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# Electrochemical performance enhancement by using graphene for energy storage and catalysis

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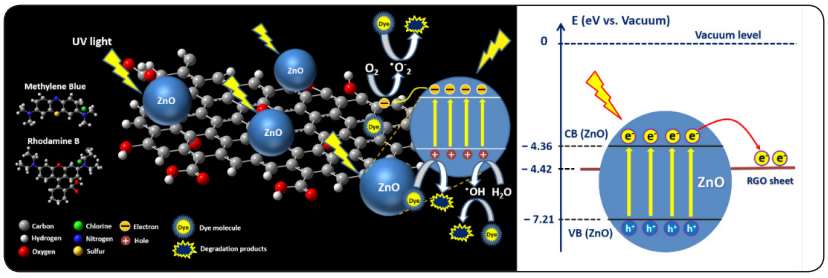
Metal oxide or sulfide nanomaterials have been developed for energy storage (supercapacitor), photo catalysis and sensor applications. Their performances have not been satisfactory and are being improved by several different ways. Two or three transition metals have been employed or reaction conditions have been tuned to get the best results. Transition metal oxides or sulfides have low thermal conductivities that result in low super capacitive and catalytic performance. To overcome this limitation, various materials that can improve the conductivity such as graphene and carbon nanotubes have studied extensively. Owing to their large surface area and high electrical conductivity, synergistic effects of excellent conductivities of graphene and high electrical properties of metal oxides or polymers have improved the overall electrochemical performances tremendously. In this study, graphene (natural or synthesized), graphene oxide, reduced graphene oxide, highly reduced graphene oxide have been tested for improving performances as a super capacitor, sensor and photocatalyst. Other methods have also been used such as doping of graphene with nitrogen or sulfur, using metal sulfides instead of metal oxides and using highly porous materials as substrates. In the synthesis of these materials, a cleaner technology has been employed.




**Scheme 1:** Mechanism of the photodegradation of dyes and illustration of electron transfer between the RGO sheets and ZnO under UV light in the presence of the ZnO/RGO catalyst.

## Recent Publications

1. Mady A H, Baynosa M L, Tuma D and Shim J J (2017) Facile microwave-assisted green synthesis of Ag-$ZnFe_2O_4$@rGO nanocomposites for efficient removal of organic dyes under UV- and visible-light irradiation. Applied Catalysis B: Environmental 203:416-427.
2. Mohamed S G, Hussain I and Shim J J (2018) One-step synthesis of hollow C-$NiCo_2S_4$ nano-structures for high-performance supercapacitor electrodes. Nanoscale 10:6620-6628.
3. Lamiel C, Nguyen V H, Kumar D R and Shim J J (2017) Microwave-assisted binder-free synthesis of 3D Ni-Co-Mn oxide nanoflakes@Ni foam electrode for supercapacitor applications. Chemical Engineering Journal 316:1091-1102.
4. Sahoo S and Shim J J (2017) Facile synthesis of three-dimensional ternary $ZnCo_2O_4$/reduced graphene oxide/NiO composite film on nickel foam for next generation supercapacitor electrodes. ACS Sustainable Chemistry and Engineering 5(1):241-251.
5. Nguyen V H and Shim J J (2015) Three-dimensional nickel foam/graphene/$NiCo_2O_4$ as high-performance electrodes for supercapacitors. Journal of Power Sources 273:110-117.

## Biography

Jae-Jin Shim received his BS degree from Seoul National University in 1980, MS degree from KAIST in 1982, PhD degree from the University of Texas at Austin in 1990. He has been a Professor in Yeungnam University since 1994 and served as School Chairman and Vice-Dean of Engineering. He served as the President of the Korean Society of *Clean Technology* and Vice President of the Korean Society of Engineering Education. He is the Director of the Institute of *Clean Technology* and the Clean Energy Priority Research Center. He has published more than 160 papers in reputed journals and served as the Chief Editor of *Clean Technology*. His current research interests are synthesis and applications of graphene (or carbon nanotube) based nanomaterials for supercapacitors, catalysts and sensors; synthesis of polymers and organic materials using supercritical fluids and ionic liquids; living polymerization in supercritical fluids and ionic liquids and *clean technology*.

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