FLOW-THROUGH ZERO GAP CELL

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INTRODUCTION

Micro Electrochemical Technologies is adapting Vanadium Redox Flow Batteries to micro scale, in which the laminar flow regime allows the removal of the membrane and promotes faster ions diffusion and charge transfer, hence improved kinetics and greater efficiency[1,2].

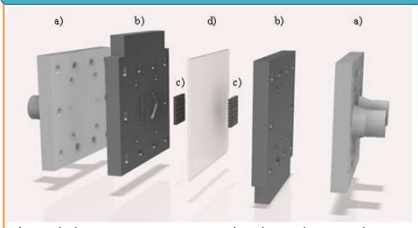
As in conventional batteries, one of the main components are their electrodes. Conventional vanadium systems integrate carbon felts (thickness between 2,5 mm and 6 mm) as the porous electrodes, where redox reactions take place. However, microfluidics application to redox flow cell has the handicap of space, because it refers not only to channel dimensions but also to electrodes distance, so carbon felts are not the best option to be integrated in the micro flow battery and are substituted by carbon papers.

Carbon paper is usually a porous carbon composite that has been heat-treated at a high temperature. Its excellent features such as high conductivity, high gas permeability, corrosion resistance, and high strength, make this a favorite base material for electrode applications. These different **carbon papers** have been studied and characterized for being micro reactor porous electrodes and compared to conventional carbon felts performance.

Material	Item	Supplier	Teflon treatment*	MPL**	Thickness (mm)
Carbon Felt	GFD 2,5 EA	SGL CARBON GmbH	No	No	2,5
Carbon Paper	Toray TP090	QuinTech e.K. - Brennstoffzellen Technologie	No	No	0,28
	Toray TP060	QuinTech e.K. - Brennstoffzellen Technologie	No	No	0,19
	Freudhenberg H23C2	Fuel Cell Store	No	Yes	0,255
	Freudhenberg H23	Fuel Cell Store	No	No	0,21

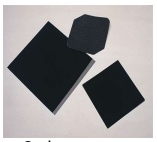
* Teflon treatment regarding supplier at the purchase.
* Micro porous layer at one carbon paper side.

MEMBRANE MICROFLUIDIC SET-UP FOR CHARACTERIZATION

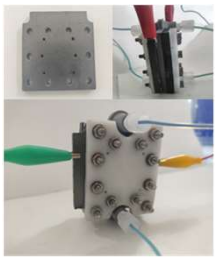


DLP 3D printing technology

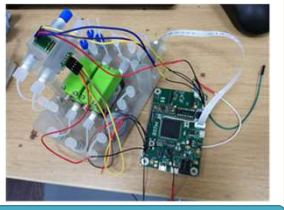
a) End plates
b) Current collectors with embedded flow distributor
c) Electrodes as carbon papers or carbon felts (50% compression)
d) Membrane



Carbon papers

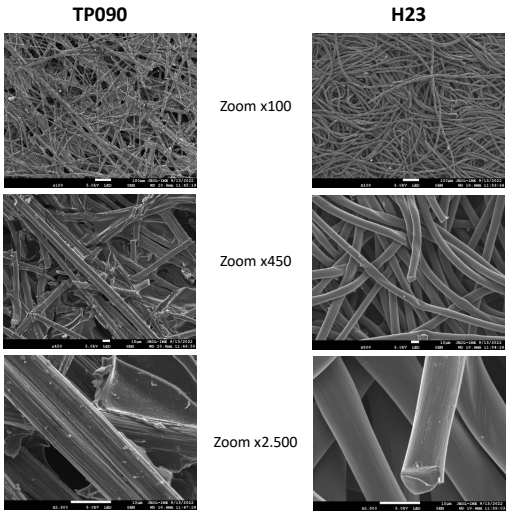


Graphite plate current collector and microfluidic membrane redox flow cell final prototype



High accuracy microfluidic flow controller

SEM CHARACTERIZATION FOR CARBON PAPERS (TP090 AND H23)

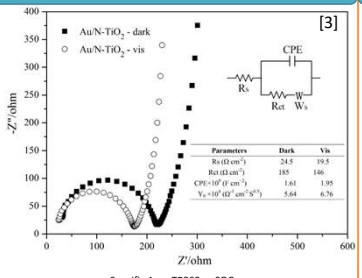


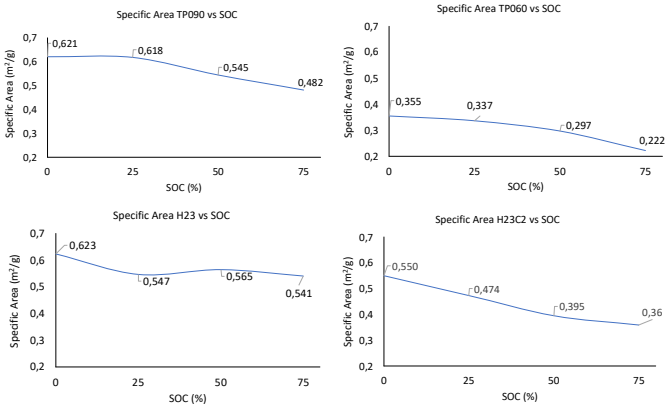
Freudenberg carbon paper has more fibers density and therefore higher porosity than Toray carbon paper, which give great specific surface to the first material. Moreover, no binder presence is detected in H23.

However, although TP090 presents more binder not in the fibers and the bulk, fibers have some corrugations or stretch marks which can increase the specific surface of carbon papers.

POROUS ELECTRODES USEFUL ACTIVE AREA

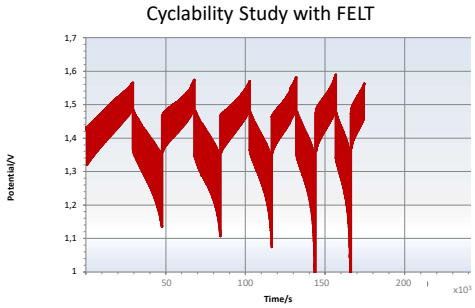
Electrochemical impedance is used for the active area study for carbon papers, by using a constant phase element in the equivalent circuit and for different states of charge (SOC): 0%, 25%, 50% and 75%.

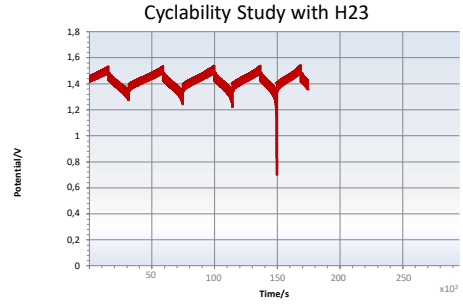




Toray Carbon TP090 and Freudhenberg H23 are the ones which present more useful specific surface, decreasing with SOC because of the available active places for the reaction to take place.

CYCLABILITY WITH OCV_COMPARISON FELT VS H23





More capacity retention

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