Facile synthesis of rGO doped transition metal oxide nanostructured materials for high energy/power density supercapacitor applications

Introduction

Gradual exhaustion of fossil fuel as well as the increase of CO_2 emissions has been arousing the search and development of renewable energy sources, such as solar, wind, ocean and biomass. To use such energy sources efficiently, high energy/power and long-lifetime energy storage devices are generally required. Meanwhile, future extensive popularization of electric vehicles, smart grids, and various portable and wearable electronics also stimulates the demand for high-performance energy storage devices. The current lithium-ion batteries were having ability to store large amount of energy (>100 W h kg^{-1}) via bulk redox reactions in electrodes, it has already been widely used in portable electronics such as laptops, smartphones and electric vehicles. Nevertheless, low power density of lithium-ion batteries cannot simply meet the requirements for acceleration, braking, and climbing of electric vehicles.

On other hand, EDLC type supercapacitors have the ability to provide much more power density than lithium-ion batteries. The high cost of the carbon derivatives used in the conventional EDLC supercapacitors and its poor energy density are the key issues in some commercial applications. To felicitate this, researchers focusses on metal oxide based pseudocapacitors due to their high energy density. The common metal oxides such as NiO, MnO_2, V_2O_5, Co_3O_4, RuO_2 and TiO_2 etc., are used in pseudocapacitors. But power density of these metal oxide pseudocapacitors were very low. To overcome this issue, researchers were working on nanostructured carbon derivatives (rGO, CNT, g-C_3N_4) doped metal oxide nanocomposites for high power/energy density supercapacitors.

Research work plans

- Hydrothermal synthesis of rGO doped MnO_2/NiO hierarchical nanostructures for high performance supercapacitor applications.
- Decoration of high energy density $LiCoO_2$ on functionalized CNT for high energy/power density supercapacitor applications.

- Synthesis of rGO doped RuO_2/MnO_2 nanocomposite for hybrid supercapacitor applications.

REFERENCES

[1] J. Zhao, Y. Tian, A. Liu, L. Song, Z. Zhao, The NiO electrode materials in electrochemical capacitor: A review, Mater. Sci. Semicond. Process. 96 (2019) 78–90. doi:10.1016/j.mssp.2019.02.024.

[2] D. Zhu, Y. Shao, NiO/ZnO nanocomposite as electrode material for supercapacitors, Int. J. Electrochem. Sci. 13 (2018) 3601–3612. doi:10.20964/2018.04.45.

[3] H. Zhang, J. Gu, J. Tong, Y. Hu, B. Guan, B. Hu, J. Zhao, C. Wang, Hierarchical porous MnO_2 /CeO_2 with high performance for supercapacitor electrodes, Chem. Eng. J. 286 (2016) 139–149. doi:10.1016/j.cej.2015.10.057.

[4] S. Kulandaivalu, M.Z. Hussein, A. Mohamad Jaafar, M.A.A. Mohd Abdah, N.H.N. Azman, Y. Sulaiman, A simple strategy to prepare a layer-by-layer assembled composite of Ni–Co LDHs on polypyrrole/rGO for a high specific capacitance supercapacitor, RSC Adv. 9 (2019) 40478–40486. doi:10.1039/C9RA08134H.

[5] S. Sundriyal, V. Shrivastav, M. Sharma, S. Mishra, A. Deep, Significantly enhanced performance of rGO/TiO_2 nanosheet composite electrodes based 1.8 V symmetrical supercapacitor with use of redox additive electrolyte, J. Alloys Compd. 790 (2019) 377–387. doi:10.1016/j.jallcom.2019.03.150.

[6] R. Thangappan, M. Arivanandhan, R. Dhinesh Kumar, R. Jayavel, Facile synthesis of RuO_2 nanoparticles anchored on graphene nanosheets for high performance composite electrode for supercapacitor applications, J. Phys. Chem. Solids. 121 (2018) 339–349. doi:10.1016/j.jpcs.2018.05.049.

[7] L. Sui, S. Tang, Z. Dai, Z. Zhu, H. Huangfu, X. Qin, Y. Deng, G.M. Haarberg, Supercapacitive behavior of an asymmetric supercapacitor based on a $Ni(OH)_2$/XC-72 composite, New J. Chem. 39 (2015) 9363–9371. doi:10.1039/C5NJ01872B.