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# NEWSLETTER

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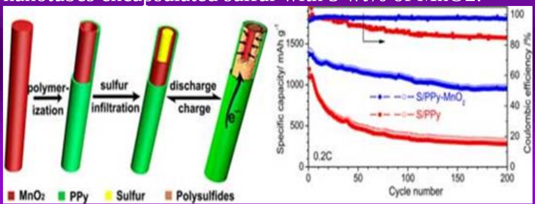
# ADVANCEMENTS IN NANO TECHNOLOGY

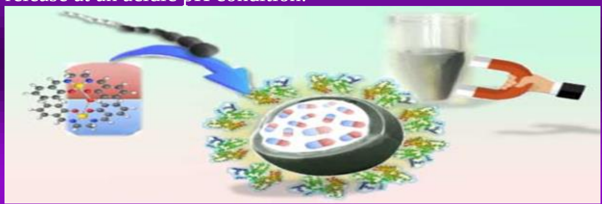
## Improving the performance of lithium-sulfur batteries with coaxial nanotubes

Lithium-sulfur (Li-S) batteries, which employ sulfur as cathode and metallic lithium as anode materials, have been extensively studied as promising alternatives to the widely used lithium-ion batteries because theoretically they can render 3-6 times higher energy density (2600 Wh kg-1) than conventional lithium-ion batteries with a theoretical value of 400-600 Wh kg-1. However, due to the intrinsic insulating nature of the active material, Li–S batteries have suffered from low utilization of sulfur and thus low energy density. Fabricating electrodes with higher mass ratio of sulfur has therefore been a key focus of Li-S battery research. Moreover, during the charging and discharging process, the reaction intermediates (lithium polysulfides) are highly soluble in the ether-based electrolyte. The dissolved lithium polysulfides will shuttle to the anode side and react with it, causing undesired discharging. Therefore, Li–S battery is facing challenges of low Coulombic efficiency and poor cyclic stability. In new work, researchers have designed PPy-MnO2 coaxial nanotubes with adjustable content of MnO2 to encapsulate sulfur as a high-performance cathode for Li-S batteries. Compared with pure PPy encapsulated sulfur, the S/PPy-MnO2 composites show much enhanced electrochemical performance, including Coulombic efficiency, cyclic stability, and rate capability. MnO2-PPy coaxial nanotubes provide a highly conductive matrix for sulfur and more importantly, strong trapping ability for polysulfides. The controlled deposition of discharging product in S/PPy-MnO2 composites is also another key factor for cyclic stability. If lithium sulfide is randomly deposited on surface of electrode, the insulating nature will make it lose electric contact with current collector and can not be used in the following recharging process. Researchers have achieved a stable Coulombic efficiency of ~98.6% and a decay rate of <0.07% per cycle with 500 cycles at 1C-rate (charge/discharge at 1 hour) for polypyrrole-MnO2 nanotubes encapsulated sulfur with 5 wt% of MnO2.




## Smart molecular magnet-enabled novel and simple recipe for cancer targeting

Molecular magnets or single molecule-based magnets are usually anti-ferromagnetic at room temperature, which so far has limited their use to laboratory environments. As the first successful molecular magnet in a real-world application, a new 'exotic' molecular magnet compound, iron salen nanoparticles, which shows intrinsic magnetic nature at room temperature as well as anticancer properties. The researchers have demonstrated that the 'unconventional' drug compound possesses a unique molecular structure with multifunctional features such as localized magnetic drug delivery, MRI imaging, and magneto-hyperthermia, for targeting various cancers such as for instance oral tumors and glioblastoma. However, the compounds have some shortcomings: they lose magnetism in organic solvents and are difficult to dissolve in an aqueous solution; similar to other existing chemotherapeutic drugs like Taxol, MTX, and DOX. This can result in severe side effects due to potential cytotoxicity when accumulated in healthy tissues and organs, and thus limits their clinical practices. Very recently, the researchers have overcome this problem by employing a one-step self-assembly technique using smart conducting copolymers, which allowed him to formulate an efficient delivery platform with high drug-loading efficiency of the water-insoluble anticancer drug (iron salen). The smart copolymer that he used in the study is consisted with two types of polymers – polypyrroles (PPy) and polycaprolactones (PCL) – as pH- and temperature- responsive components, respectively, and these copolymers are highly biodegradable. As a result, by a hydrophobic-hydrophobic interaction between the drugs and PCLs of the polymers, the drugs in a solvent can be loaded inside the PCL matrix encapsulated by PPy shells, forming a core-shell structure. Subsequently, this structure can be readily coated by natural bioadhesive agents such as albumin or gum arabic. Compared with standalone iron salen, not only were their solubility, biocompatibility and stability improved, but they show enhanced magnetism via a magnetic coupling between the core and shell system, resulting in boosted magnetic drug delivery, higher contrast in MRI, amplified hyperthermal effect, and controlled release at an acidic pH condition.



## NANO PRODUCTS

### Alusion™ Alumina Powders

This is a product of Advanced Nanotechnology Limited, Australia. The uniform molecular structure of Alusion™ provides superior slip, adhesion and transparency. Specifically designed for use in cosmetics, it diffuses any light that the skin reflects, making wrinkles and fine lines difficult to see. Alusion™ is highly transparent, so the powder doesn't change the skin's natural hue. Although some similar technologies are unsuitable for use in cosmetics, Alusion™ is safe to use and approved by the FDA. It's currently used in cosmetics such as face powders, foundations, eye shadow and lipstick, as well as bath and body products.

### Flex-Power® Joint & Muscle Pain Relief Cream

This is the product of the Flex-Power®, Inc., USA. Flex-Power Joint & Muscle Pain Relief Cream's active ingredient is trolamine salicylate (10%), and also contains MSM and Glucosamine. Flex-Power's combined ingredients with nanotech delivery system are what make it so effective. Flex-Power Pain Relief Cream utilizes a nanotechnology system to deliver active ingredients for pain relief through the skin. The product contains Tiny liposomes that are 90 namometers long which can penetrate deep into skin to soothe away muscle pain.

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## A giant leap towards inexpensive and large-scale fabrication of triboelectric nanogenerators for sustainable energy

Notwithstanding the progress in extracting renewable energy from many natural resources through nanotechnologies, a research team have now begun to develop triboelectric nanogenerators (TENGs) for harvesting energy from "good (mechanical) vibrations" including human walking and ocean waves, which are otherwise wasted. TENGs utilize charges arising from friction similar to the static we experience on dry winter days. As like combing your hair with a plastic comb can also build up triboelectricity that allows the comb to attract tiny pieces of paper. This natural affinity for retaining electric charges is pronounced in certain materials, which when integrated in the right combination function as efficient TENGs to generate electricity from mechanical vibrations (e.g., walking and ocean waves) in the surrounding environment. Nanostructuring the materials in a TENG device amplifies the produced energy by increasing the contact area of the surfaces. The Clemson team found a new way to scalably manufacture large area TENGs with a very high-throughput using off-the-shelf materials. The standard techniques reported so far to boost the performance of TENG device involve nano/micro-patterning of the electrodes, which is complex, tedious, and expensive. The Nano Energy article describes a facile procedure for fabricating devices with tens of cm2 area in less than five minutes with readily available and common materials such as polyethylene terephthalate (PET) and Kapton (polyimide) adhesive tape. The market proliferation and large-scale deployment of TENGs for harvesting energy from ocean waves is now possible with a new inexpensive and high-throughput fabrication. Researchers can also integrate them into textiles or staircases for harvesting random mechanical vibrations and they are now endeavoring to make ~m2 area devices to demonstrate practical applications by harvesting energy from ocean waves.