Wonder nanomaterial created from low-cost chemical

A new wonder material that can generate hydrogen, produce clean water and even create energy has been created.

The material can also desalinate water, be used as flexible water filtration membranes, help recover energy from desalination waste brine, be made into flexible solar cells, double the lifespan of lithium ion batteries and can also be used to develop a new type of antibacterial bandage.

Scientists at Nanyang Technological University (NTU) in Singapore, led by Associate Professor Darren Sun have succeeded in developing a single, revolutionary nanomaterial that can do all the above and at very low cost compared to existing technology.

This breakthrough which has taken Prof Sun, from NTU's School of Civil and Environmental Engineering, five years to develop is dubbed the Multi-use Titanium Dioxide (TiO2)

The material is formed by turning titanium dioxide crystals into patented nanofibres, which can then be easily fabricated into patented flexible filter membranes which include a combination of carbon, copper, zinc or tin, depending on the specific end product needed.

"While there is no single silver bullet to solving two of the world's biggest challenges: cheap renewable energy and an abundant supply of clean water; our single multi-use membrane comes close, with its titanium dioxide nanoparticles being a key catalyst in discovering such solutions," Prof Sun said.

"With our unique nanomaterial, we hope to be able to help convert today's waste into tomorrow's resources, such as clean water and energy."

Titanium dioxide is a cheap and abundant material and Prof Sun believes such a low-cost and easily produced nanomaterial is expected to have immense potential to help tackle on-going global challenges in energy and environmental issues.

The material is capable of concurrently producing both hydrogen and clean water when exposed to sunlight, desalinating water as a high flux forward osmosis membrane, being made into a low-cost flexible solar cell to generate electricity and doubling battery life when used as the anode in lithium ion batteries.

It can also be made into a low-cost flexible filtration membrane that is anti-fouling, recover energy from waste desalination brine and wastewater and kill harmful microbial organisms, leading to new antibacterial bandages.

Prof Sun had initially used titanium dioxide with iron oxide to make anti-bacterial water filtration membranes to solve biofouling – bacterial growth which clogs up the pores of membranes obstructing water flow.

But while developing the membrane, Prof Sun's team also discovered that it could act as a photocatalyst, turning wastewater into hydrogen and oxygen under sunlight while still producing clean water. Such a water-splitting effect is usually caused by Platinum, a precious metal that is both expensive and rare.

"With such a discovery, it is possible to concurrently treat wastewater and yet have a much cheaper option of storing solar energy in the form of hydrogen so that it can be available any time, day or night, regardless of whether the sun is shining or not, which makes it truly a source of clean fuel," said Prof Sun.

"As of now, we are achieving a very high efficiency of about three times more than if we had used platinum, but at a much lower cost, allowing for cheap hydrogen production. In addition, we can concurrently produce clean water for close-to-zero energy cost, which may change our current water reclamation system over the world for future liveable cities."

Prof Sun and his team of 20, which includes 6 undergraduates, 10 PhD students and 4 researchers, are now working to further develop the material while concurrently spinning off a start-up company to commercialise the product.