POLITECNICO DI TORINO
Repository ISTITUZIONALE

Novel infiltration method of membranes over activated carbons electrodes

Original
Novel infiltration method of membranes over activated carbons electrodes / Molino, D., Pedico, A., Lamberti, A., Bocchini, S.. - STAMPA. - (2022). (International Symposium on Enhanced Electrochemical Capacitors, ISEECap 2022 Bologna (ITA) 11/07/2022 - 15/07/2022).

Availability:
This version is available at: 11583/2974426 since: 2023-01-09T11:51:51Z

Publisher:
Elsevier

Published
DOI:

Terms of use:

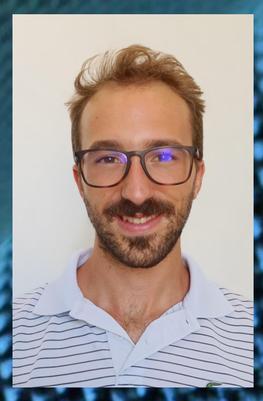
This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

Publisher copyright

(Article begins on next page)

02 November 2026

Novel infiltration method of membranes over activated carbons electrodes



Davide Molino,[a] Alessandro Pedico, [a] Andrea Lamberti, [a,b] Sergio Bocchini [b]

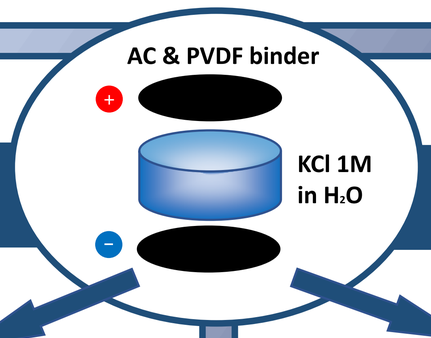
[a] DISAT Dipartimento di Scienza Applicata e Tecnologia, Politecnico di Torino, corso Duca degli Abruzzi 24, 10129, Torino, Italy

[b] Istituto Italiano di Tecnologia, Center for Sustainable Future Technologies, Via Livorno 60, 10144, Torino, Italy

davide.molino@polito.it

Background

A novel method to modify **activated carbon electrodes** through addiction of **selective ion exchange polymers** (IEM) is presented. Nowadays the preferred method to self-polarize an electrode in an EDLC is to place a stand-alone membrane in proximity of the electrode itself [1, 2]. This technique produces some drawbacks brought about the dimension of the device: an increase of the internal series resistance and reduction of overall capacitance. With the propoesed methods, it is possible to use the IEM **directly in the production** of the slurry (instead of traditional binders) or in a **conformal contact** with the electrode.



IEM as binder

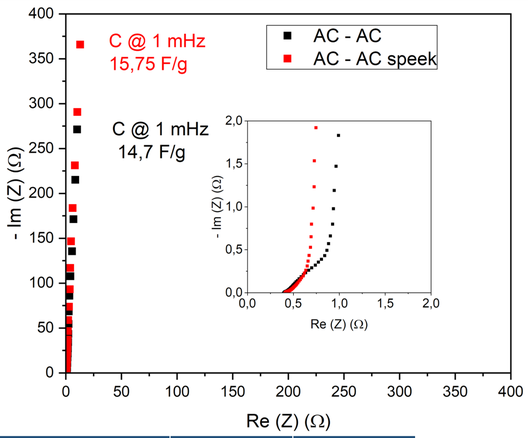
Electrode fabrication

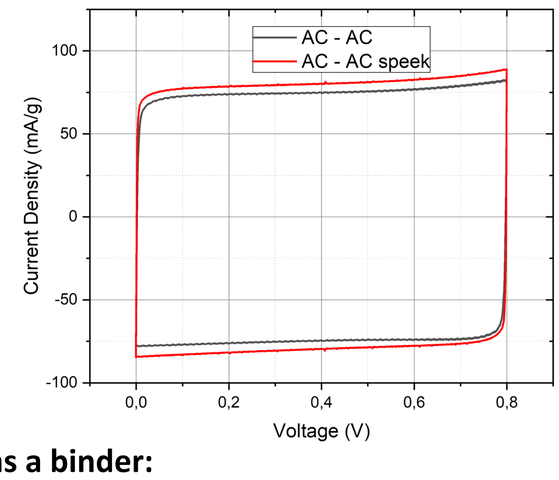
Materials:

- Activated carbon *90%*
- Sulphonated poly ether-ether ketone (SPEEK) *10%*
- DMSO *1 ml / 20 mg binder*
- Glass fiber separator

Electrodes are then laser cutted and placed inside a coin cell.

Electrochemical characterization





@ 0,8 V	PVDF binder	SPEEK binder
Mass loading [mg/cm²]	9,27	6,3
C [F/g]	14,84	15,8
Coul. Eff.	99%	99%
OCV [mV]	23	110

IEM as a binder:

- invariated ESR
- Constant efficiency
- Much higher OCV
- Increase of specific capacitance

IEM as conformal coating

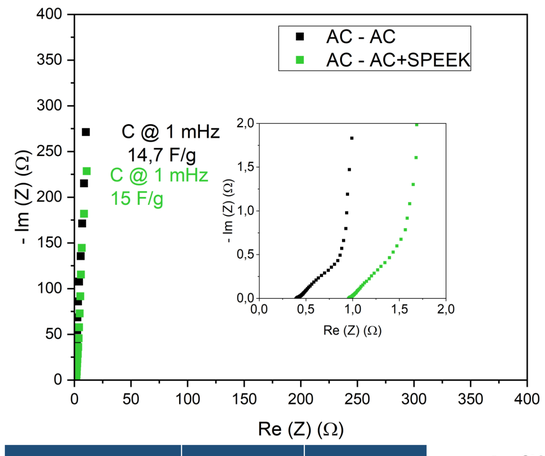
Infiltration method

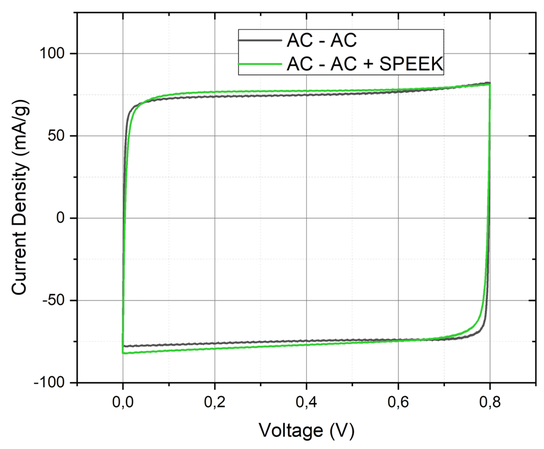
Materials:

- Activated carbons *90%*
- Poly vinyldene fluoride (PVDF) *10%*
- DMSO *1 ml / 20 mg binder*
- Glass fiber separator

Casting of SPEEK under vacuum over electrode to get a conformal membrane.
Electrodes are then laser cutted and placed inside a coin cell.

Electrochemical characterization



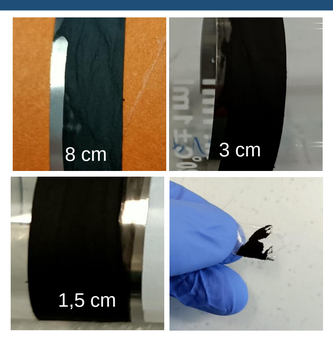


@ 0,8 V	No IEM	Inf. IEM
Mass loading (slurry) [mg/cm²]	9,27	10,7+2,48
C [F/g]	14,84	15,1
Coul. Eff.	99%	99%
OCV [mV]	23	458

Infiltering process:

- Invariated capacitance
- Same Coulombic efficiecy
- Highly increased OCV
- Direct contact electrolyte - membrane

Adhesion test

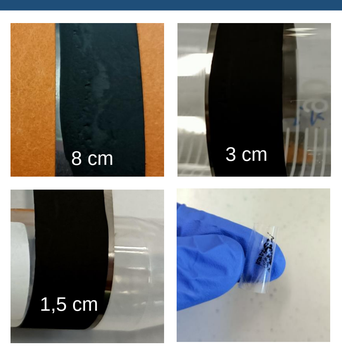


PVDF binder

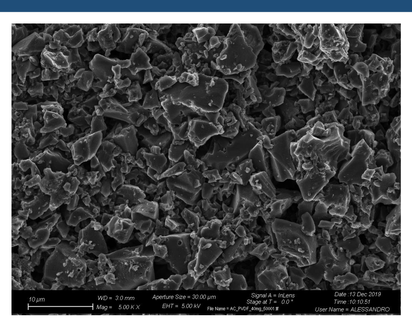
No delamination due to deformation of the substrate. Remotion of all the deposited material during peeling test.

SPEEK binder

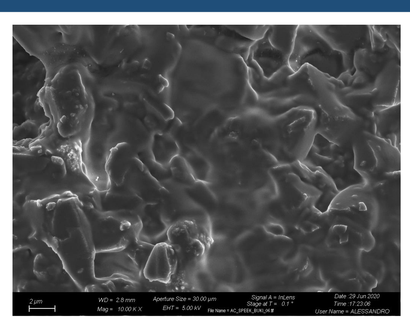
No delamination due to deformation of the substrate. Remotion only of all the upper layer of carbon during peeling test.



SEM comparison

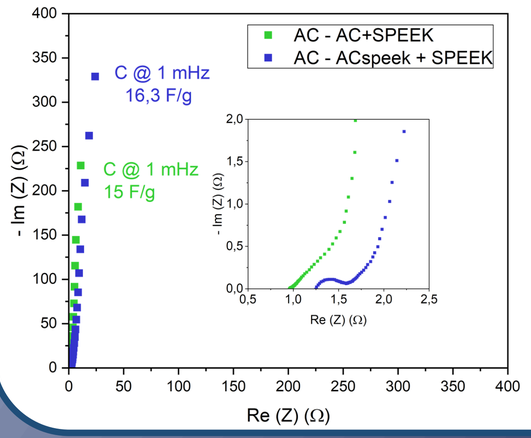


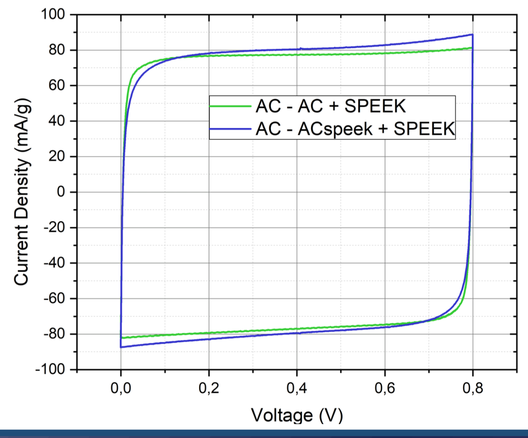
No membrane



Vacuum infiltred membrane

Combination of binder + infiltred IEM





Combination:

- Invariate specific capacitance
- Invariate coulombic efficiency
- Comparable OCV

@ 0,8 V	PVDF Binder + IEM inf	IEM binder + IEM inf
Mass loading [mg/cm²]	10,7+2,48	6,7+3,98
C [F/g]	15,1	15,2
Coul. Eff.	99%	99%
OCV [mV]	458	442

Conclusions

- Speek binder provides a better adhesion to Ti
- Infiltering process allows to maintain constant the ESR of the device, but highly increases its OCV
- It is possible to combine both approaches presented

Future outlooks

- Repeat same tests with a anion exchange membrane and combine with SPEEK
- Test the obtained electrodes in a device built for capmix or RED

Bibliography:

[1] Sales, Bruno B., et al. <<Electrochemical characterization of a supercapacitor flow cell for power production from salinity gradients>> *Electrochemica acta*, 86 (2012) 298-304

[2] Wang, Xingfeng, et al. <<A 1.8 V aqueous supercapacitor with a bipolar assembly of ion-exchange membranes as separator>> *Journal of The Electrochemical Society*, 163.9 (2016): A1853

ISEECAP 2022 — Bologna, 11-15 July 2022