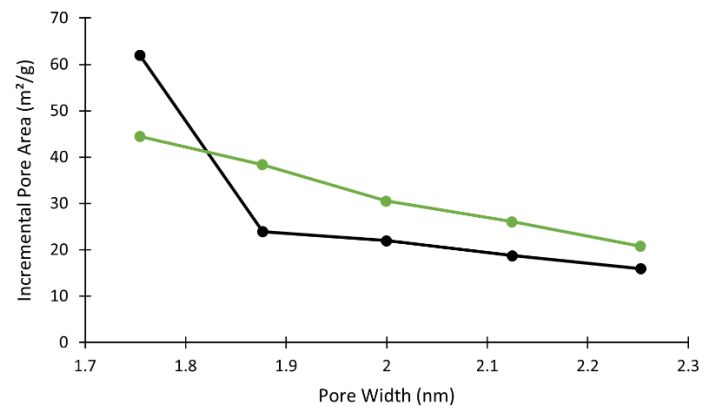


Figure S4 - Pore area distribution for commercial (black) and for MC-recovered (green) carbon electrodes

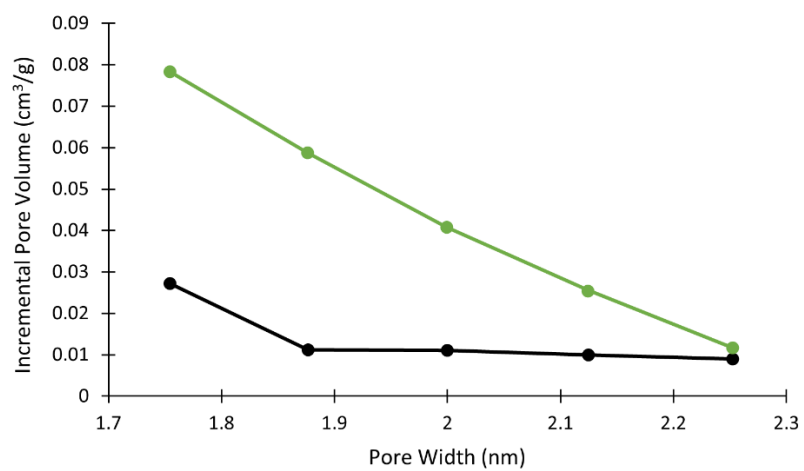


Figure S5 - Pore volume distribution for commercial (black) and for MC-recovered (green) carbon electrodes