Supplementary material:
Beyond power density: unexpected scaling laws in scale up of characterization of reverse-electro-dialysis membranes.

Timothée Derkenne [a], Annie Colin[a] and Corentin Tregouet[*,a]

1 Masking window sizes

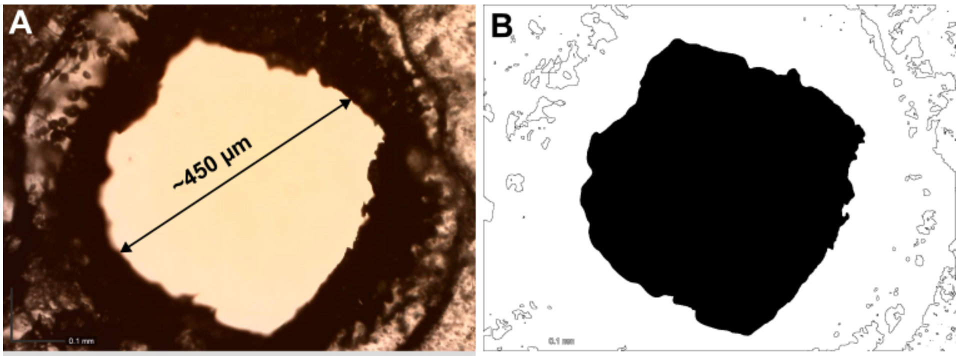

Fig. 1 Example of the measurement of the opened area of a masking window. The microscope image (a) is modified under ImageJ to binarise it and define the boundaries. The interest area is then darken (b) to calculate it's surface. The image is scaled thanks to the microscope calibration on the bottom left. Here for a theoretical diameter of 450 µm the calculated area is 0,196 mm².

Diameter	Area (mm²)
10x10 mm	102,8
7,5 mm	46,8
5 mm	20,2
2,5 mm (large window)	4,9
1 mm (large window)	0,93
2,5 mm (small window)	4,2
1 mm (small window)	0,97
450 μm	0,19
250 μm	0,05
140 μm	0,013

Table 1 Windows sizes measured with ImageJ. The left and right window areas are averaged has if it was symmetrical (to be able to compare it to Green's model).

[a] ESPCI Paris, PSL Research University, MIE-CBI, CNRS UMR 8231, 10, Rue Vauquelin, F-75231 Paris Cedex 05, France.
[*] Corresponding author: corentin.tregouet@espci.psl.eu

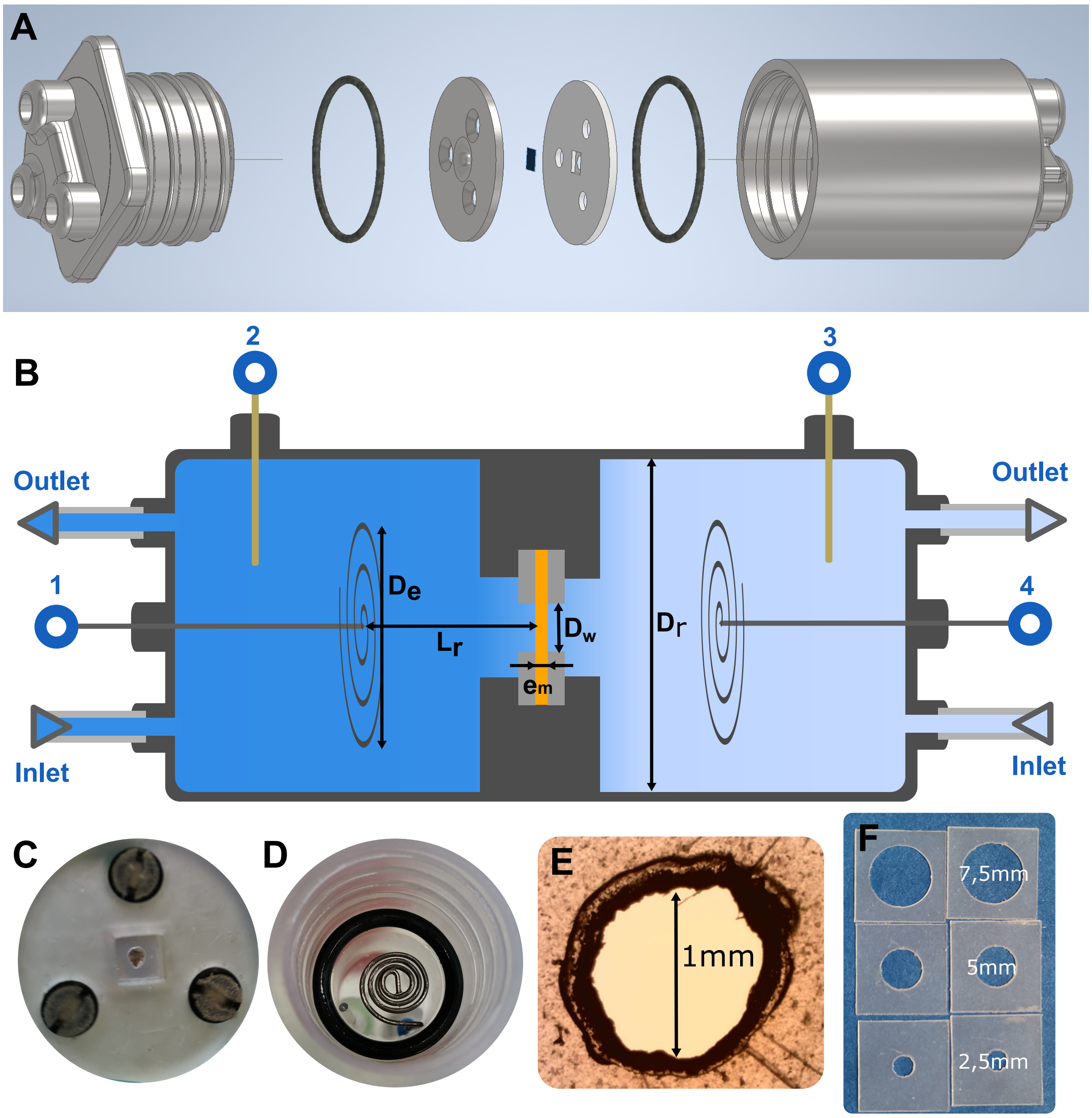

Fig. 2 Experimental set up used for all the measurements. (a) 3D conception of the electro-chemical cell for the 3D printing. (b) Schematic of the cell with the two water reservoirs filled thanks to the water inlet and outlet. The two silver chloride electrodes made of a wire spiral. The membrane (orange) fixed in a mounting bracket with a masking window on each side (grey). Two platinum wires are placed behind the silver chloride electrodes. Electrical connection are done with 1, 2, 3 and 4 for the experiments, electric circuit are presented Figure 4. (c) Top view of the membrane mounting bracket. Three screws with O-rings ensure the waterproof fixing. In the middle square is the membrane (transparent) with a masking window on each side. (d) Top view of a reservoir with the silver chloride electrode and an O-ring. (e) Microscope image of a 1 mm diameter masking window. (f) Pictures of the laser-cutted mylar masking windows.

2 Cell resistance measurement

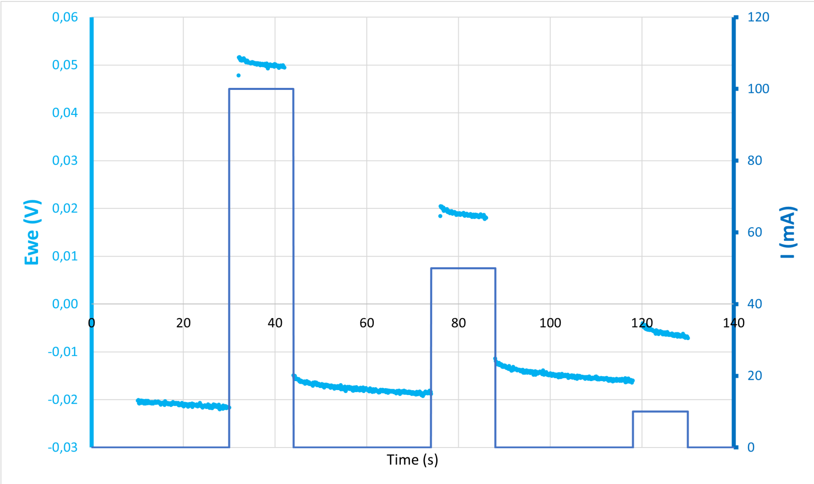

Fig. 3 Example of a measurement of the cell resistance (R_{cell}). The configuration of the measurement is with a symmetric salt concentration [KCl] = 10 g/L and a masking window with a diameter of 1 mm (measured window area of 0,97 mm²).

3 Equivalent electric circuit

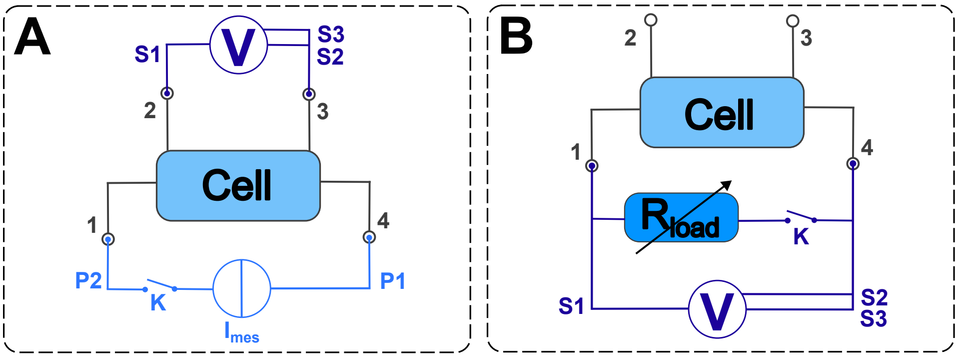

Fig. 4 Electrical circuit of the connection made for the measurements. (a) four electrodes setup used for the resistance measurement. (b) two electrodes setup with a variable resistor used to measure the power dependency to the load resistor. And measure the open circuit voltage of the cell (E_{OCV}).

4 Effect of geometrical parameters on the measured resistance

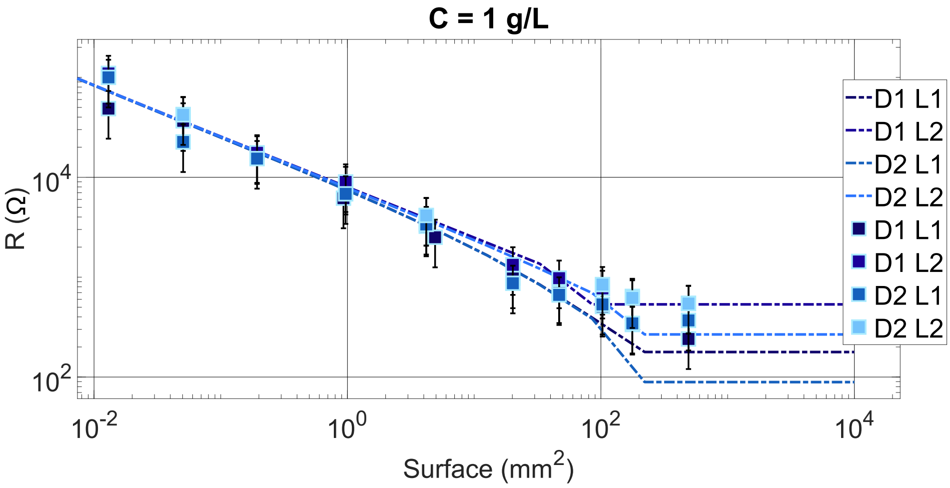

Fig. 5 Geometry modification of the cell at 1 g/L. The reservoirs (distance electrode-membrane) could be $L_1 = 3mm$ or $L_2 = 13mm$. The electrode diameter could be $D_1 = 1cm$ or $D_2 = 2cm$. Square points are experimental measurement and dashed lines are Green's model calculated for each geometry.

5 Generated power measurement

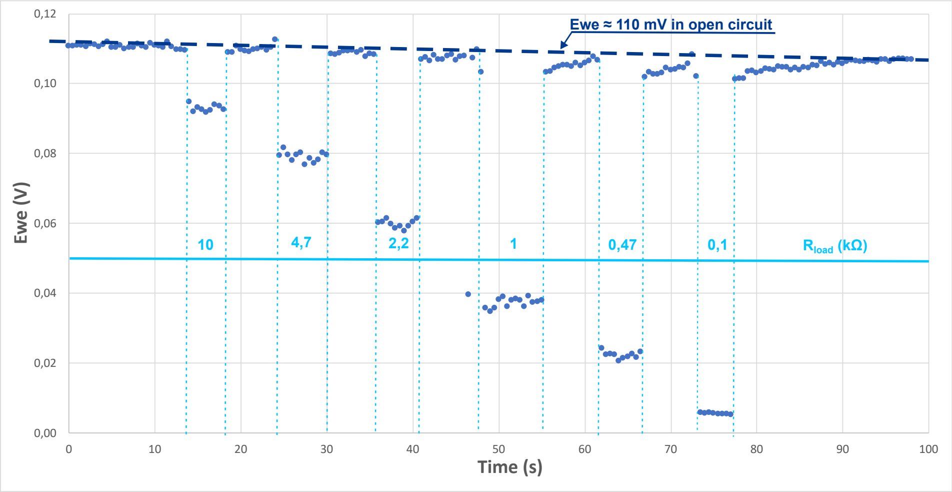

Fig. 6 Example of a measurement of the potential done on the cell to evaluate the generated power according to the load resistor (R_{load}). Salinity ratio value is 10 and the masking window has an area of 4,2 mm².

R_{load} (kΩ)	E_{we} (mV)	P (nW)
10	93	865
4,7	80	1362
2,2	60	1636
1	38	1444
0,47	24	1225
0,1	5	250

Table 2 Average E_{we} measured value according to R_{load}. The generated power is calculated using $P = \frac{E_{we}^2}{R_{load}}$. This table is measured for all window sizes and ratio values of 10 and 100.

6 E_{ocv} dependency to the geometry

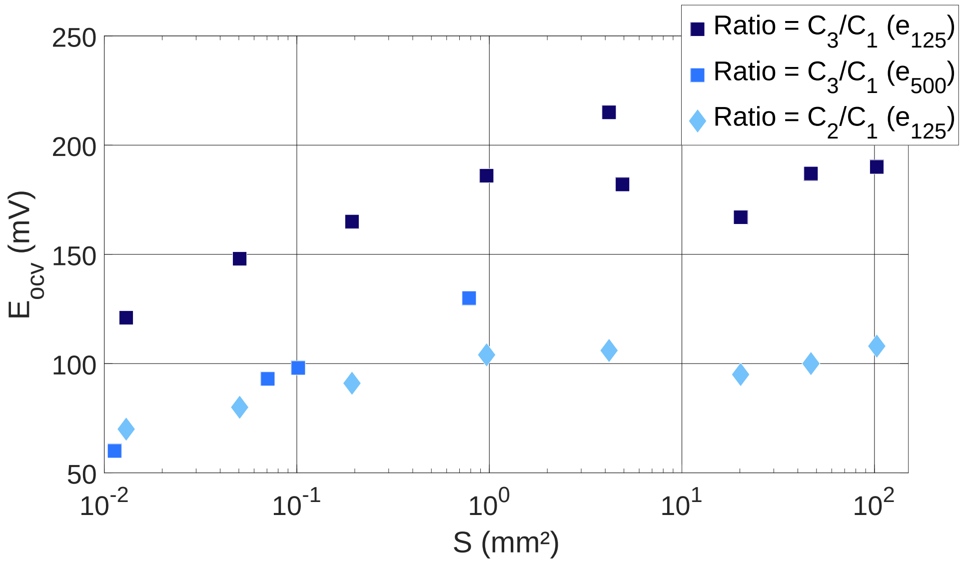

Fig. 7 Measured open circuit potential (E_{ocv}) with silver chloride electrodes during ratio experimentation (electrical wiring Figure 2 (b) with K open). For 100 salt ratio, two masking window thicknesses have been tried : 125 μm and 500 μm.

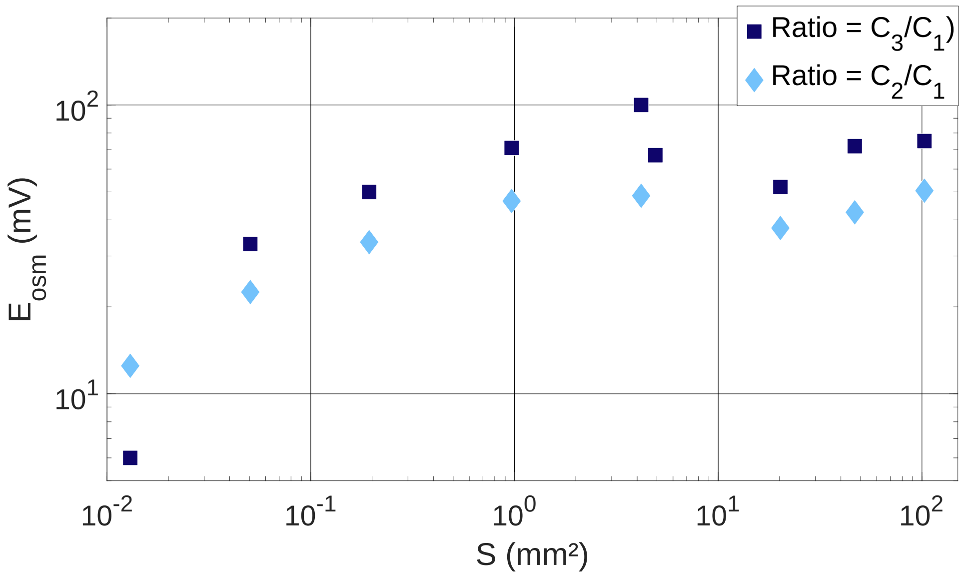

Fig. 8 Measured osmotic potential ($E_{osm} = E_{ocv} - E_{Nernst}$). Presenting only the osmotic part of the potential highlights the strong geometrical effect on concentration fields and the subsequent osmotic potential.