Study on Cu(II) Metal Ion Adsorption Performance of the Lignosulfonate Activated Carbon Fiber (LACF)

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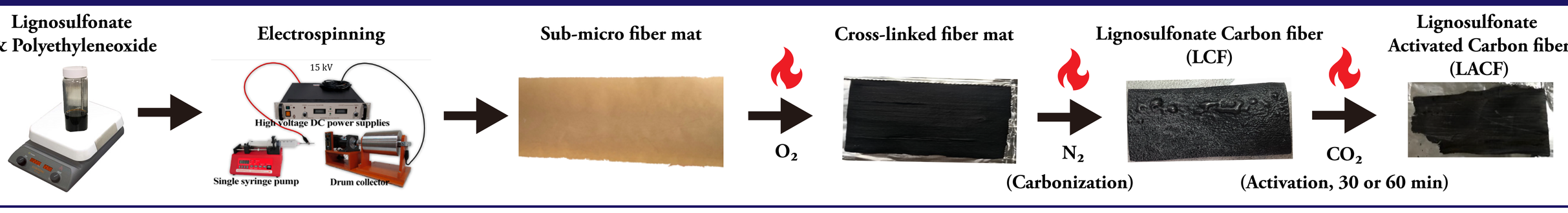
Motivation

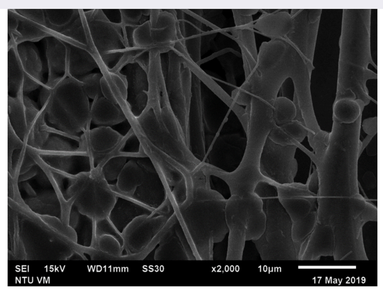
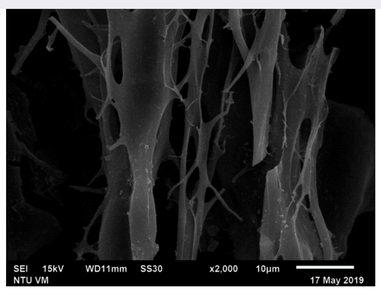
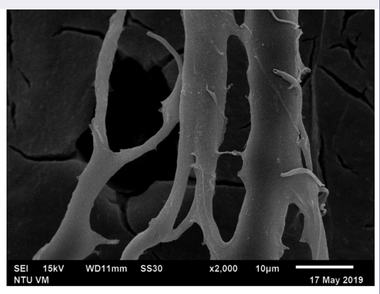
- Lignosulfonate, a byproduct from paper industry, is usually burnt as fuel. Its high carbon content & easily modified features, make it a suitable activated carbon fiber precursor.
- Physically activated electrospun lignosulfonate activated carbon fiber (LACF) is yet investigated.
- E-wastes are accumulating rapidly, among which copper occupies the largest portion.
- Goal: (1)Prepare LACF ; (2)Study Cu(II) adsorption performance

Materials & Methods



Results & Discussions

Physical Characterization

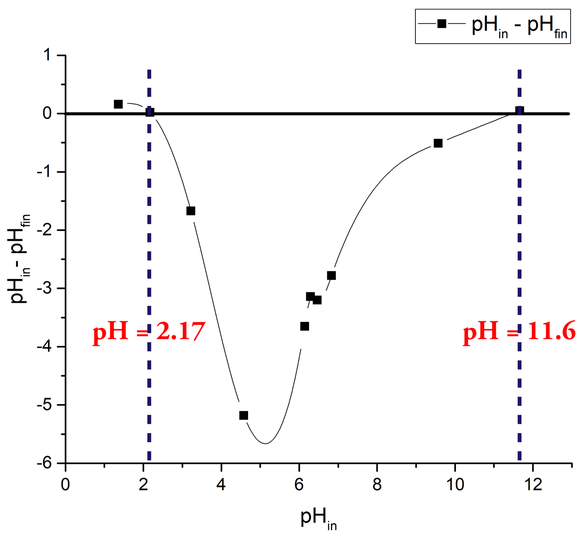
	LCF	LACF－30	LACF－60
			
WL (%)	40.41 ± 2.81 [a]	60.63 ± 10.77 [b]	70.37 ± 7.78 [b]
SSA (m^2/g)	8.94 ±5.77 [a]	174.85 ± 64.33 [a,b]	276.89 ± 114.80 [b]
TPV (cm^3/g)	0.01 ± 0.004 [a]	0.14 ± 0.044 [b]	0.22 ± 0.057 [b]
PSD (micro:meso)	4 : 96	21 : 79	24 : 76

*WL: Weight Loss; SSA: Specific Surface Area; TPV: Total Pore Volume; PSD: Pore Size Distribution

*WL is lower in LCF; but only LACFs have compatible SSA, TPV, & PSD

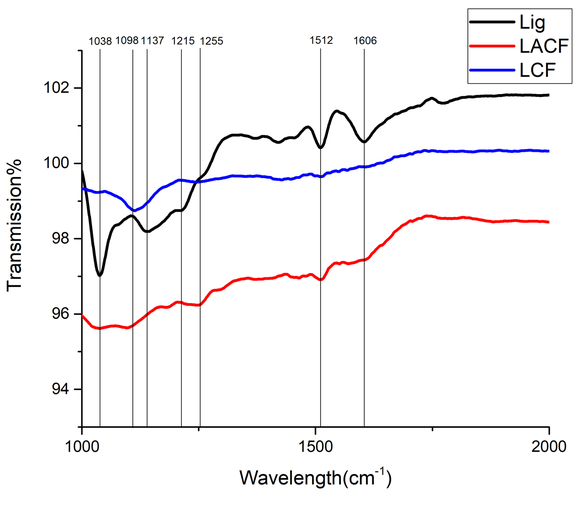
Chemical Characterization

(1) Point of Zero Charge (PZC) & Zeta Potential (ZP)



PZC = 2.17 & 11.6	
2.17 < pH < 11.6	Negative Charged
ZP @ pH = 6.4	～ －35 mV
pH < 2.17 or pH >11.6	Positive Charged

(2) Fourier - Transform Infrared Spectroscopy (FTIR)

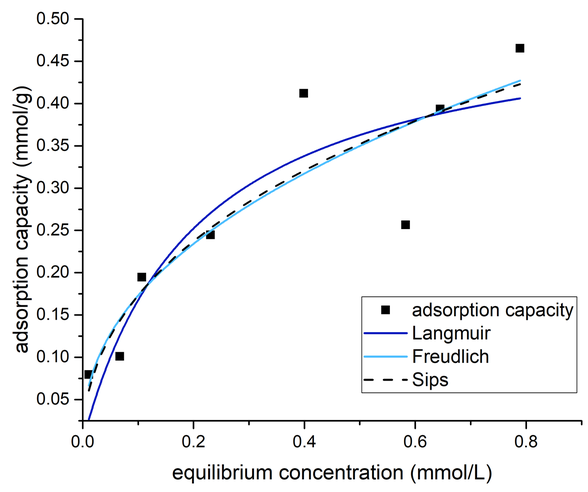


(cm^{-1})	Group	Lig	LCF	LACF
1038	C-O stretch/ vib.	v		v
1098			v	v
1137		v		
1215		v		
1255	C-O-C vib. (Lactone)			v
1512	C=O stretch (Carboxyl)	v		v
1606		v		v

*Lig: Lignosulfonate; vib.: vibration

*Under various pH, LACF can carry negative or positive charge on the surface; it has useful oxygen-containing groups

Batch Adsorption



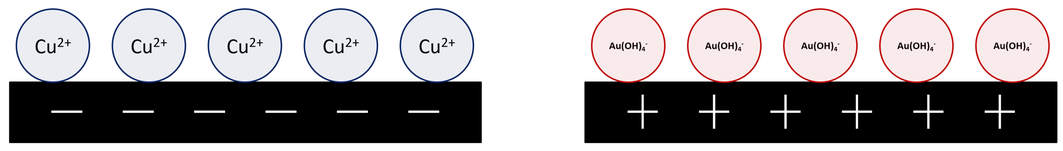
Model	Comments	R^2
Langmuir	uniform adsorption	0.77
Freudlich	not-uniform adsorption	0.79
Sips	in between	0.68
ΔG^0	～－21 KJ/mol (physi & chemisorption)	

*Copper adsorption follows Freudlich, showing uneven activation sites on LACF; ΔG^0 lies between physi & chemisorption

Adsorption Mechanism Assumptions

(1) Physisorption

(i) Electrostatic Force



2.17 < pH < 11.6

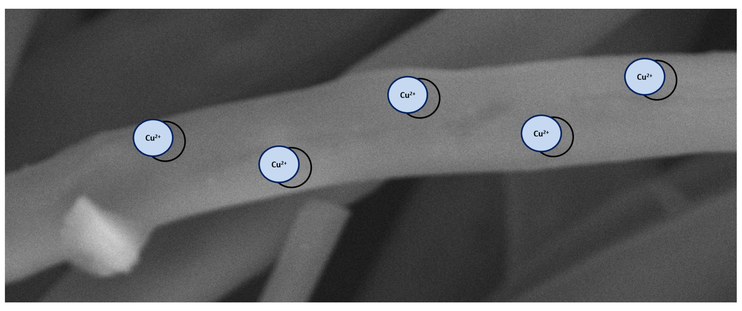
For Cu^{2+}: 2.17 < pH < 5.5 (precipitation)

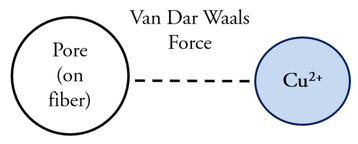
pH < 2.17 or pH >11.6

For Au^{+}: 2.17 < pH , ∵ pH >10 (precipitation)

*Various pH leads to negaitve or positive surface, which adsorbs different types of metal ions by attractive Coulumbic force.

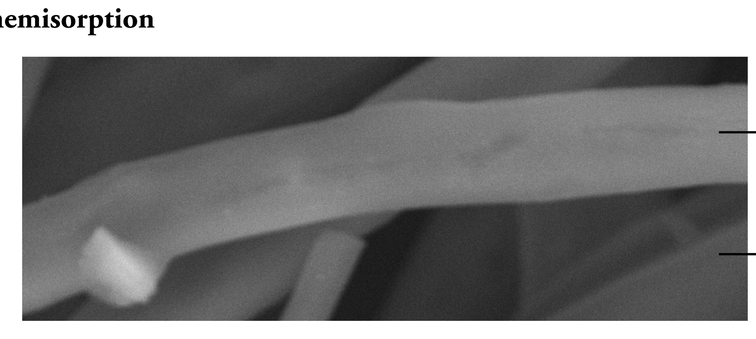
(ii) Van Dar Waals Force

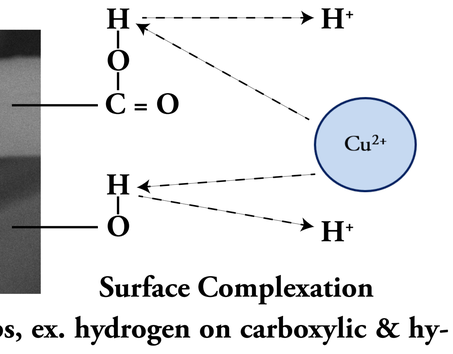




*LACF contains micro & mesopores, which are on a similar scale with metal ions. In Cu(II)'s case (600pm), micropores on fibers assist the formation of Van Dar Walls force.

(2) Chemisorption





Surface Complexation

*Copper metal ions complexate with oxygen-containing groups, ex. hydrogen on carboxylic & hydroxylic groups, assisting chemisorption.

Conclusions

- The lab-made LACF pocesses favorable features for metal-ion adsorption.
- Physical features: compatible SSA, TPV, and PSD, which assist physisorption.
- Chemical features: negative or positive surface in accordance to pH change, and oxygen-containing groups, which assist chemisorption
- Future work: Desorption & Dynamic adsorption test for practical use.

Acknowledgements

This work was financially supported by the "Advanced Research Center for Green Materials Science and Technology" from The Featured Area Research Center Program within the framework of the Higher Education Sprout Project by the Ministry of Education (108L9006) and the Ministry of Science and Technology in Taiwan (MOST 108-3017-F-002-002)