Improving the electrochemical catalyst performance of VRFB electrodes using carbon nanomaterials

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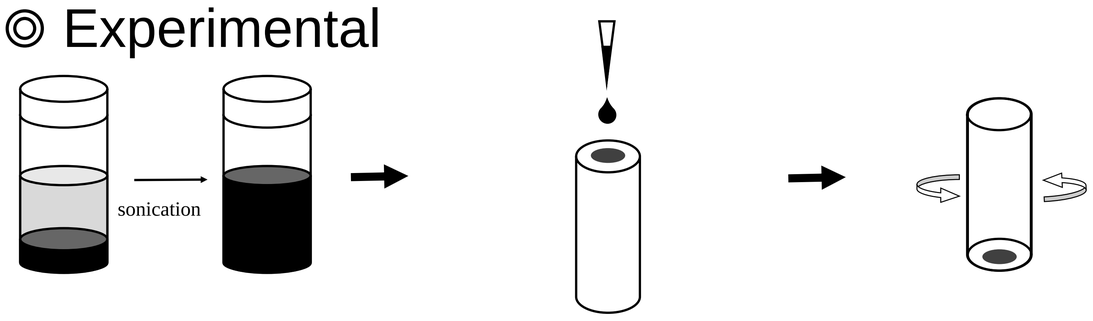
◎ Introduction

- **The redox flow battery (RFB)** is emerging as a potential grid-scale electric energy storage system (ESS) to cope with the intermittent nature of solar and wind power.
- **vanadium redox flow battery (VRFB)**, which utilizes vanadium ion pairs for both the positive- and the negative-side redox reactions is currently one of the leading RFB systems, and in an early stage of commercial deployment.
- The purpose of this study is investigating and analyzing **kinetic effects of carbon nanomaterials** for vanadium redox kinetics by using rotating disk electrode(RDE) and

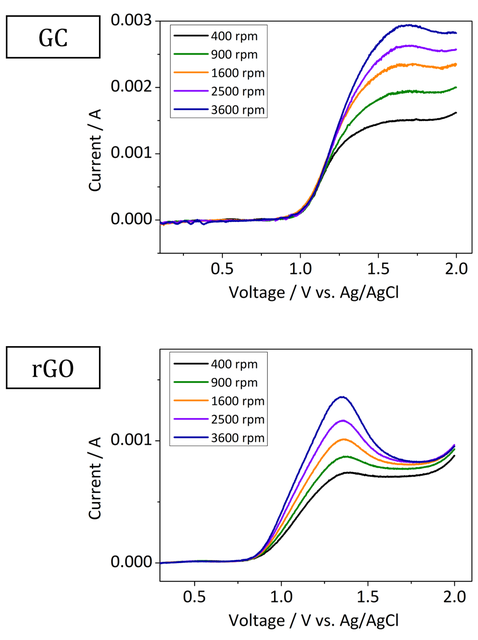
◎ Experimental

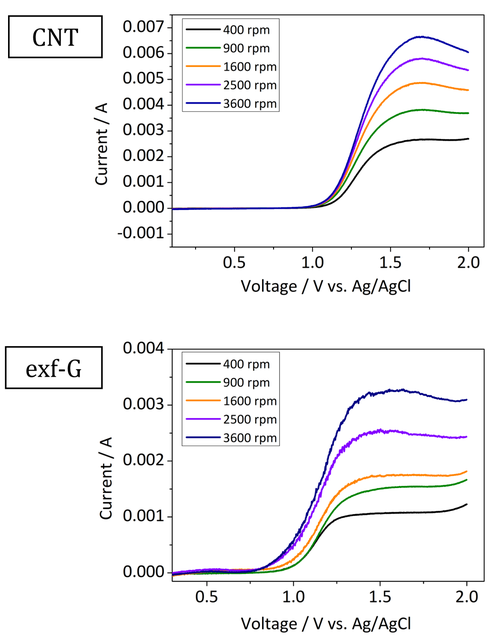


1) Each carbon materials disperse in specific solution (rGO : water 4 mL+ iso-propanol 1 mL, CNT, exf-G : EtOH 3 mL + iso-propanol 2 mL)
2) Using dispersion solution, we put carbon materials on surface of glassy carbon(GC) electrode with micro pipette.
3) Electrocatalytic properties of carbon materials were characterized by LSV and EIS using RDE.

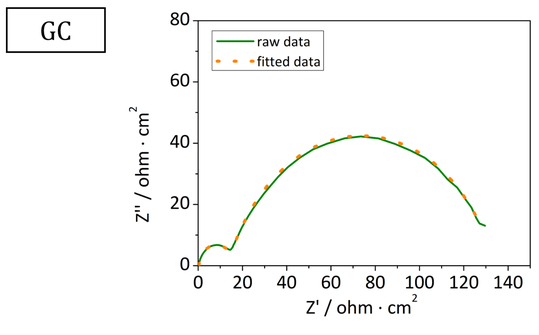
◎ Results and Discussion

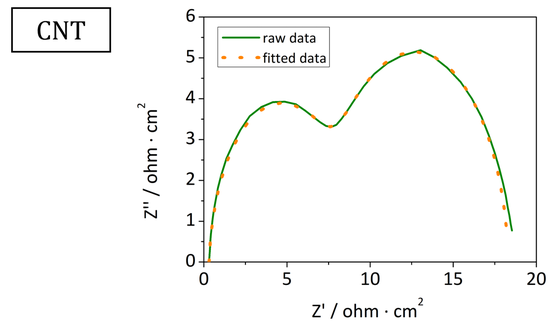
- LSV results of each carbon materials at certain rpm.

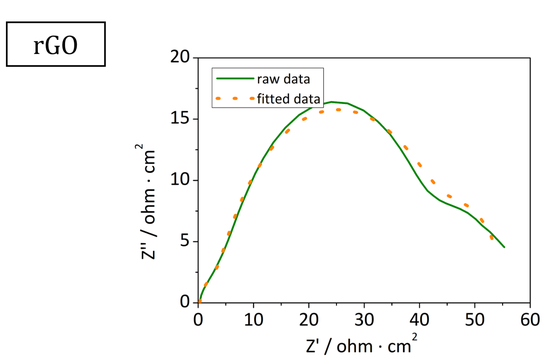


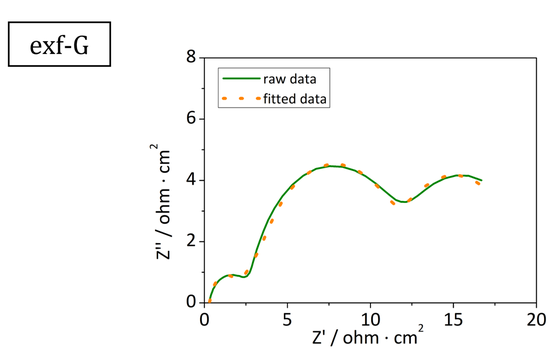


- EIS results of each carbon materials at 1600 rpm.





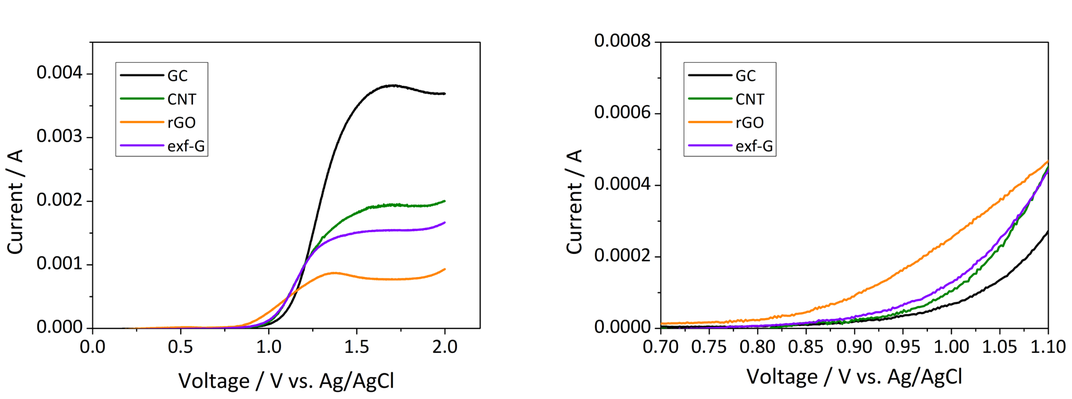




- Calculation of reaction rate constant(k_0) using Koutechy – Levich equation and Tafel plot.

	GC	CNT	rGO	exf-G
k_0	2.25×10^{-4}	5.00×10^{-4}	6.55×10^{-3}	3.95×10^{-3}

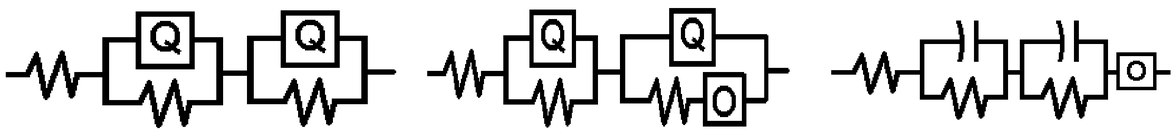
- Relation of k_0, peak current and onset potential.



LSV result of 900 rpm

	Resistance (ohm·cm²)				
	R_{ohm}	R_{hf}	R_{ct}	n_1	n_2
GC	0.326	13.6	120	0.926	0.783
CNT	0.308	7.62	10.6	0.943	0.937
rGO	0.306	2.63	40.9	0.850	0.794
exf-G	0.294	1.34	7.58	-	-

- Each open circuit model of carbon materials.



CNT, GC rGO exf - G

◎ Conclusions

1) Kinetic effects of carbon nanomaterials are analyzed by using RDE and various electrochemical analysis methods.
2) Carbon nanomaterials make vanadium redox reaction rate and charge transfer resistance low.
3) Each carbon nanomaterials have a different functionality. and they must be used properly depending on the situation.