Synthesis of carbon and Ag-doped carbon prepared by hydrothermal for supercapacitor application

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1. Introduction

Nowadays, supercapacitor, one of energy storage devices, is becoming popular due to its rapidly charging and discharging rate, small size, light weight and long term of use. Therefore, it is suitable for new technology by using with batteries in electronic circuits, for example, electrical vehicles and pacemakers. Supercapacitor can be divided into two main groups by its mechanism, Pseudocapacitor based on redox reaction and Double-layer capacitor based on electrostatics. Double-layer capacitor could be fabricated to be more stable (Jocelyn E. Zuliani, 2015) if proper electrodes are used. In this project we synthesize and investigate carbons, which has high surface area and be a good ion transmitter (Yang Fan, 2014), and Ag-doped carbons in different ratio of silver to be used in Double-layer capacitor, by attached them to the electrodes of the supercapacitor which could provide more space to carry ions.

2. Objective

This project aimed to synthesize carbon and Ag-doped carbon by hydrothermal process and investigate the surface morphology and the component of elements on electrode surface by scanning electron microscopy (SEM) and dispersive X-ray spectrometer (EDX), then find the best ratio of silver in synthesis process that provide the highest specific capacitance.

3. Methodology

We synthesized Ag-doped carbon spheres by using glucose 1.25 grams with $AgNO_3$ per DI water 50 ml. Heated at 200°C, 10 hrs. by hydrothermal process to form the structure, then heated at 450°C, 2 hrs in argon atmosphere to prevent the contamination, as shown in figure 1.

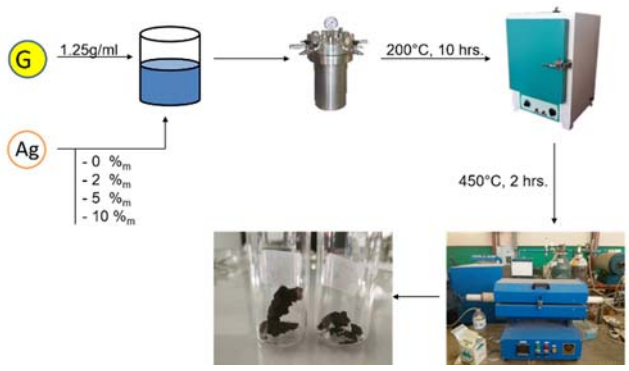


Figure 1 shows how Ag-doped carbon spheres were synthesized.

After that, Ag-doped carbon spheres were mixed with Poly (vinylidene fluoride) which role as the glue. To make the mixture electrically conductive, carbon black was added. The weight ratio of carbon spheres: carbon black: Poly (vinylidene fluoride) was 80:10:10.

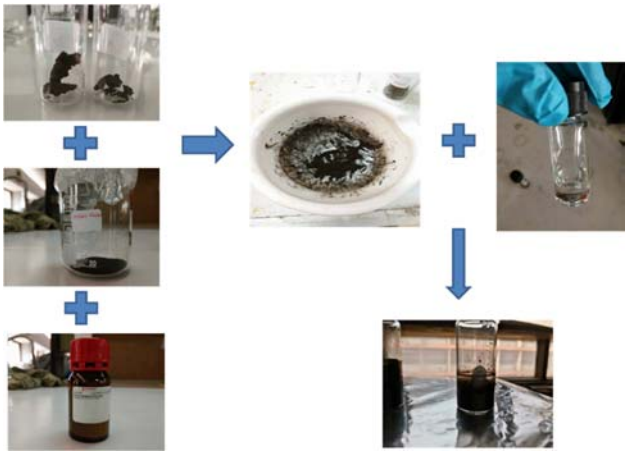
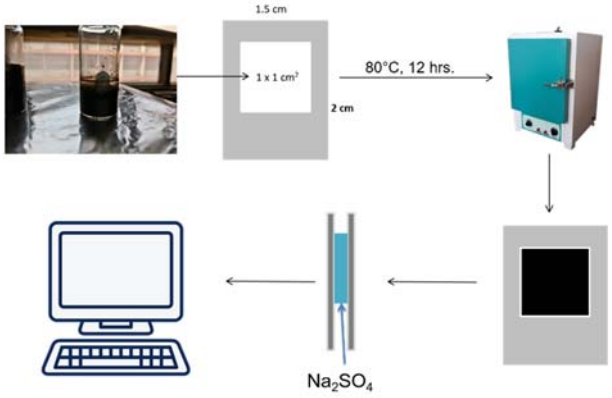


Figure 2 shows how the solution was made.

Ag-doped carbon spheres films on stainless electrodes were prepared by using spin coating technique. The films were heated at 80°C for 12 hrs. to get rid of the NMP (solvent of Poly). A supercapacitor was fabricated by using 2 stainless electrodes with Na_2SO_4 electrolyte. The measurements of the capacitance were carried out with charge-discharge technique by using a computer-controlled system, as shown in figure 3.



Picture 3 shows how the film was made and how we measure the capacitance.

4. Results

SEM images in figure 4 (a)-(d) was taken in micro scale, the figures show that carbon is more likely to form into sphere and bigger when the silver ratio increase. EDX spectra of Ag doped carbon in figure 4 (e)-(h) show three main peaks identified as carbon, gold and copper. The gold and copper signals are from the gold-coated copper coin which was used as a plate.

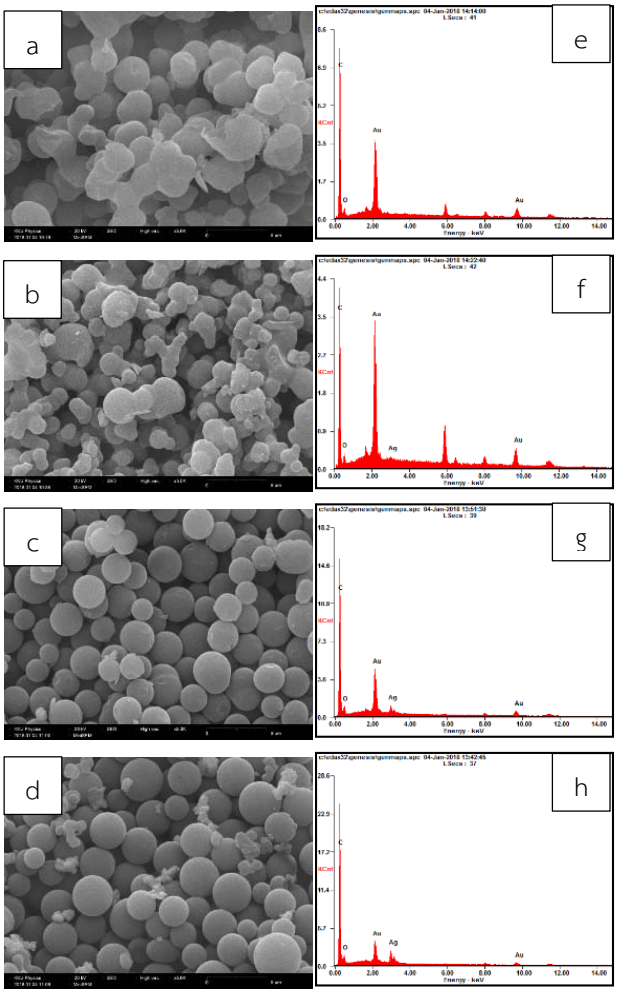


Figure 4 shows the SEM images of Ag-doped carbon spheres which prepared with silver ratio 0%(a), 2%(b), 5%(c), and 10%(d) and shows the EDX of Ag-doped carbon spheres which prepared with silver ratio 0%(e), 2%(f), 5%(g), and 10%(h)

The measurement results of specific capacitance are shown in figure 5. Ag-doped carbon which synthesized with 2% of silver provided the highest specific capacitance at 1 A/g and Ag-doped carbon which synthesized with 5% of silver provided the highest specific capacitance at 2 A/g

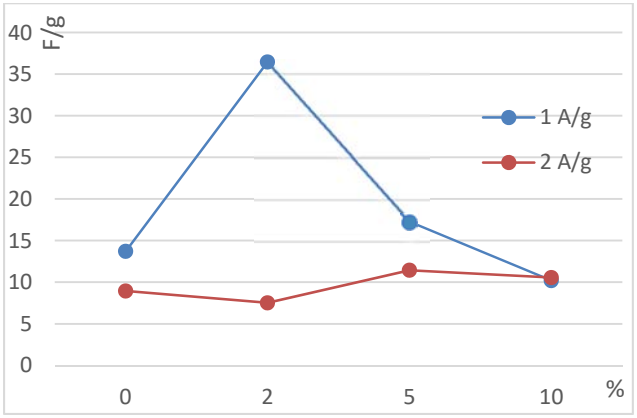


Figure 5 shows the specific capacitance of the supercapacitors using the electrodes doped with various Ag concentrations.

5. Conclusion

It was demonstrated that Ag-doped carbon spheres could be synthesized by hydrothermal process at 200°C. Silver plays a role in carbon structural formation. Carbon is likely to form into spheres when the silver ration increase. It was found that the specific capacitance could be increased by doping Ag in carbon films on the electrodes. However, there was no clear relation between the increase of the specific capacity and the silver concentration and thus further investigations are needed.

6. Acknowledgement

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7. References

Jocelyn E. Zuliani. 2015. Considerations for consistent characterization of electrochemical double-layer capacitor performance.
Yang Fan. 2014. Micro-mesoporous carbon spheres derived from carrageenan as electrode material for supercapacitors.