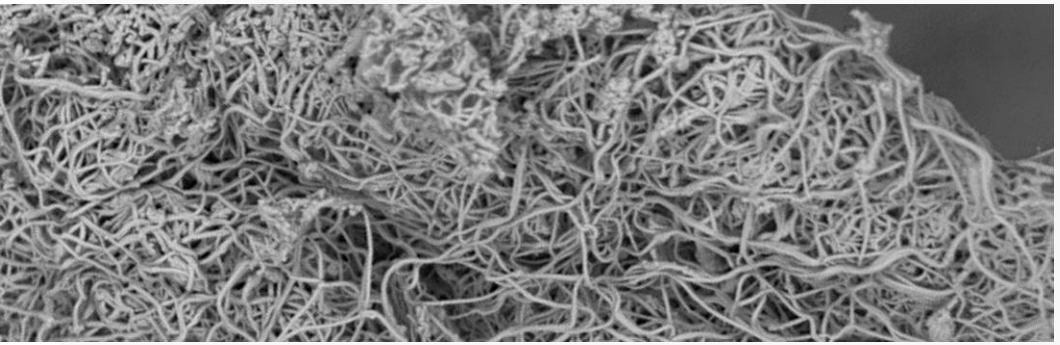
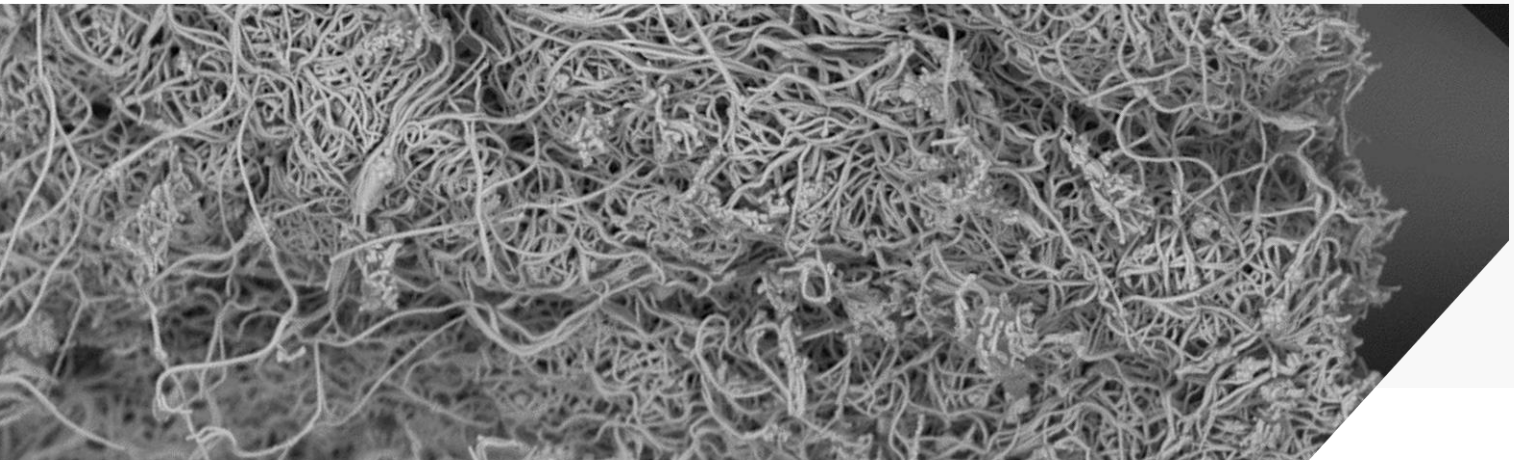
Electrospun Nanocomposites for Energy Storage

Progetto “UdA Pro VAL” PNRR Missione 1 Componente 2 Investimento 6





Società Chimica Italiana
Gruppo Giovani

MYCS 2024

Electrospun Nanocomposites for Energy Storage

The SPINNERET project*

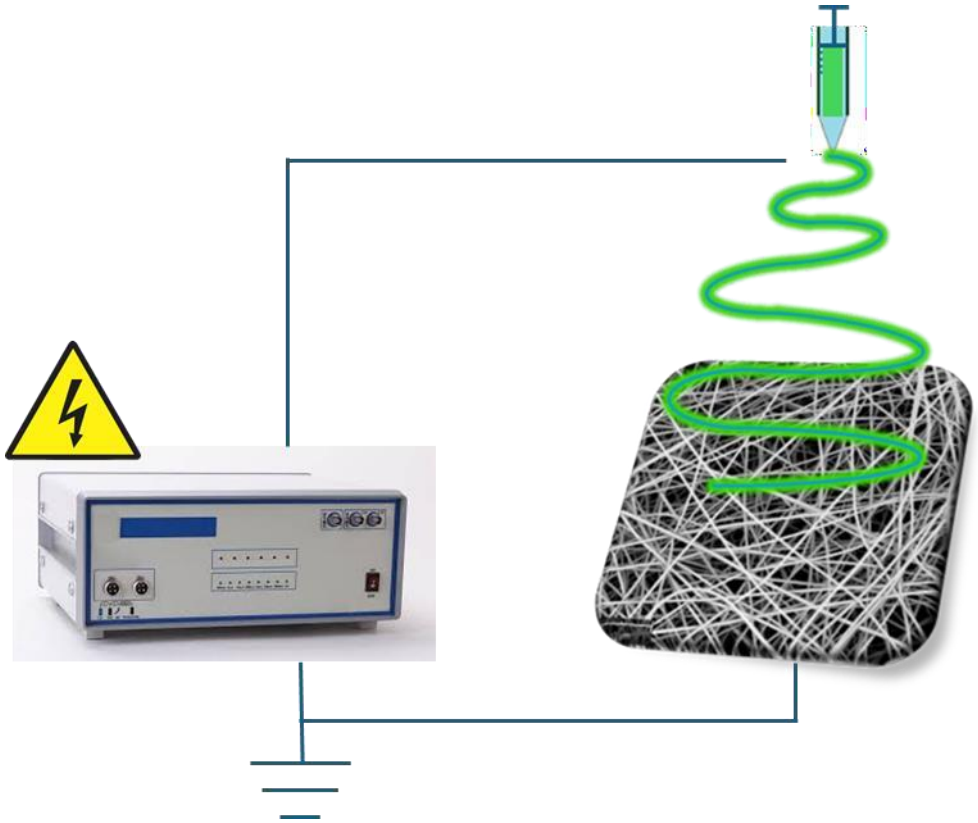
Use of a new precursor and different preparation conditions

Technology readiness level

Validation and repeatability of the project

*Patent number: 2018IT-0010452

The Electrospinning Process



Polymeric solution

Voltage Applied

Flow Rate

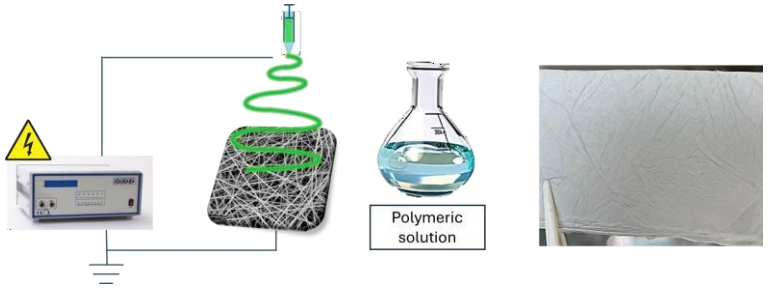
Polymer Concentration

Stabilization in air atmosphere

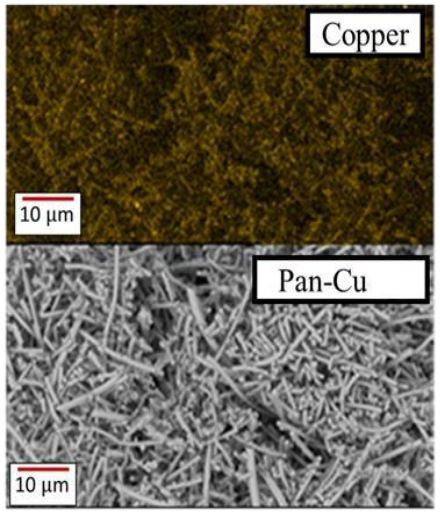
Annealing
Argon 95%
Hydrogen 5%

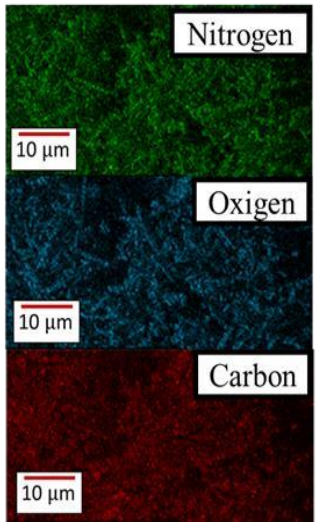
Annealing
Nitrogen

Formulation and energy dispersive X-ray analysis

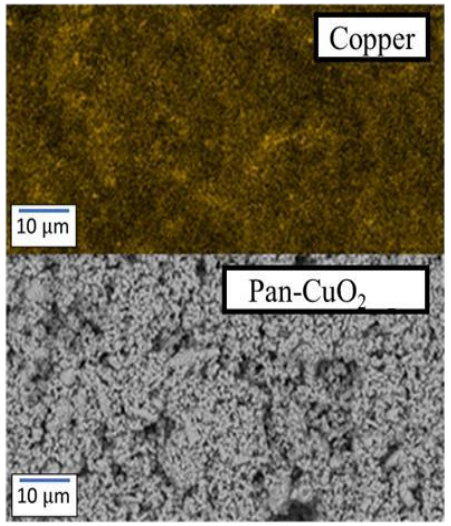


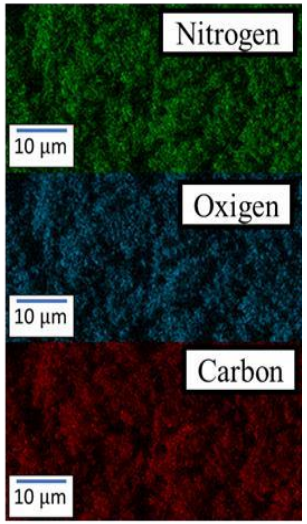
Formula	Solvent	Polymer	Precursor
A	DMF	Pan	-
B	DMF	Pan	Cu
C	DMF	Pan	Cu_2O

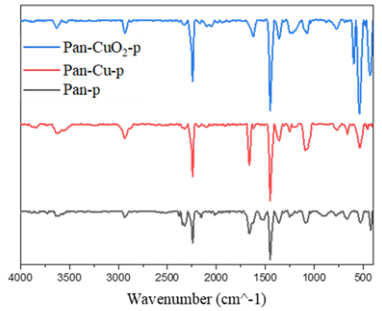


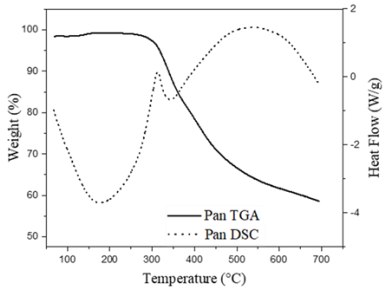


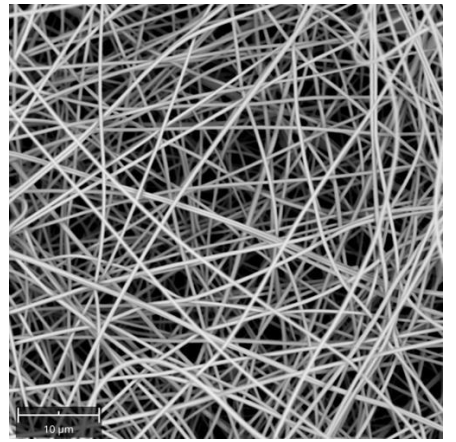
Uniform distribution of **Copper, Nitrogen, Oxigen and Carbon** nanoparticles in **Cu e CuO_2** membranes.

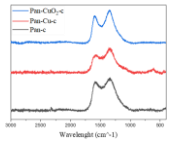


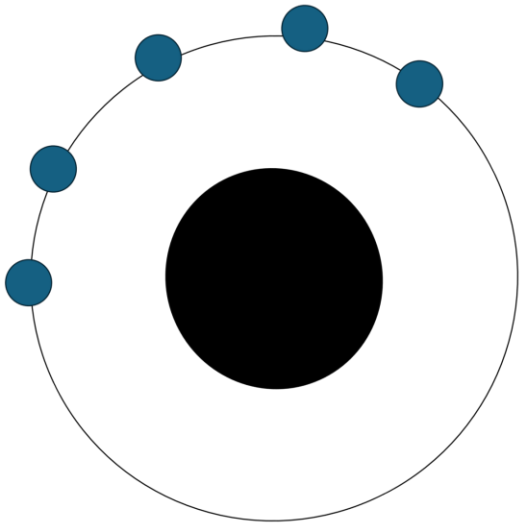




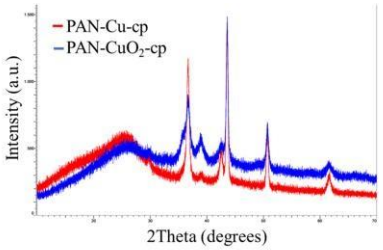


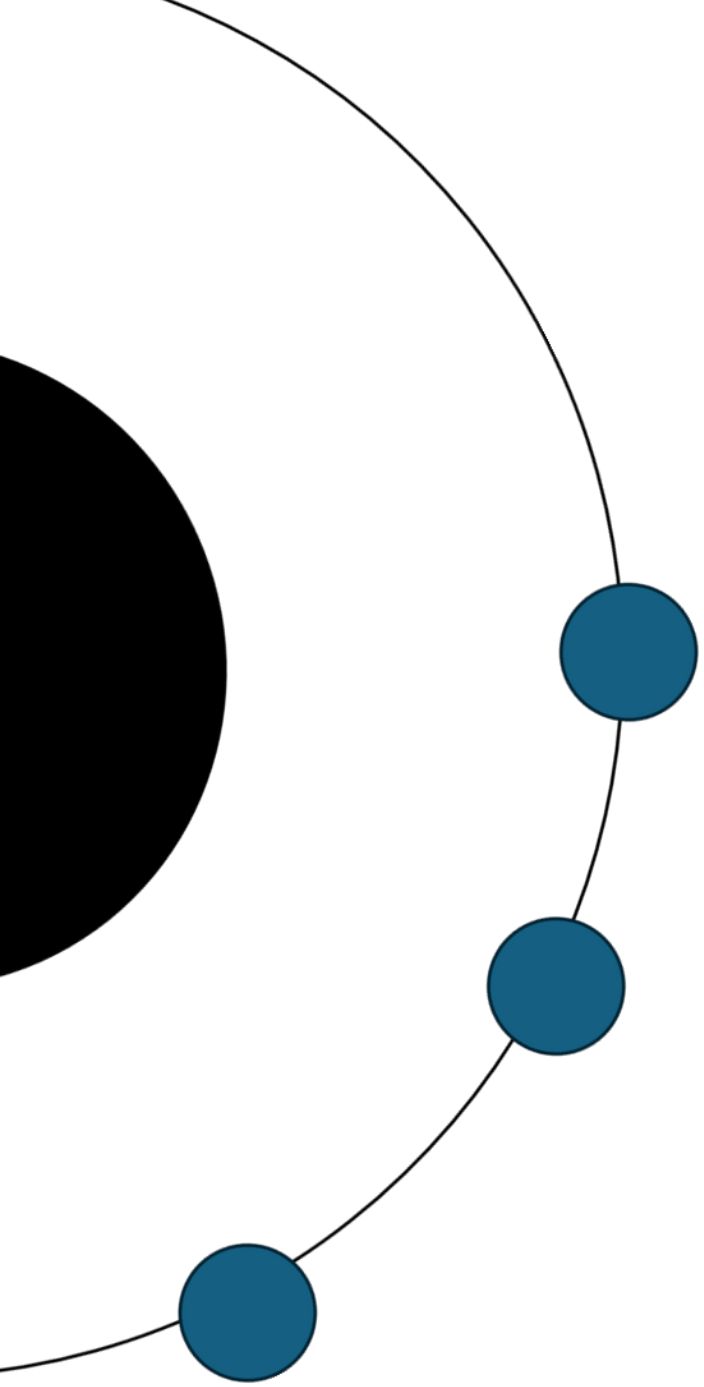






Characterization





Scanning Electron Analysis

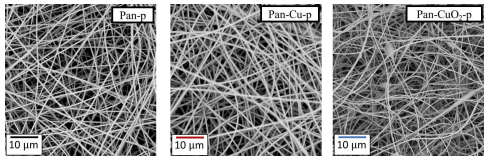
Differential scanning calorimetry and thermogravimetric analysis

Scanning Electron Analysis

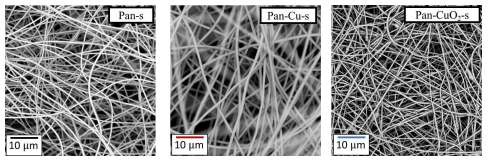
	A	B	C
Pristine	Pan-p	Pan-Cu-p	Pan-CuO_2-p
Stabilized (air)	Pan-s	Pan-Cu-s	Pan-CuO_2-s
Calcined (N_2)	Pan-c	Pan-Cu-c	Pan-CuO_2-c
Ground carbon	Pan-cp	Pan-Cu-cp	Pan-CuO_2-cp

Detailed study of the morphological and compositional evolution of fibers during different process steps:
electrospinning, stabilization, carbonization and grinding.

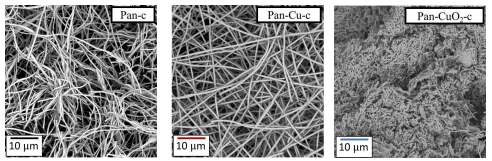
Pristine



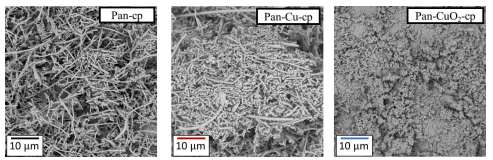
Stabilized (air)



Calcined (N_2)



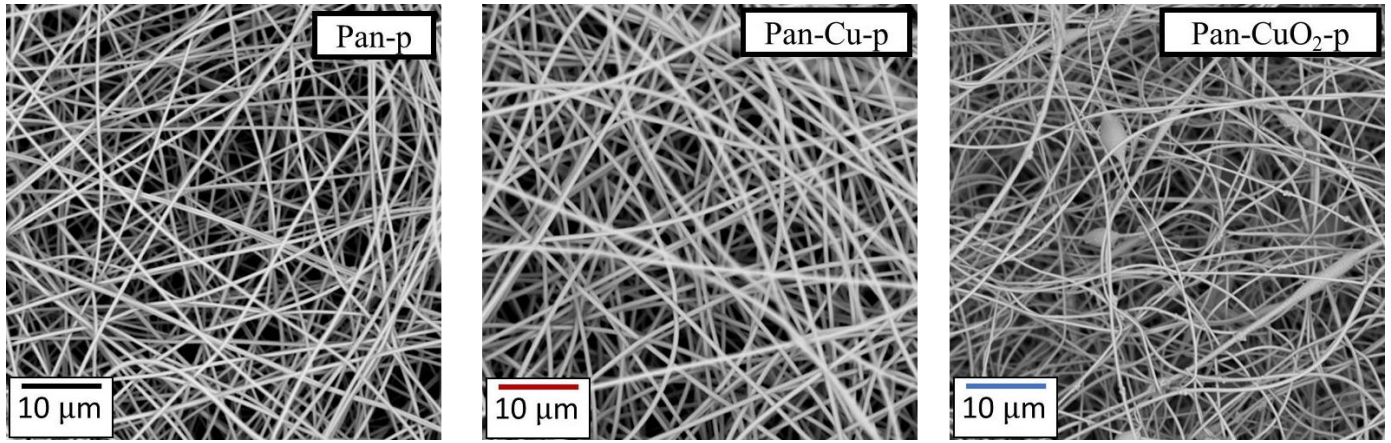
Ground carbon



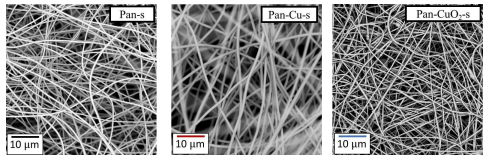
Scanning Electron Analysis

	A	B	C
Pristine	Pan-p	Pan-Cu-p	Pan-CuO_2-p
Stabilized (air)	Pan-s	Pan-Cu-s	Pan-CuO_2-s
Calcined (N_2)	Pan-c	Pan-Cu-c	Pan-CuO_2-c
Ground carbon	Pan-cp	Pan-Cu-cp	Pan-CuO_2-cp

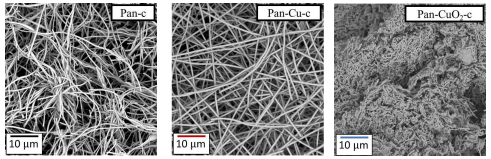
Pristine



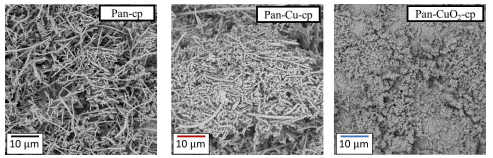
Stabilized (air)



Calcined (N_2)



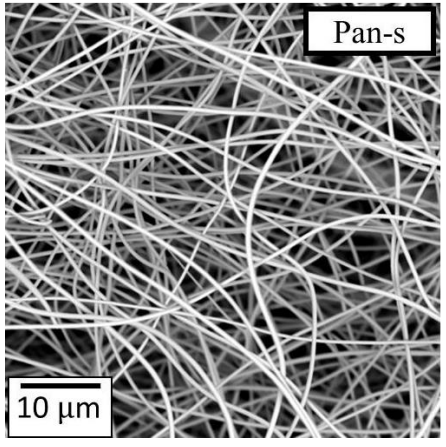
Ground carbon

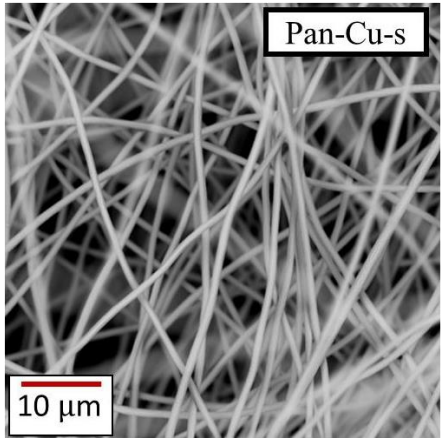


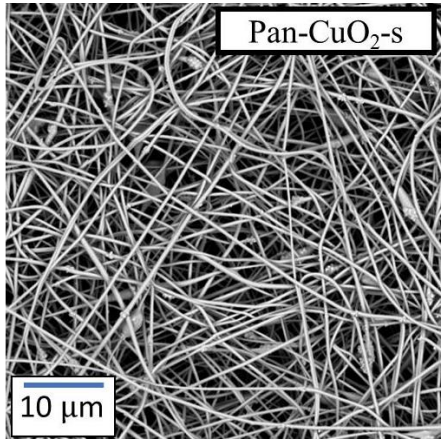
Scanning Electron Analysis

	A	B	C
Pristine	Pan-p	Pan-Cu-p	Pan-CuO_2-p
Stabilized (air)	Pan-s	Pan-Cu-s	Pan-CuO_2-s
Calcined (N_2)	Pan-c	Pan-Cu-c	Pan-CuO_2-c
Ground carbon	Pan-cp	Pan-Cu-cp	Pan-CuO_2-cp

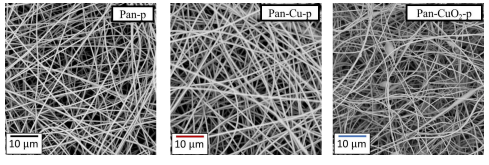
Stabilized (air)



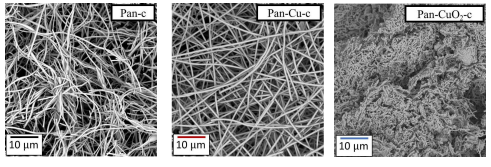




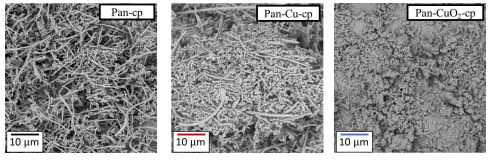
Pristine



Calcined (N_2)



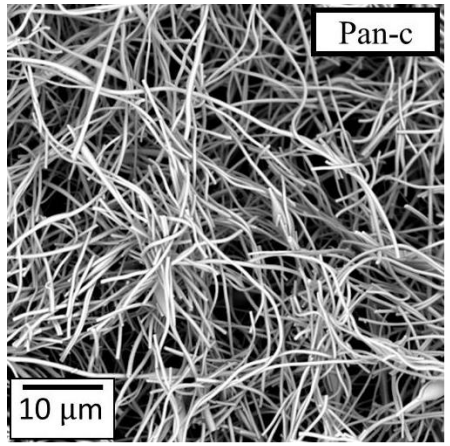
Ground carbon

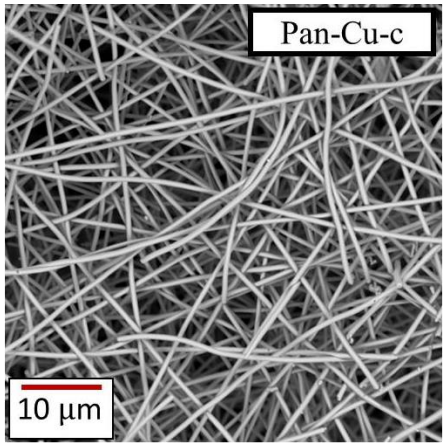


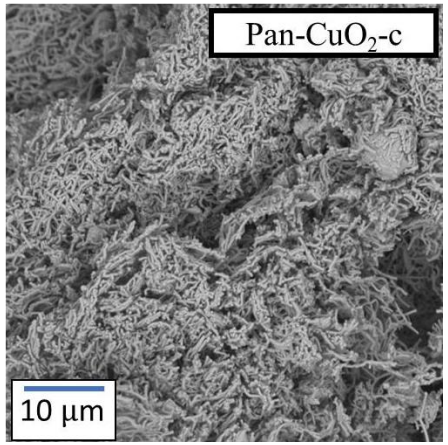
Scanning Electron Analysis

	A	B	C
Pristine	Pan-p	Pan-Cu-p	Pan-CuO_2-p
Stabilized (air)	Pan-s	Pan-Cu-s	Pan-CuO_2-s
Calcined (N_2)	Pan-c	Pan-Cu-c	Pan-CuO_2-c
Ground carbon	Pan-cp	Pan-Cu-cp	Pan-CuO_2-cp

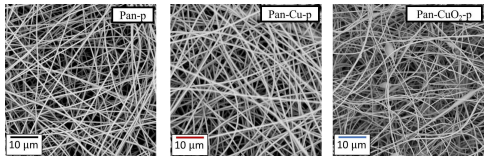
Calcined (N_2)



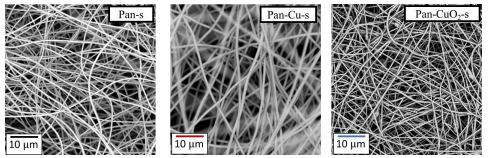




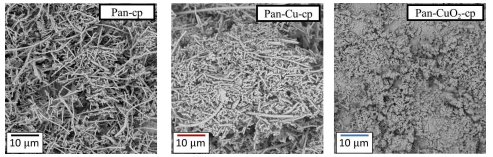
Pristine



Stabilized (air)



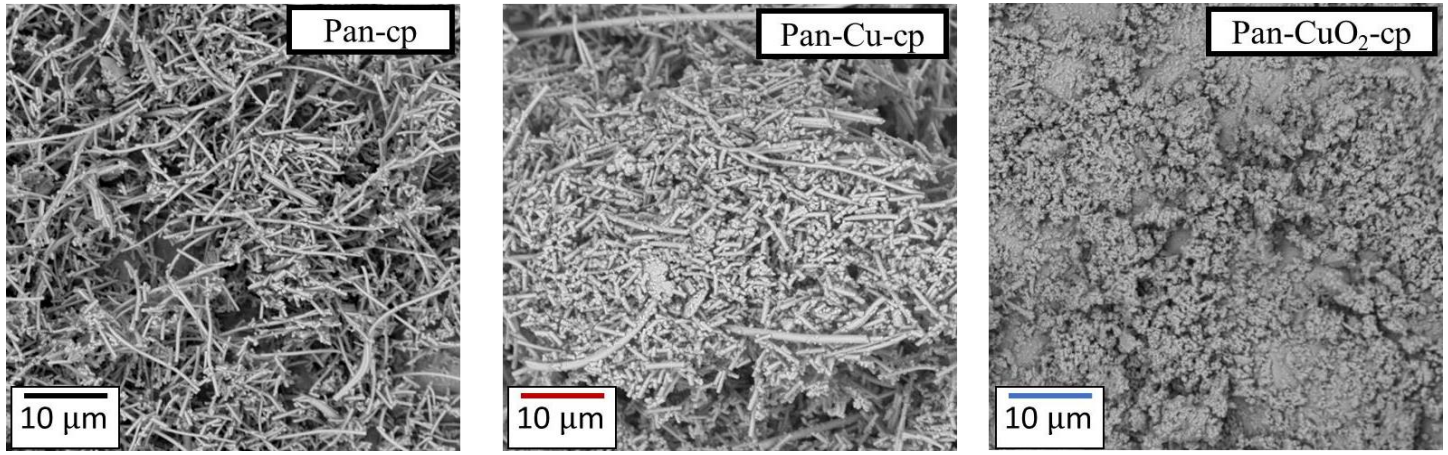
Ground carbon



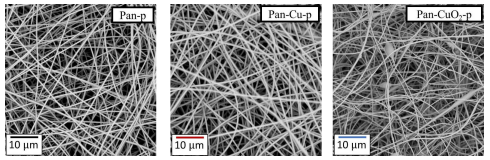
Scanning Electron Analysis

	A	B	C
Pristine	Pan-p	Pan-Cu-p	Pan-CuO_2-p
Stabilized (air)	Pan-s	Pan-Cu-s	Pan-CuO_2-s
Calcined (N_2)	Pan-c	Pan-Cu-c	Pan-CuO_2-c
Ground carbon	Pan-cp	Pan-Cu-cp	Pan-CuO_2-cp

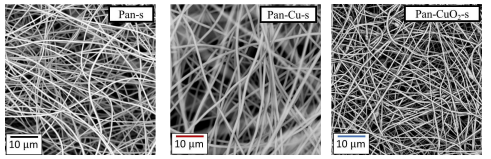
Ground carbon



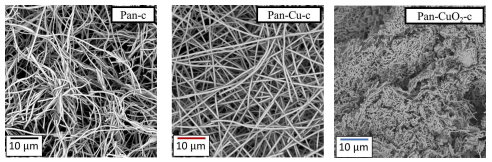
Pristine

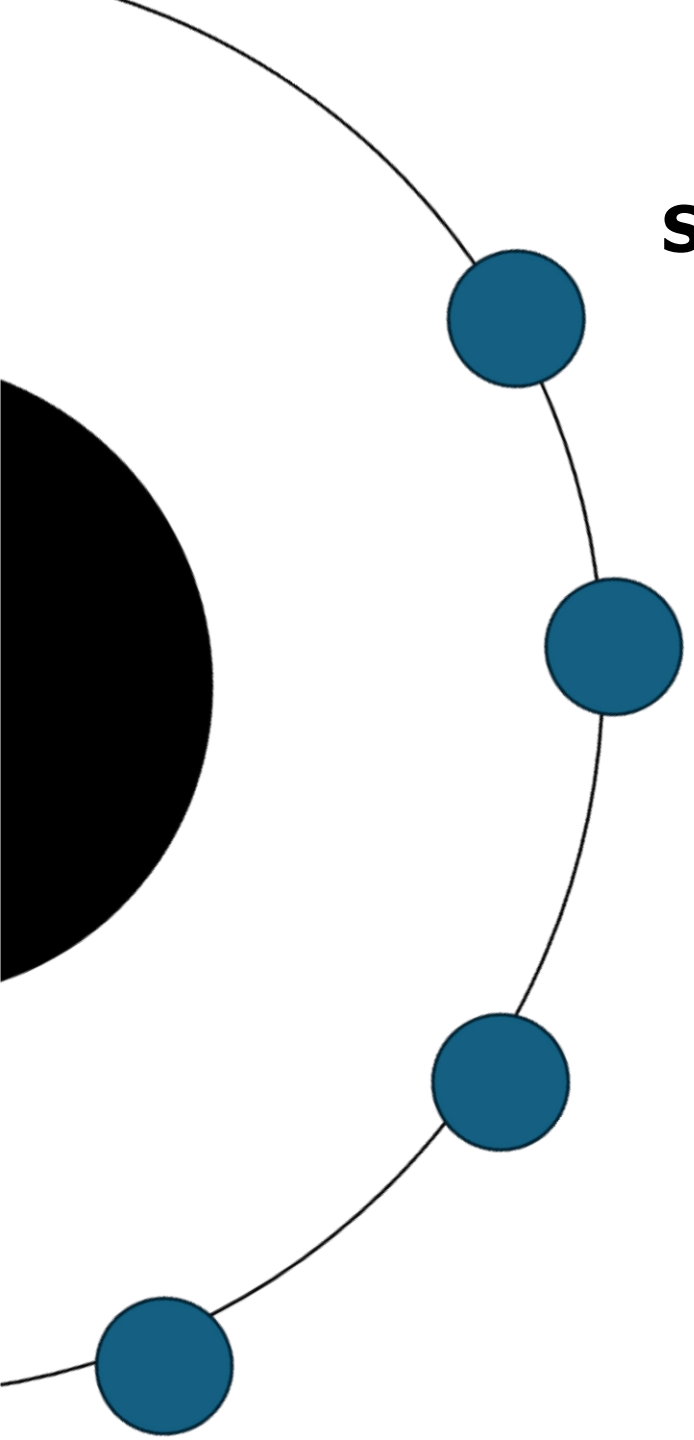


Stabilized (air)



Calcined (N_2)





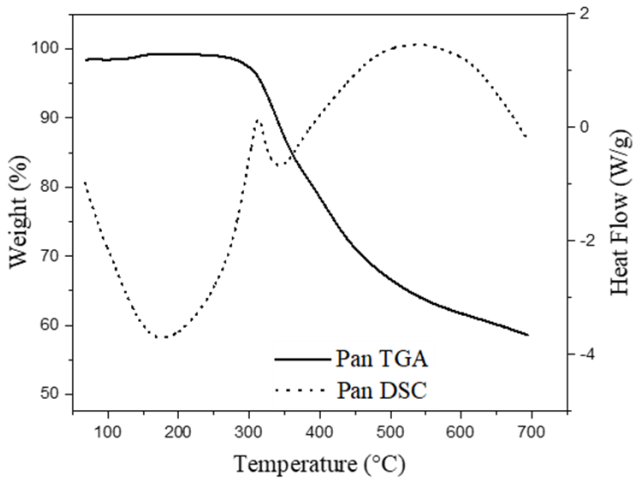
Scanning electron microscopy analysis

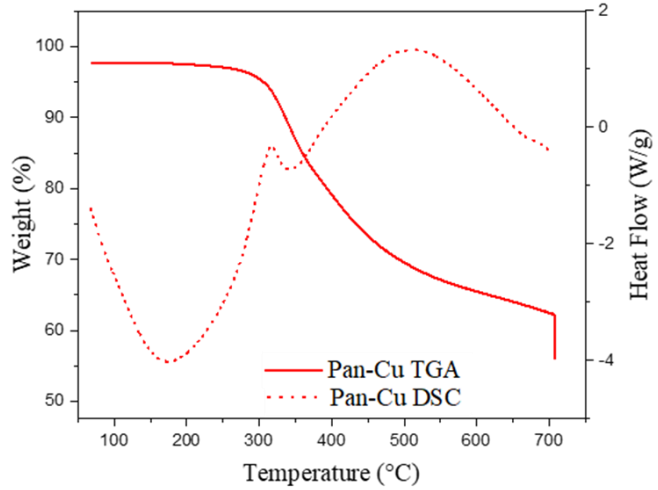
Differential scanning calorimetry and thermo gravimetric analysis

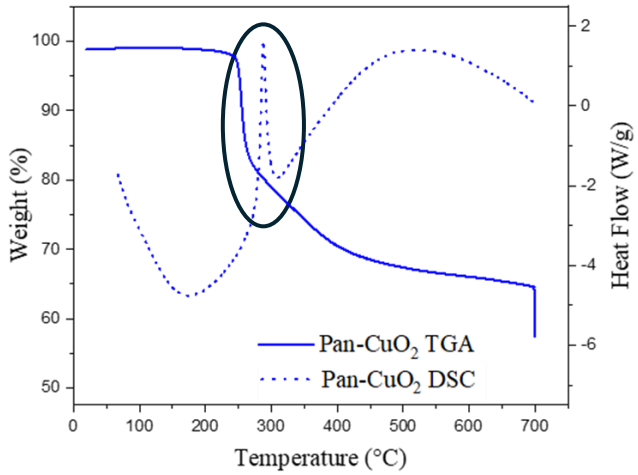
Raman Spectroscopy and X-Ray diffraction Analysis

Differential scanning calorimetry and thermo gravimetric analysis

	A	B	C
Carbon (N_2)	Pan	Pan-Cu	Pan-CuO_2

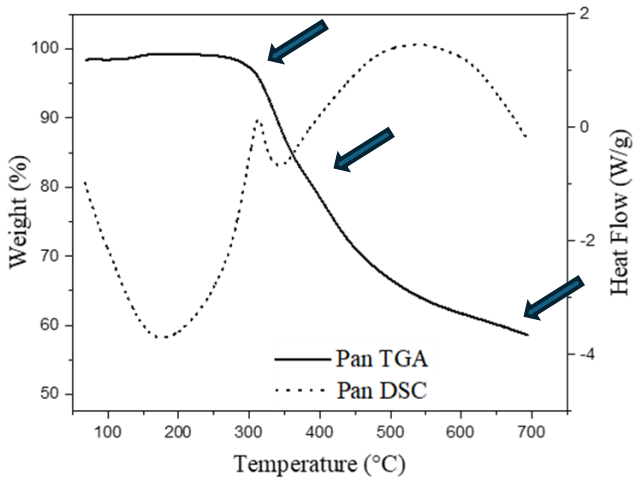


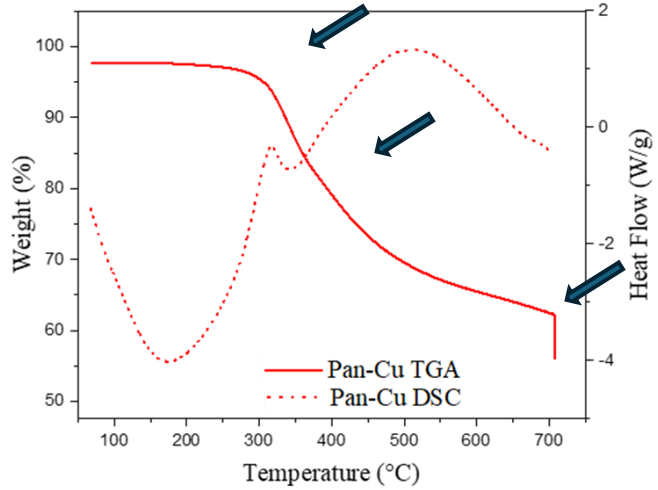


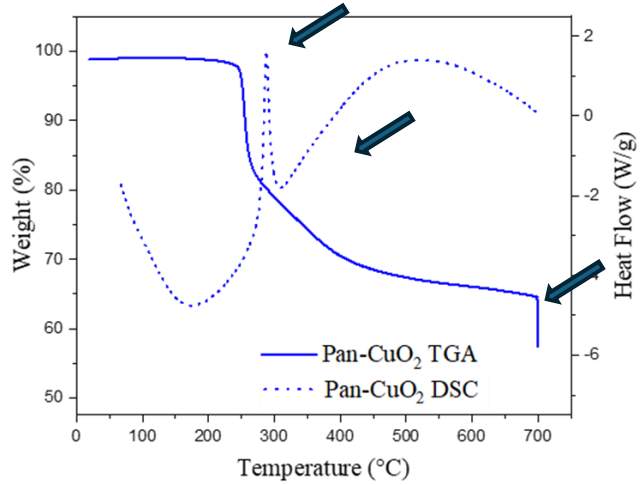


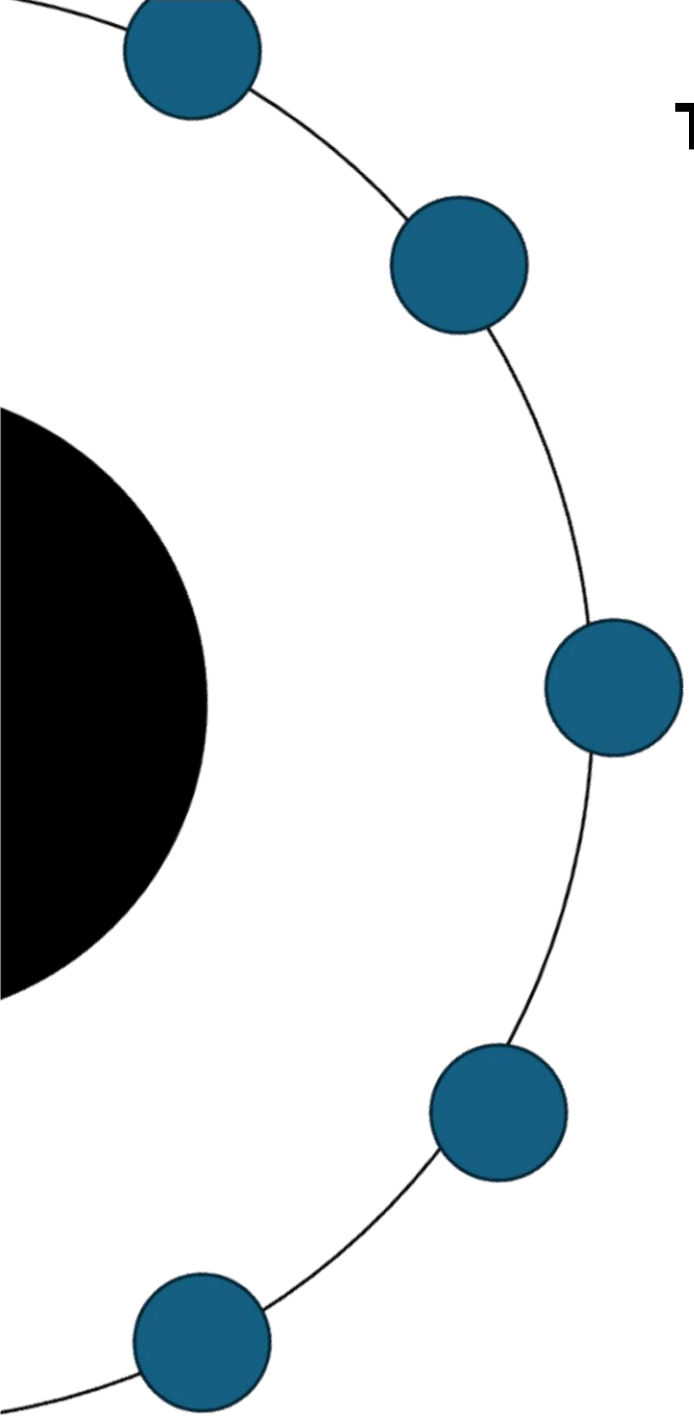
Differential scanning calorimetry and thermo gravimetric analysis

	A	B	C
Carbon (N_2)	Pan	Pan-Cu	Pan-CuO_2









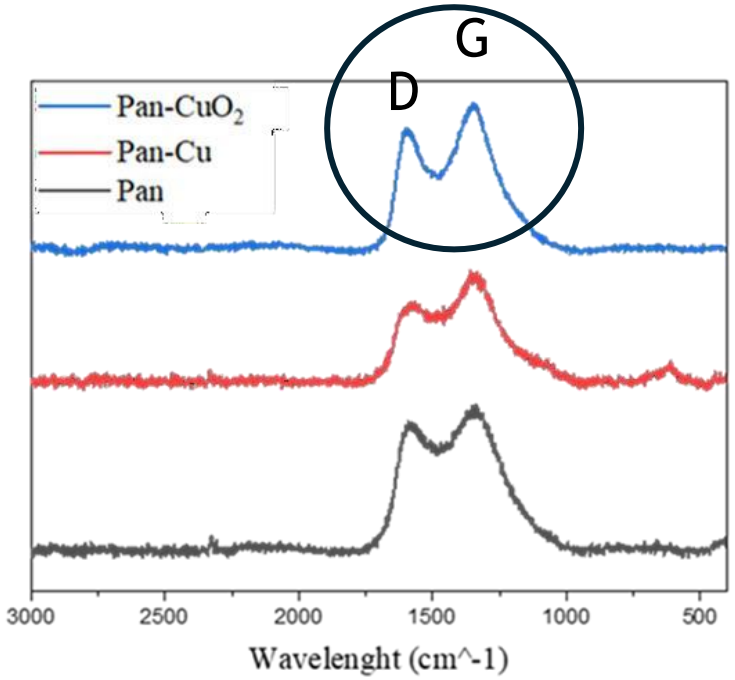
Thermal DSC and TGA analysis

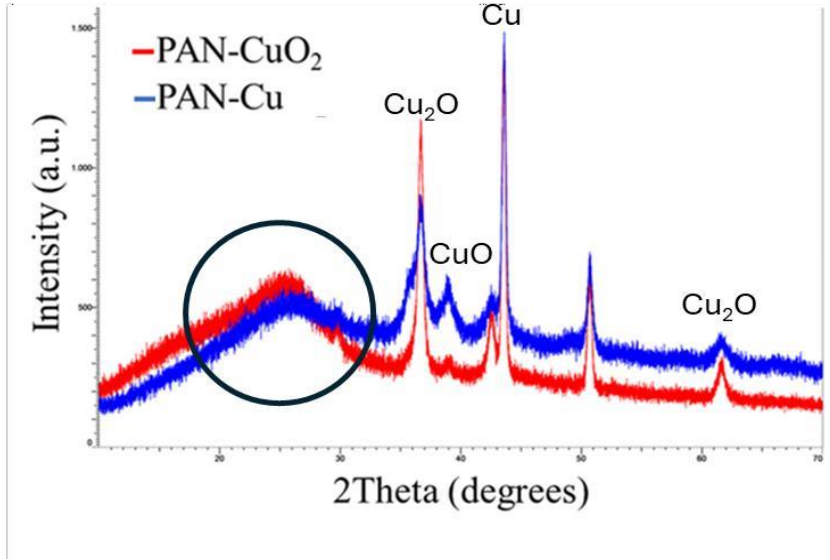
Raman Spectroscopy and X-Ray diffraction Analysis

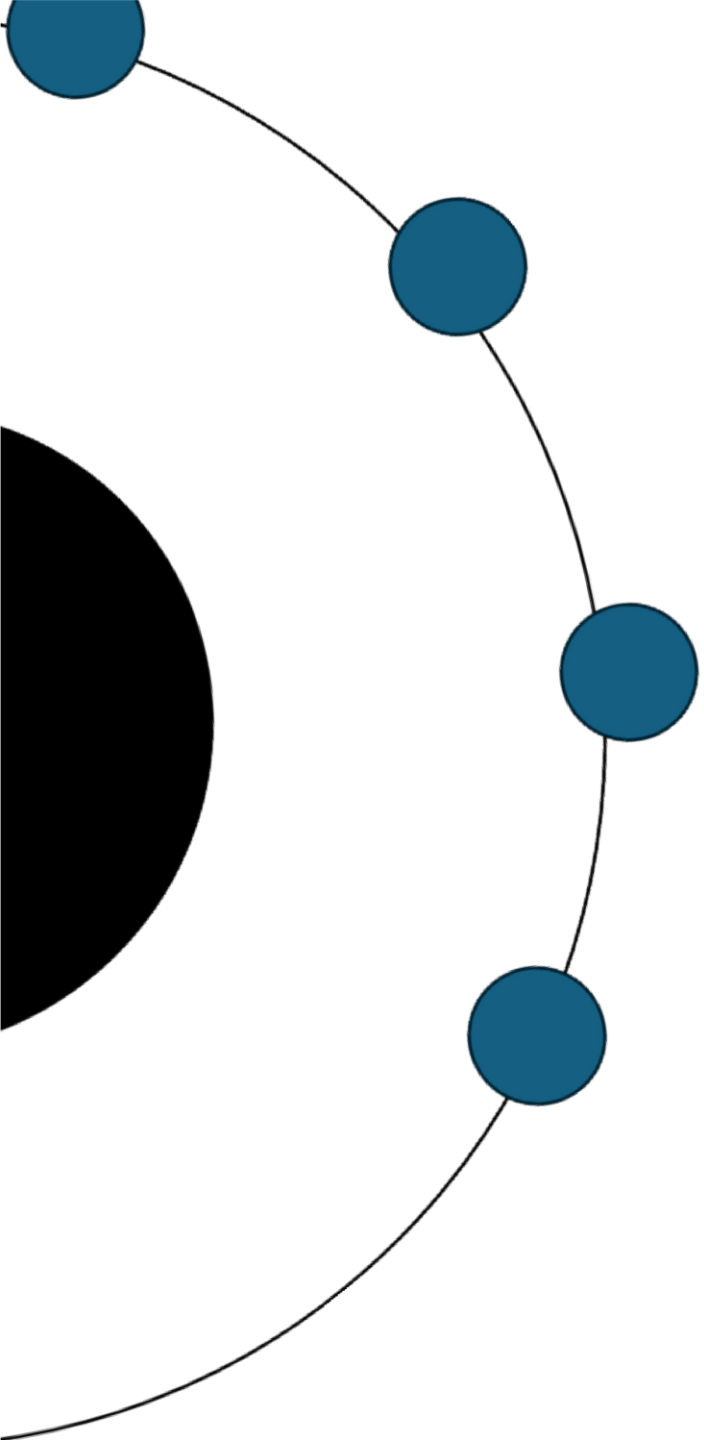
Infrared spectroscopy analysis

Raman Spectroscopy and X-Ray diffraction Analysis

	A	B	C
Carbon (N_2)	Pan	Pan-Cu	Pan-CuO_2







Raman Spectroscopy and X-Ray diffraction Analysis

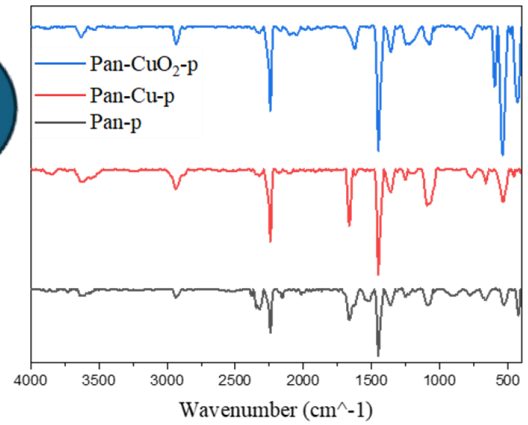
Infrared spectroscopy analysis

Conclusion

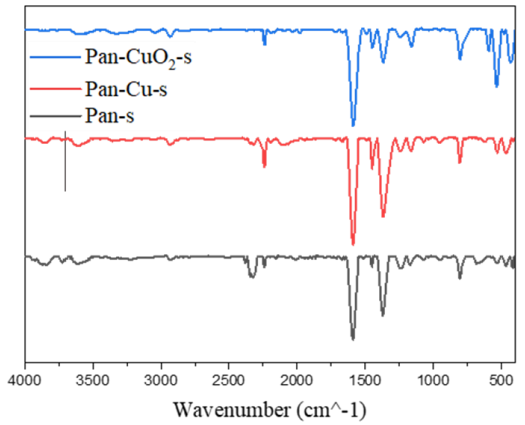
Infrared spectroscopy analysis

	A	B	C
Pristine	Pan-p	Pan-Cu-p	Pan-CuO_2-p
Stabilized (air)	Pan-s	Pan-Cu-s	Pan-CuO_2-s
Calcined (N_2)	Pan-c	Pan-Cu-c	Pan-CuO_2-c

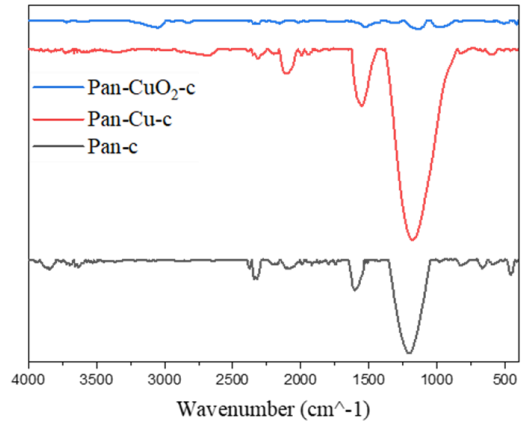
Electrospinning

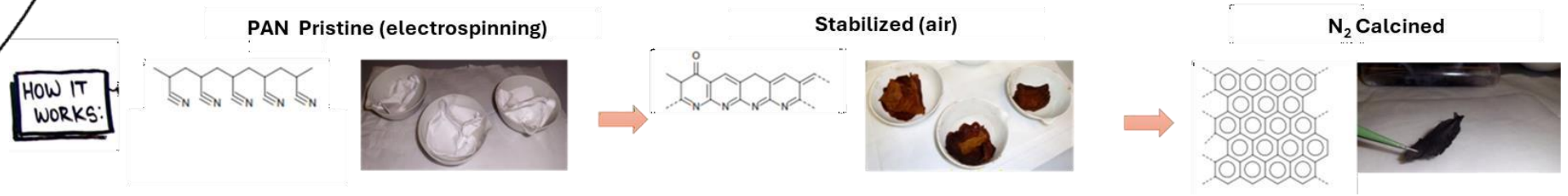


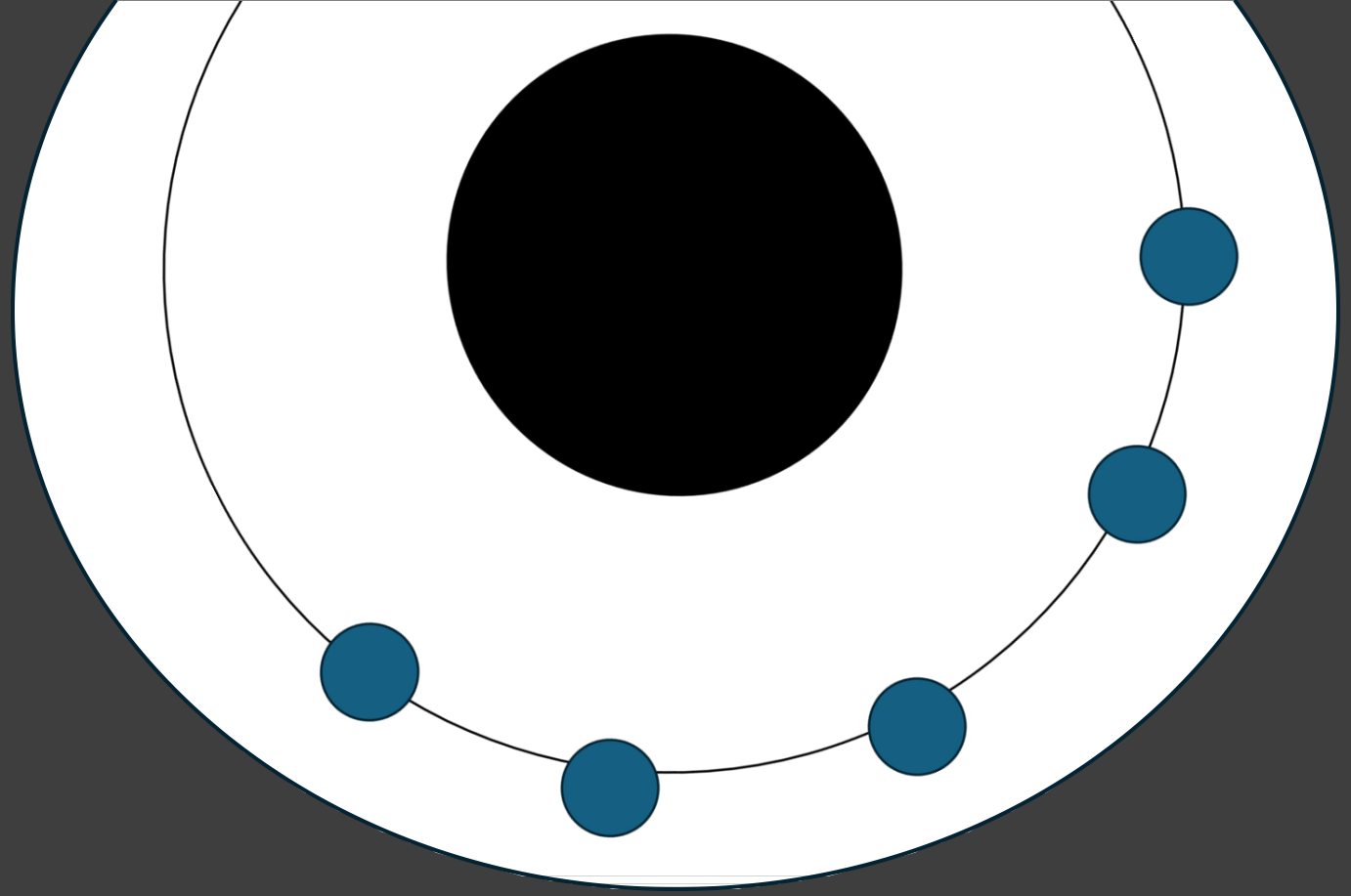
Stabilization



Carbonization







Conclusion

The chemical-physical characterization of the membranes allowed us to identify the optimal morphological configurations for future electrochemical applications. These results represent a step forward towards the large-scale application of innovative and sustainable materials for the batteries of the future.