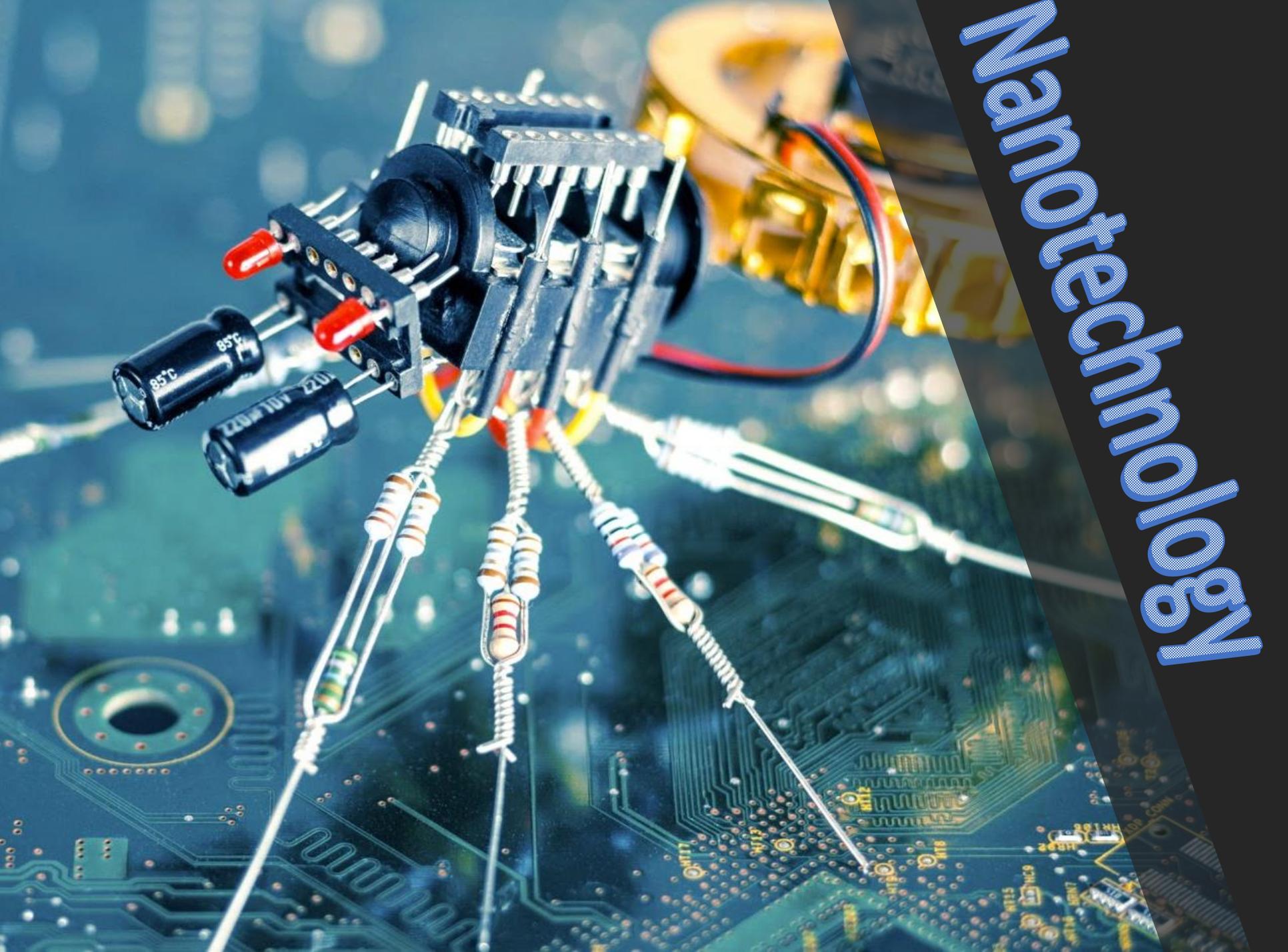


# Nanotechnology



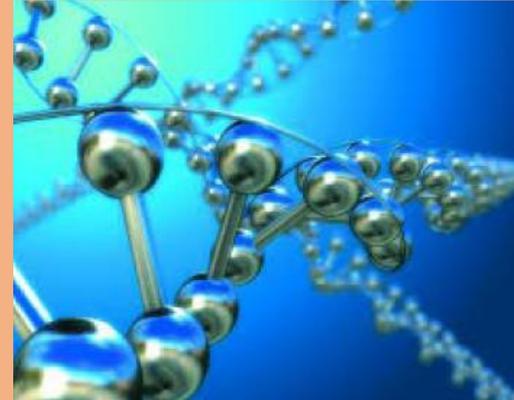
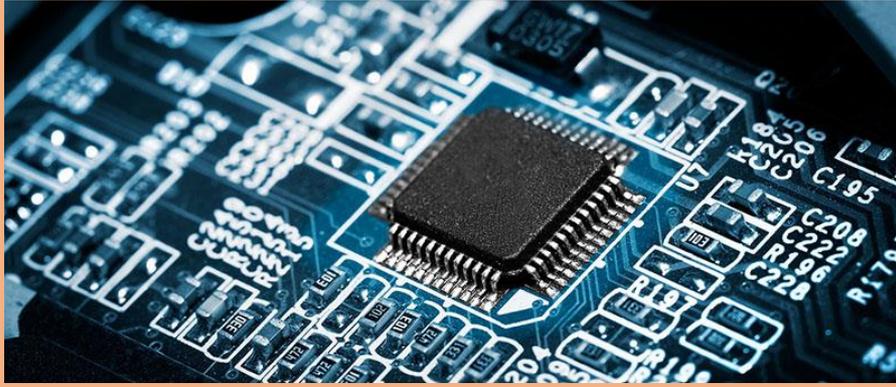
# Nanotechnology

Nanotechnology is the manipulation of matter at the near-atomic and molecular (or **nanoscale**) level through engineering and scientific design. Nanotechnology is essential in the production of new materials, structures, systems and devices and seeks to improve functions and reactions of products.

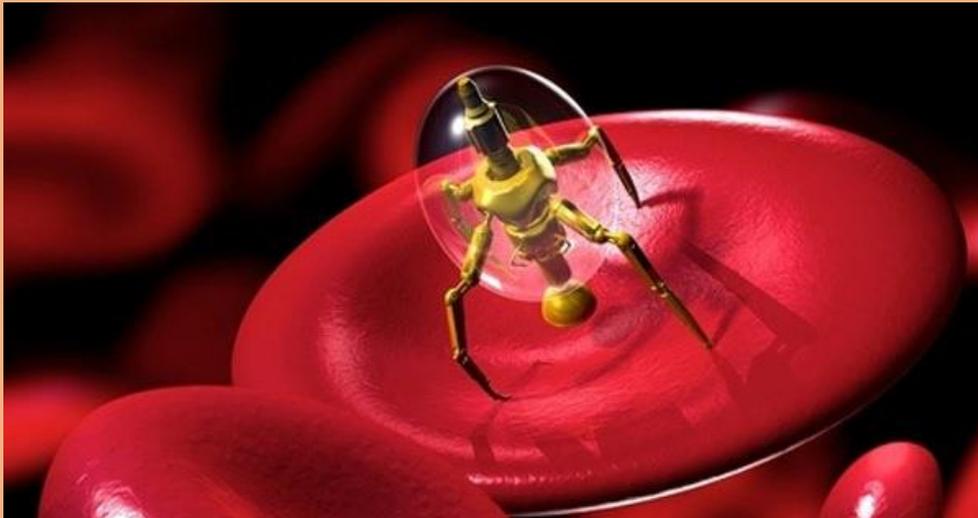


# Nanotechnology

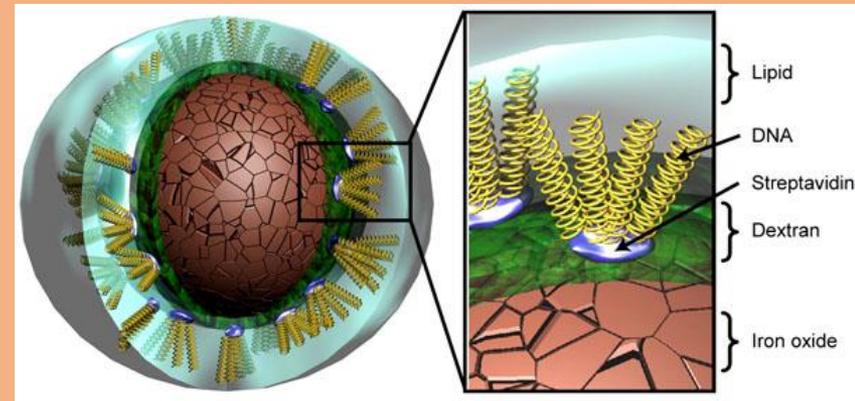
... has potential in a variety of industrial applications such as:



advanced engineering materials

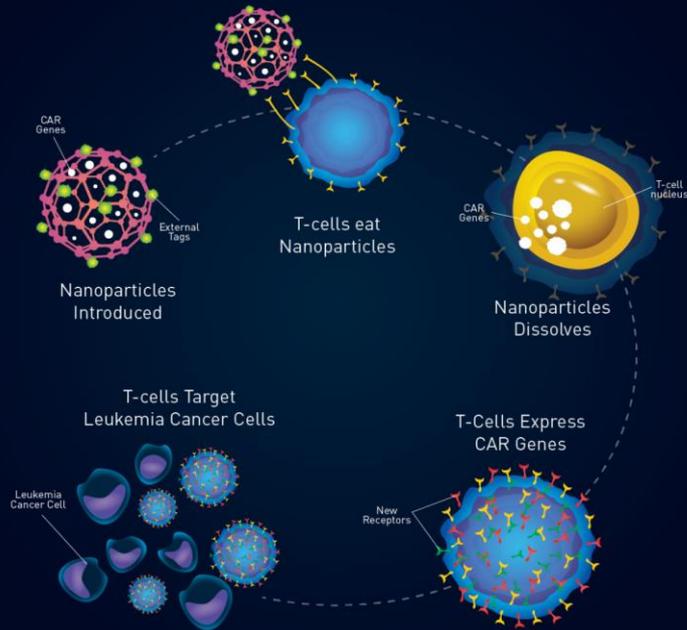


nanomedicine



drug and gene delivery

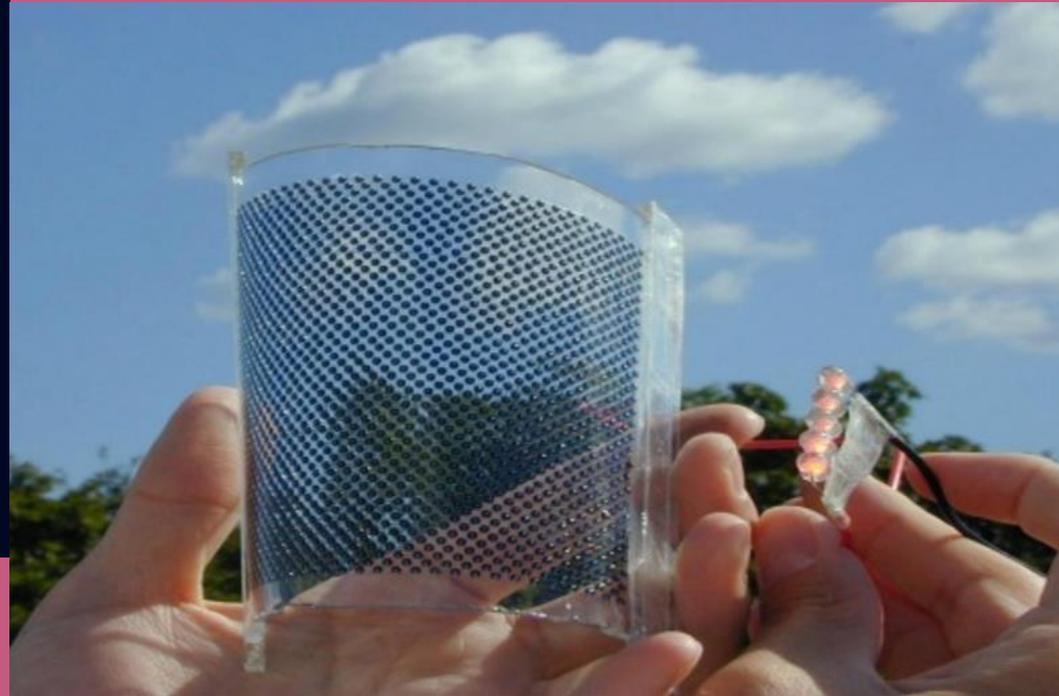
# NANOPARTICLE CANCER TREATMENT



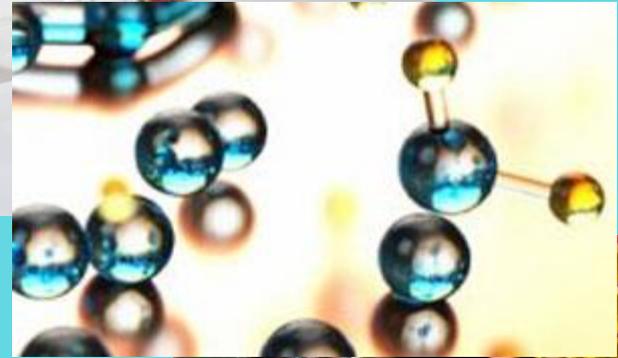
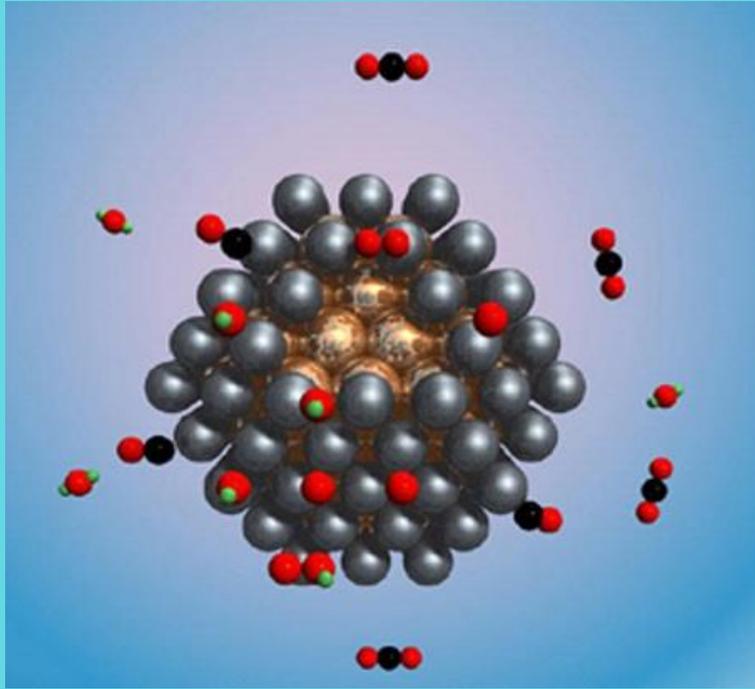
Futurism

Source: "Nanoparticles reprogram immune cells to fight cancer" EurekAlert

imaging and sensors



energy generation and storage materials

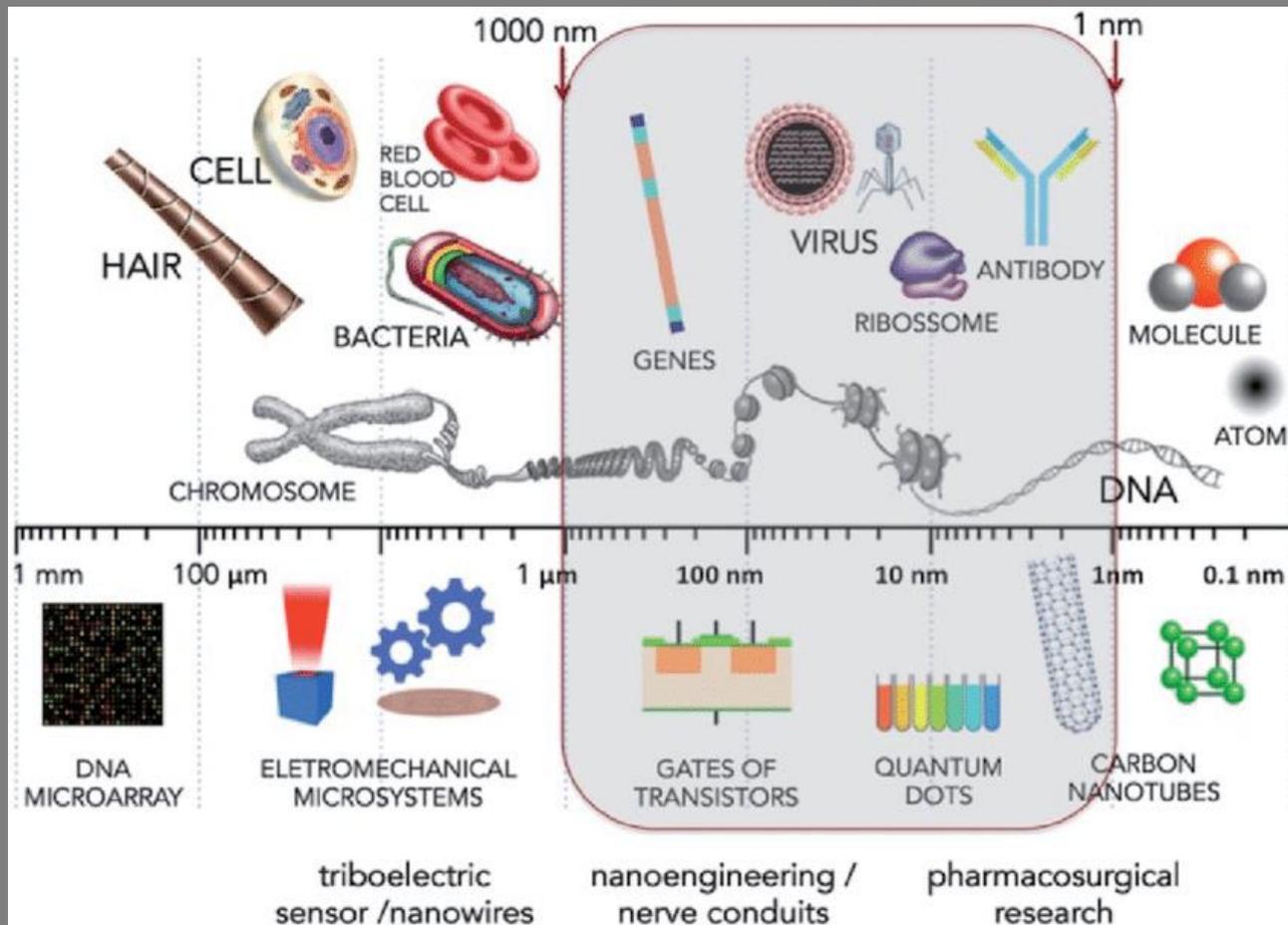


catalysts, foods and personal care products



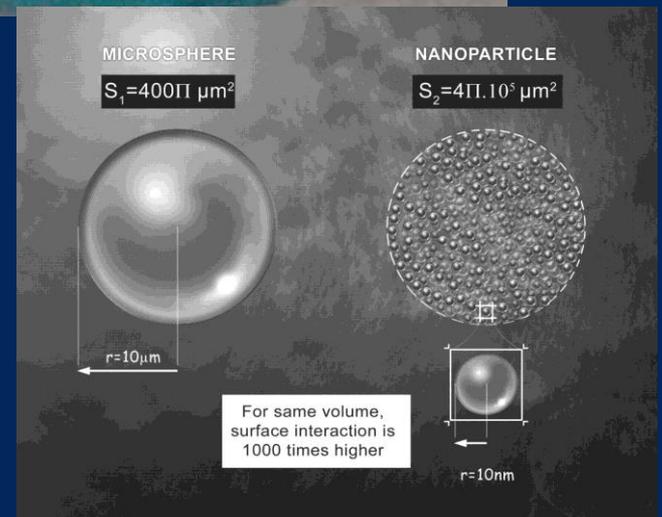
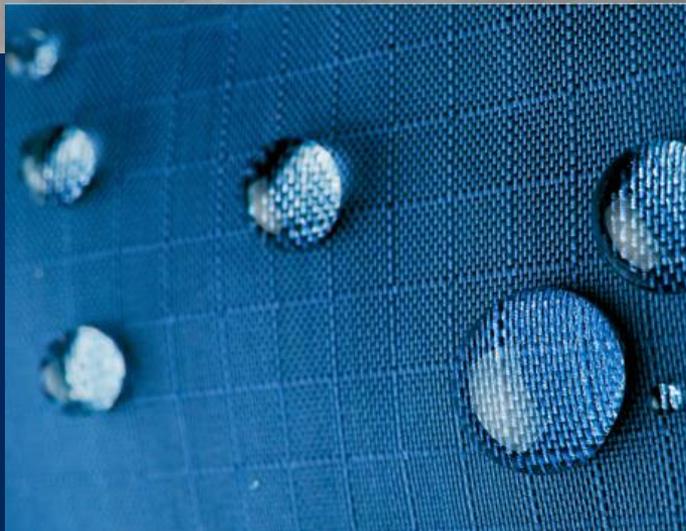
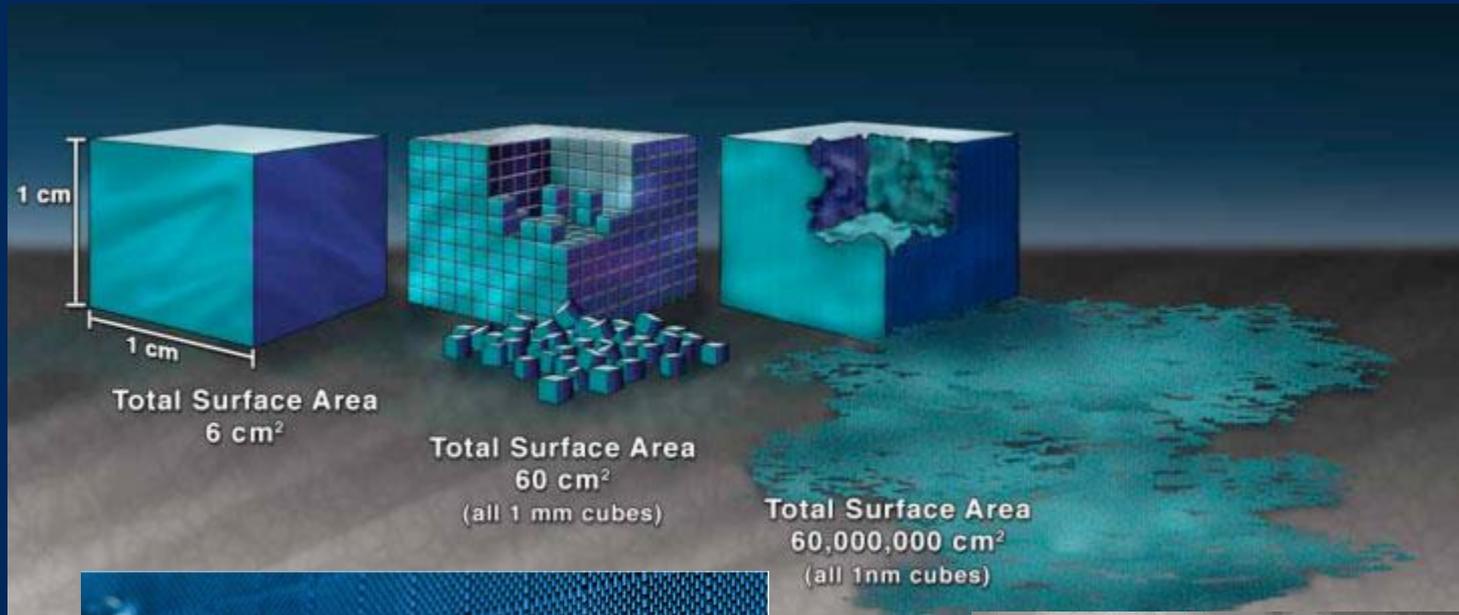
# Nanoscale

Nanomaterials typically measure between 1nm and 1000 nm



# Nanoscale

At this size, materials begin to exhibit unique properties that affect physical, chemical, and biological behavior



# Types of Nanoparticles

Nanomaterials can be categorized in 4 major types:

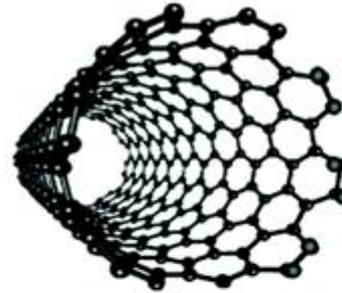
## CARBON-BASED



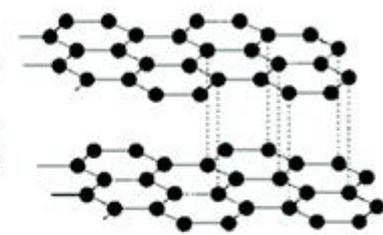
**Diamond**



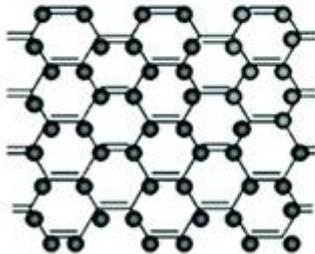
**Fullerene**



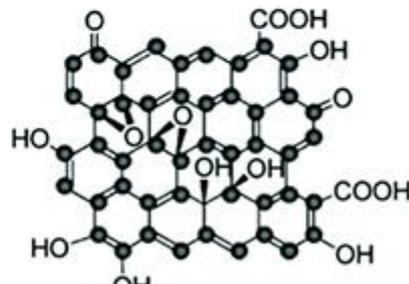
**Carbon nanotube**



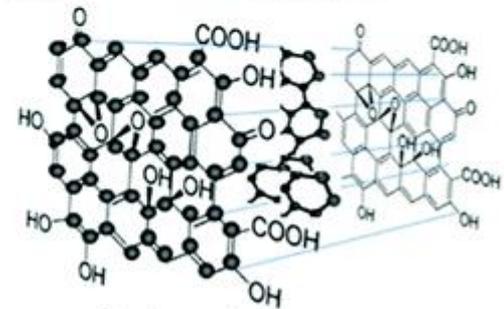
**Graphite**



**Graphene**

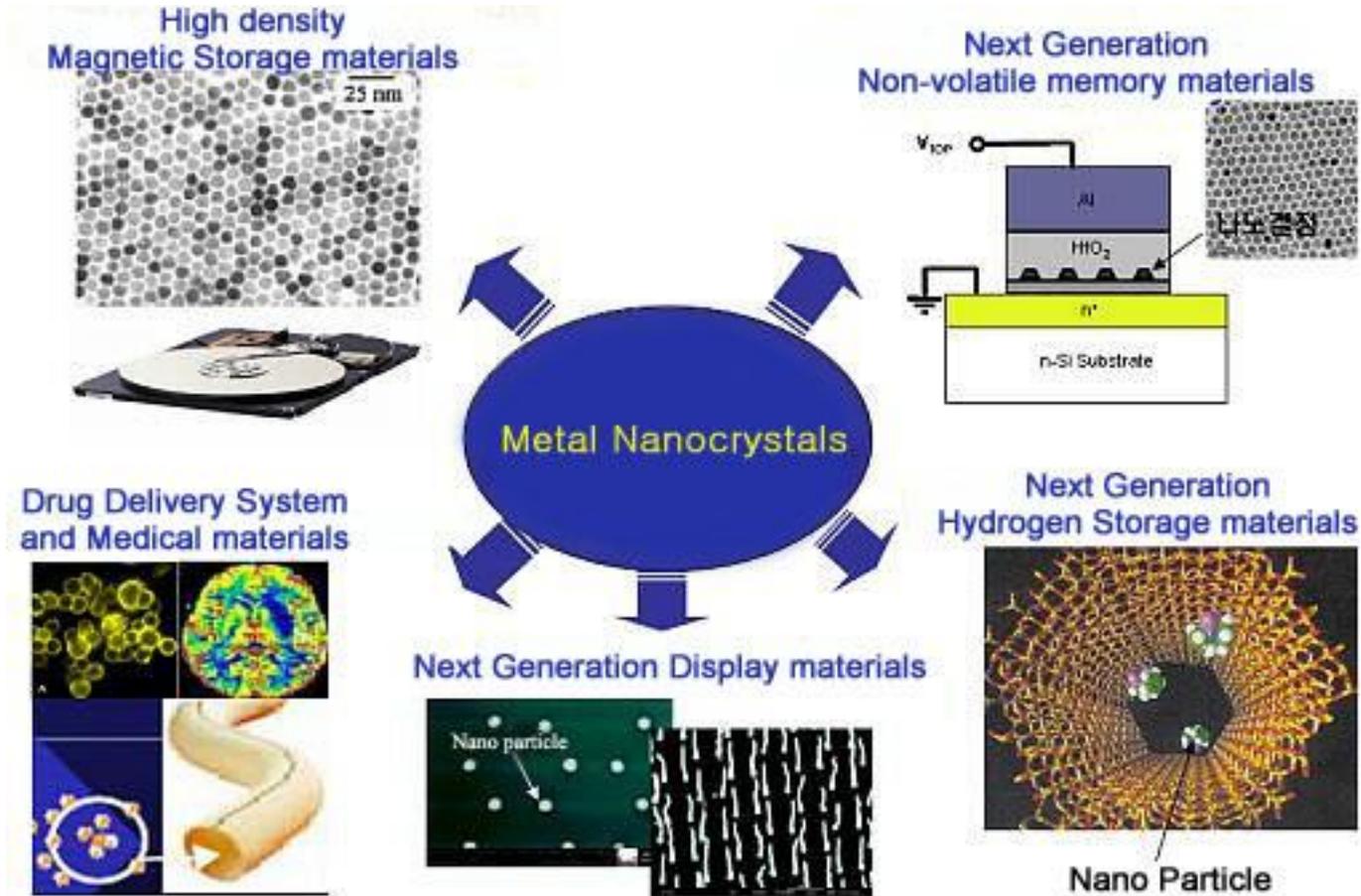


**Graphene oxide**



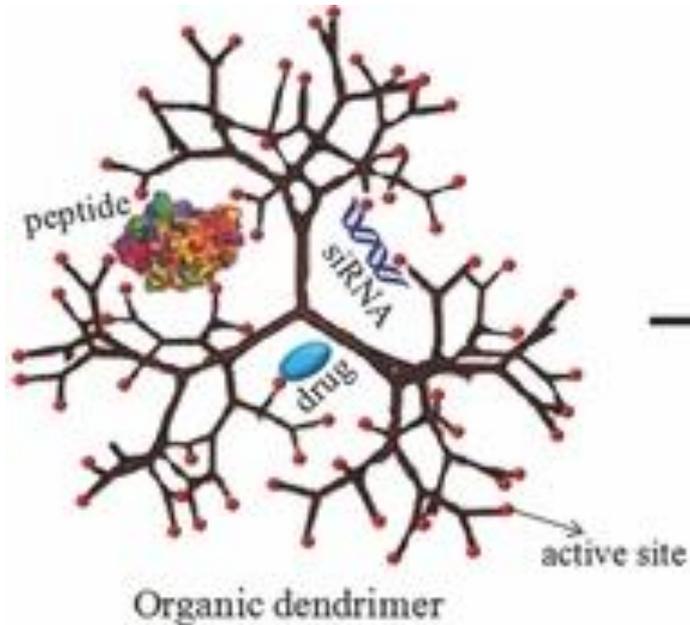
**Carbon dot**

# METAL-BASED

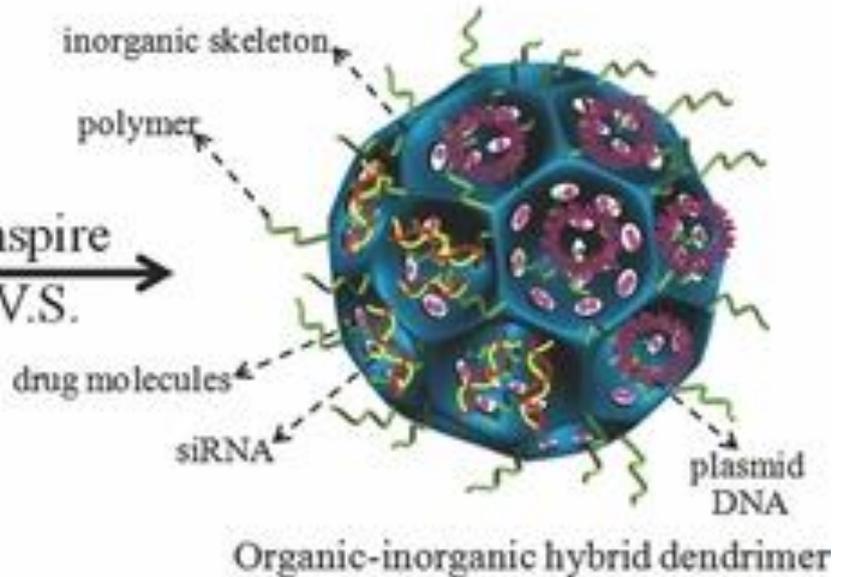


# DENDRIMER

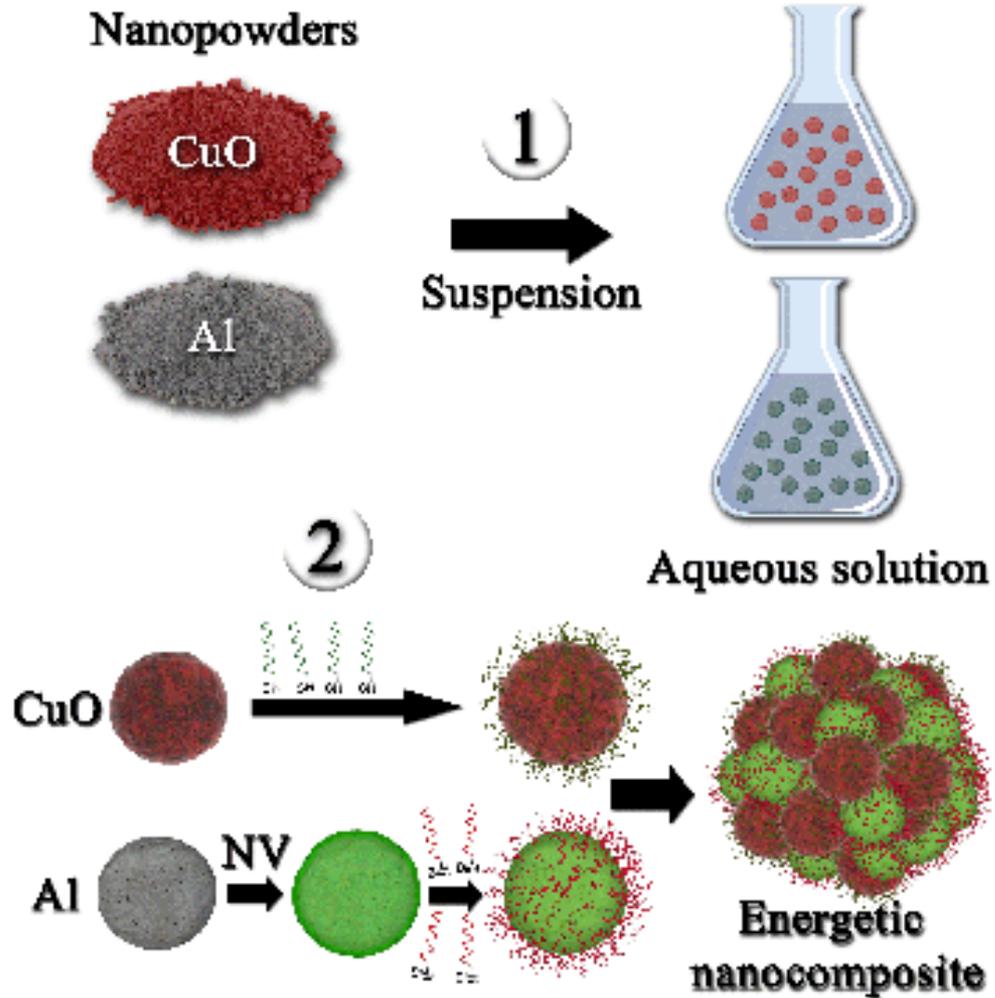
(a synthetic polymer with a branching, treelike structure)



inspire  
V.S. →

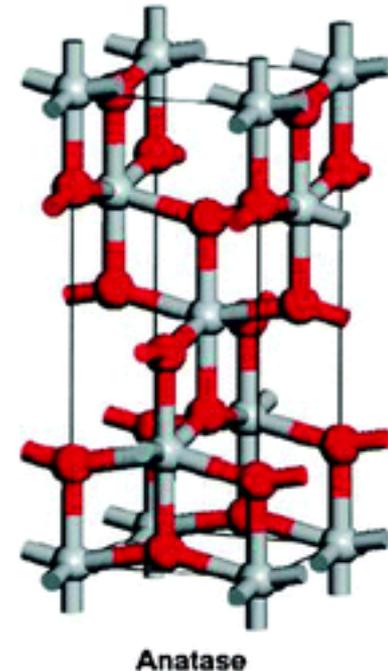
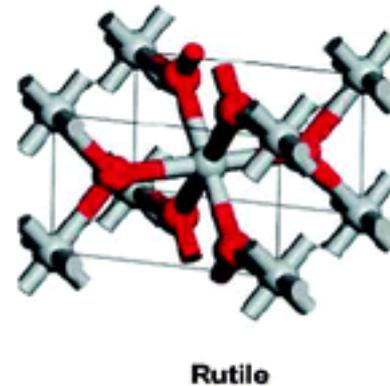
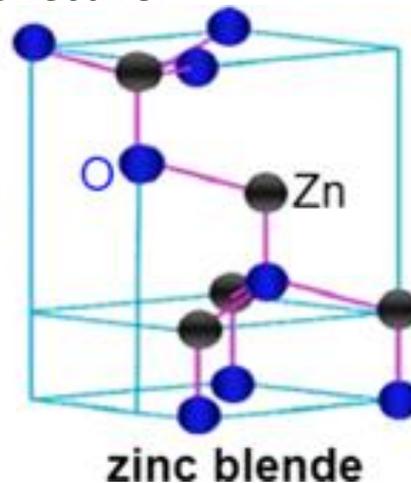
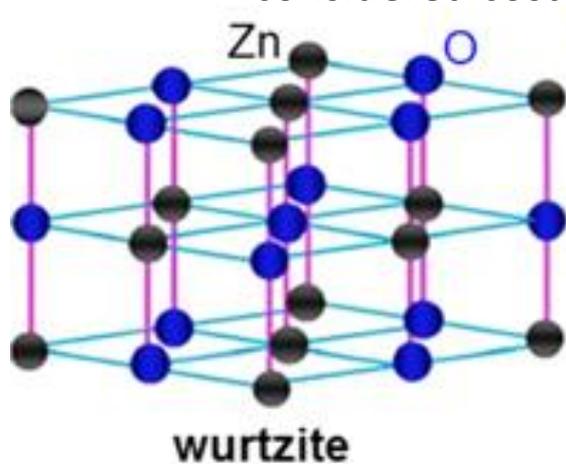


# COMPOSITE



# Photocatalytic Nanoparticles

Some nanoparticles have photocatalytic properties that scientists can engineer to speed up reactions using a light source. Photocatalytic nanoparticles are organic, may have antimicrobial properties, and are considered cost-effective.



# Photocatalysis

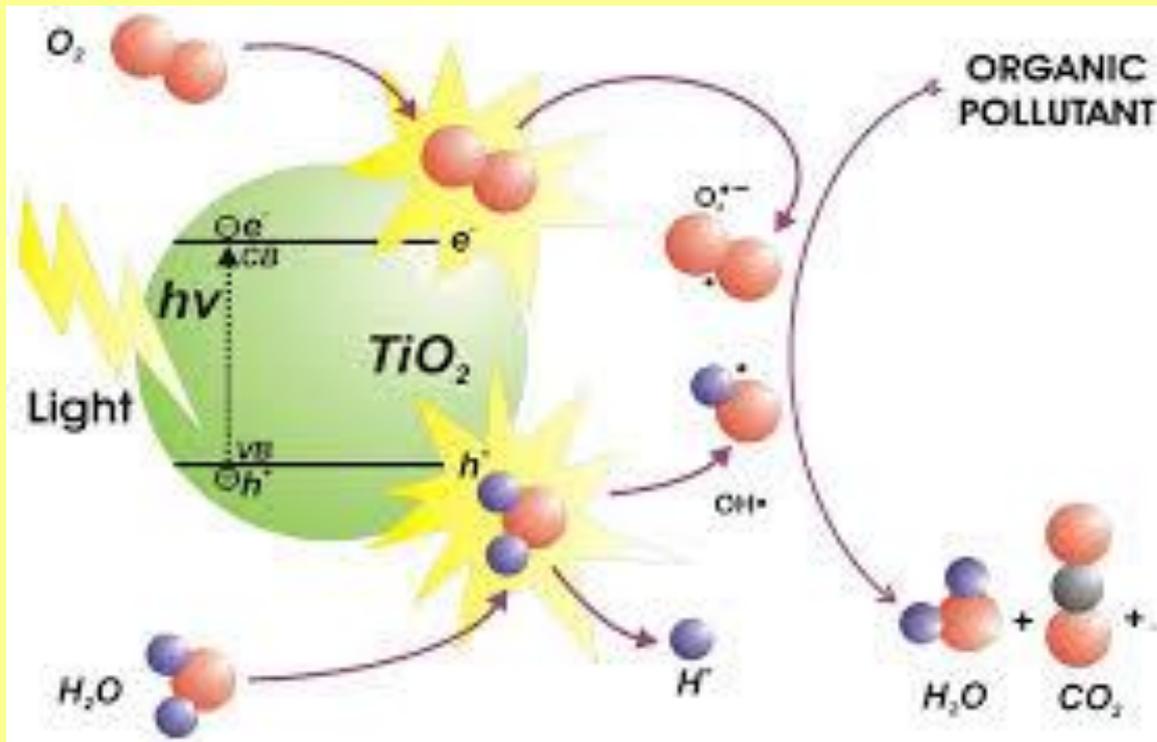
photo = light

catalysis = using a catalyst

catalyst = decreases activation energy to speed up a reaction

# Photocatalytic Nanoparticles

These specific nanoparticles have the unique property of acting as a catalyst and speeding up a reaction using a light source (usually UV light).

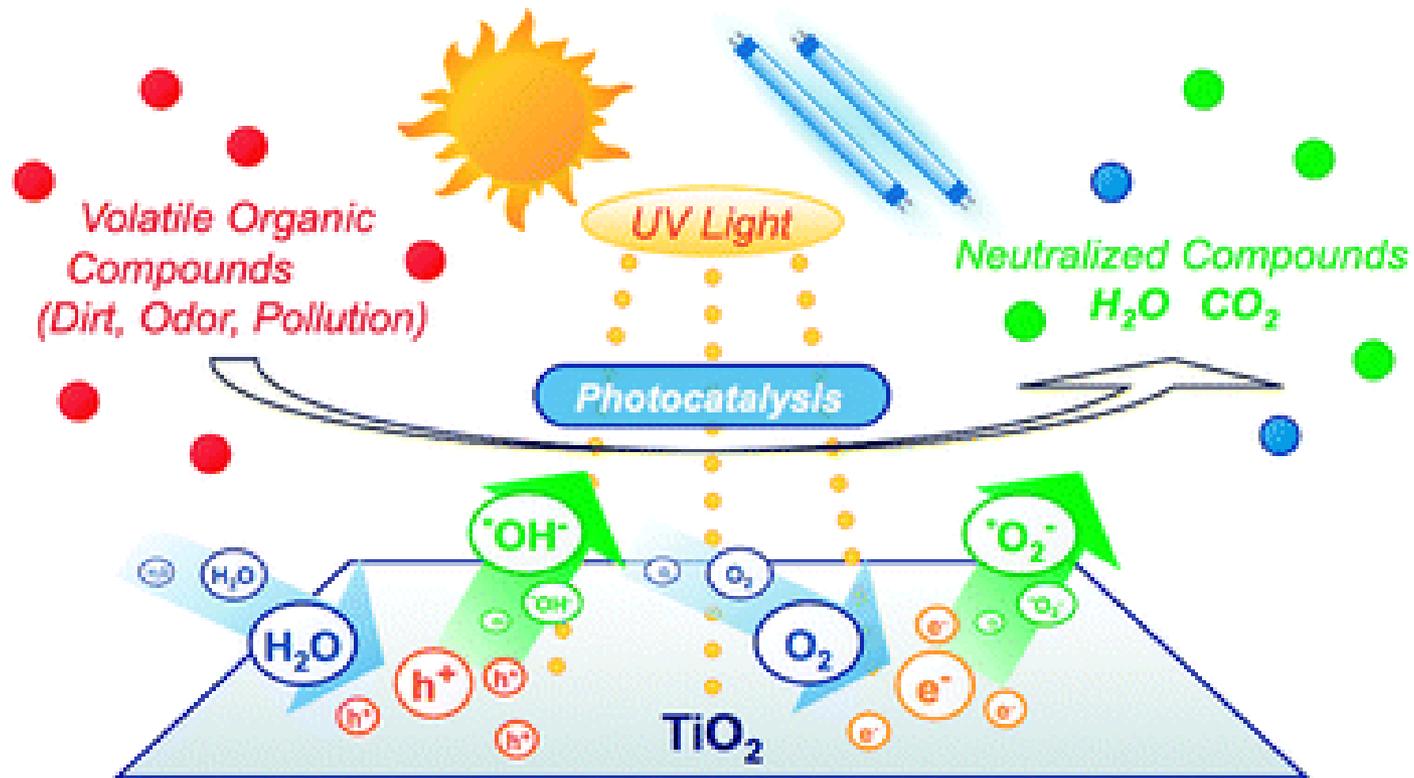


# Photocatalytic Nanoparticles

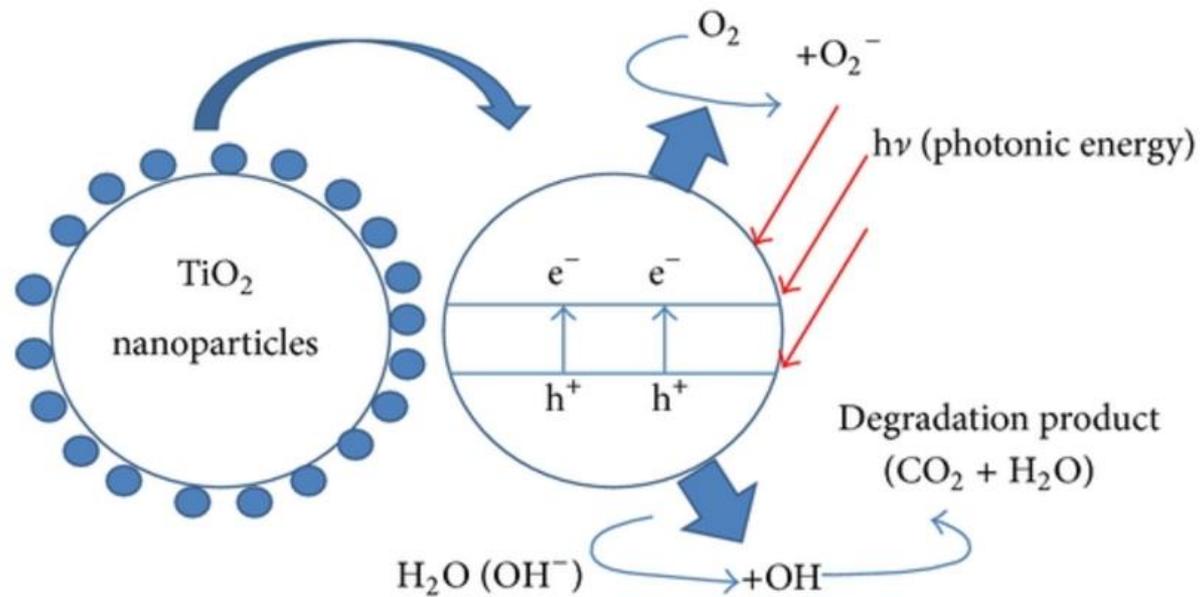
Through this process, nanoparticles such as titanium dioxide, act as organic destroyers and degrade organic toxins in the process of hydroxylation. (A chemical process that introduces a oxygen bonded to hydrogen—or a hydroxyl group—into an organic compound.)



# Titanium Dioxide Nanoparticle Photocatalytic Activity



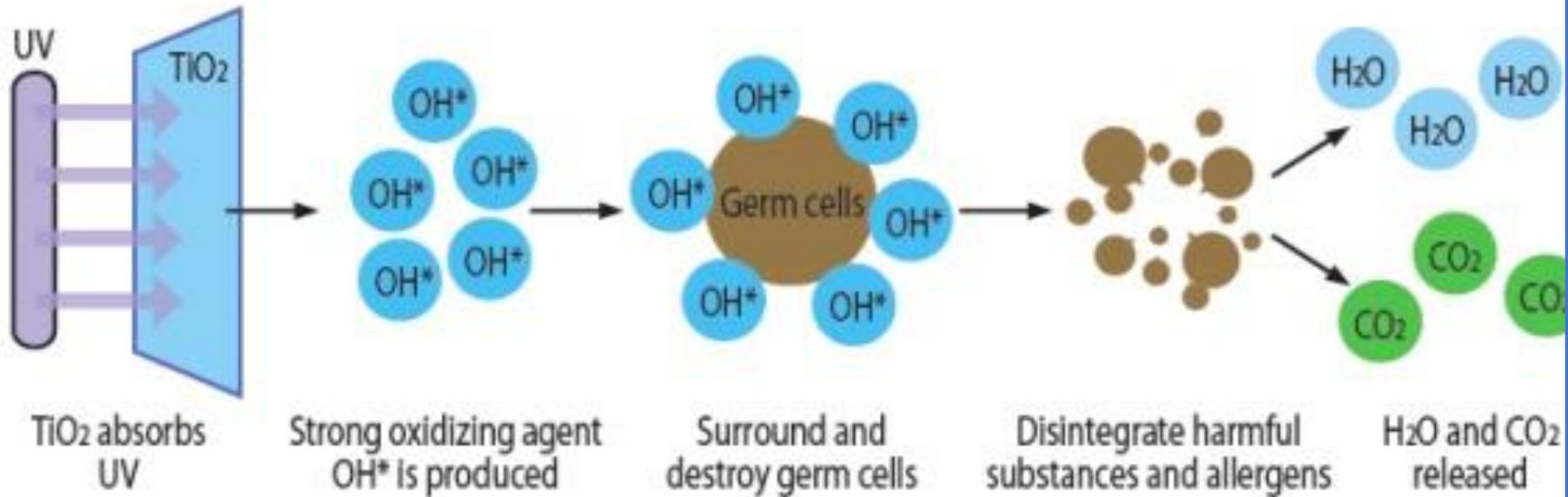
Organic Compounds → photocatalyzed by TiO<sub>2</sub> with UV light → to produce H<sub>2</sub>O and CO<sub>2</sub>  
Organic Compounds → degraded/destroyed in the process through hydroxylation



# Photocatalytic Process

Photocatalysts create a strong oxidation agent and electronic holes to break down the organic matter into carbon dioxide and water when in the presence of photocatalysts such as light and water

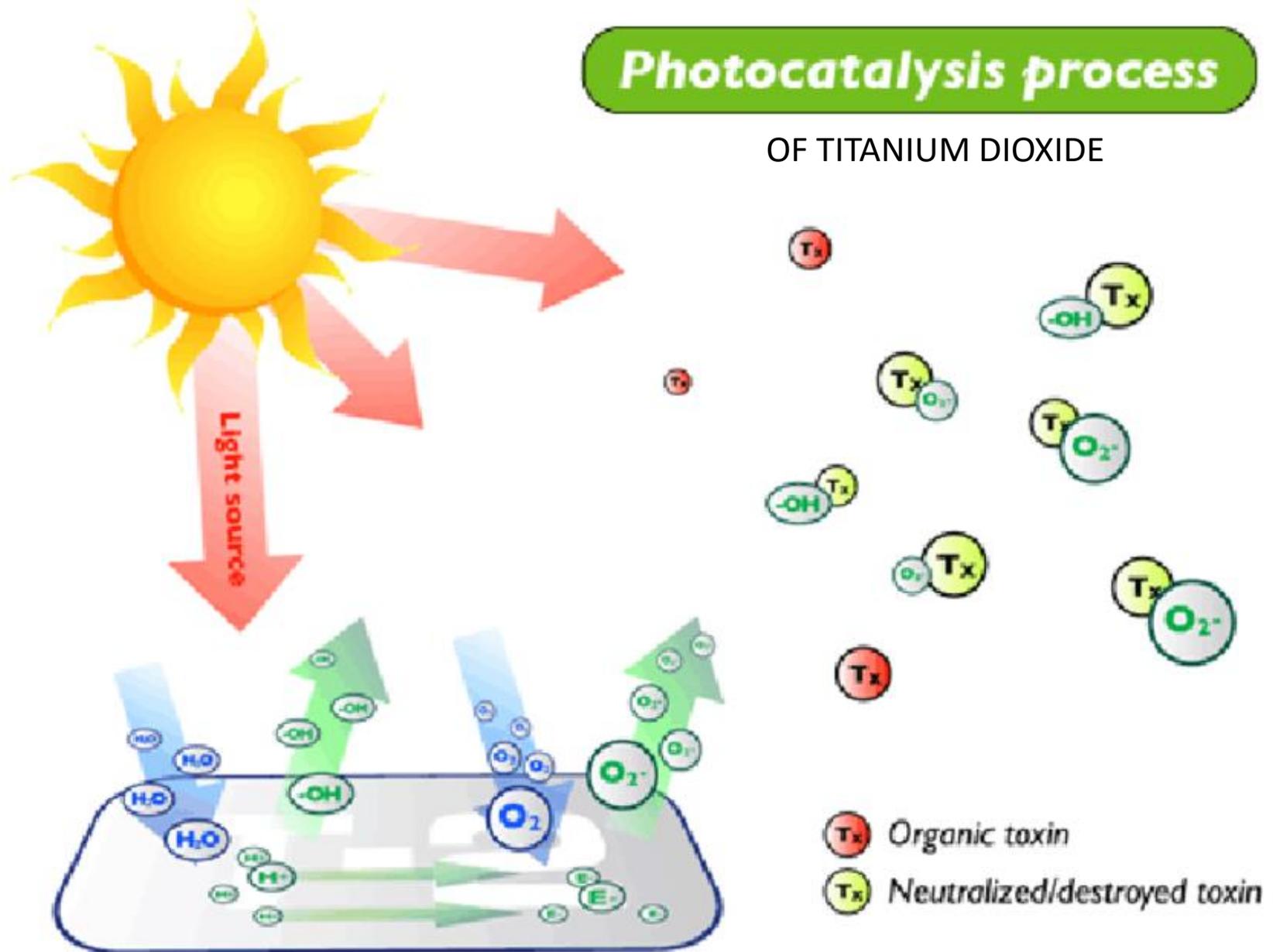
# The Process of Photocatalyst Action



HYDROXYLATION TO DESTROY ORGANIC COMPOUNDS

# Photocatalysis process

OF TITANIUM DIOXIDE

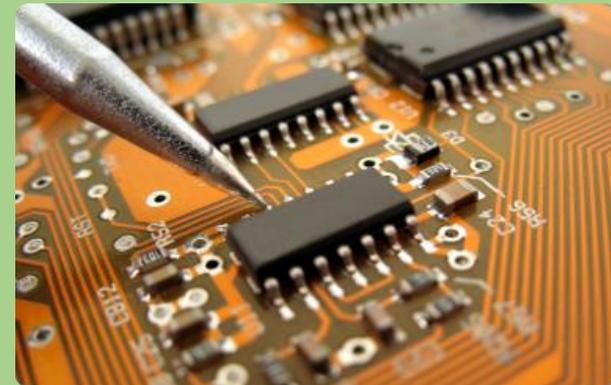


Using energy from light, T-2 creates two oxidation reactants:  
hydroxyl radicals and superoxide anion.

These reactants decompose toxic organic substances through oxidation.

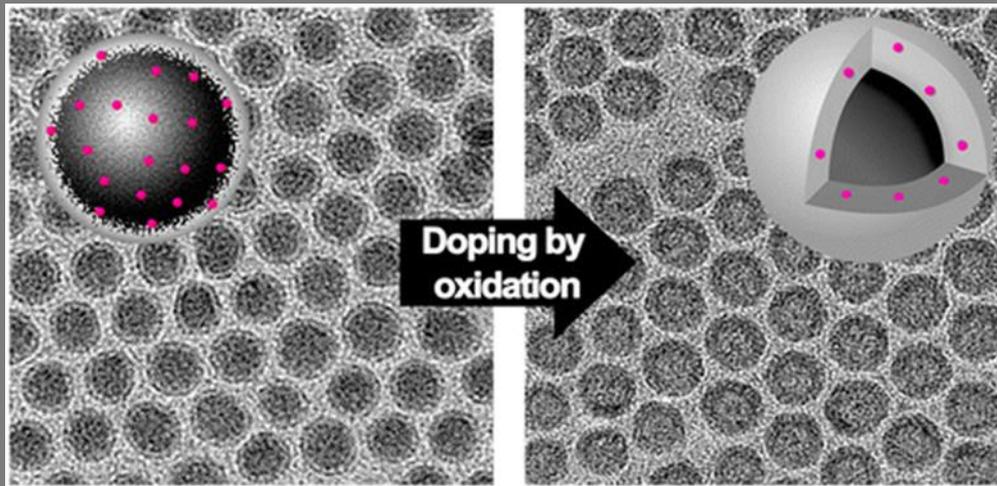
# Uses of Photocatalytic Nanoparticles

Nanoparticles are essential in industries such as water sanitation and purification. They are also used in products from antimicrobial agents, cosmetics, and sunscreens to semiconductor systems.



# Future Research

Photocatalytic nanoparticles are currently being doped (an approach to modulate the electronic and optical properties of nanoparticles) and manipulated to trigger specific properties for nanoparticles in order to build an effective material.



Researching, developing, and utilizing these properties is at the heart of engineering nanoscale technologies.

**Image links for each slide (from left to right on the page)**  
**®PowerPoint slides and images are for classroom use only**

Slide #	Image 1	Image 2	Image 3	Image 4
1	<a href="http://nanodome.info">http://nanodome.info</a>			
2	<a href="https://dornsife.usc.edu/news/stories/1111/analyzing-life-on-a-molecular-level/">https://dornsife.usc.edu/news/stories/1111/analyzing-life-on-a-molecular-level/</a>			
3	<a href="http://www.drrnlahotipolytechnic.com/course/computer-technology">http://www.drrnlahotipolytechnic.com/course/computer-technology</a>	<a href="http://www.european-coatings.com/Raw-materials-technologies/Technologies/Nanotechnology/Layer-by-layer-deposition-of-nano-patterned-thin-films-optimised">http://www.european-coatings.com/Raw-materials-technologies/Technologies/Nanotechnology/Layer-by-layer-deposition-of-nano-patterned-thin-films-optimised</a>	<a href="https://www.quora.com/What-invention-if-it-were-invented-today-would-quantum-leap-human-technology-by-several-decades-if-not-centuries-overnight">https://www.quora.com/What-invention-if-it-were-invented-today-would-quantum-leap-human-technology-by-several-decades-if-not-centuries-overnight</a>	<a href="https://www.hopkinsmedicine.org/wilmer/research/retina/lutty/nano.html">https://www.hopkinsmedicine.org/wilmer/research/retina/lutty/nano.html</a>
4	<a href="https://futurism.com/in-the-future-cells-reprogrammed-inside-our-bodies-will-fight-cancer-for-us/">https://futurism.com/in-the-future-cells-reprogrammed-inside-our-bodies-will-fight-cancer-for-us/</a>	<a href="http://www.energydigital.com/sustainability/no-limits-total-abundance-transparent-solar-windows">http://www.energydigital.com/sustainability/no-limits-total-abundance-transparent-solar-windows</a>		
5	<a href="https://news.wisc.edu/new-nanoparticle-catalyst-brings-fuel-cell-cars-closer-to-showroom/">https://news.wisc.edu/new-nanoparticle-catalyst-brings-fuel-cell-cars-closer-to-showroom/</a>	<a href="https://nanofixit.wordpress.com/2015/04/28/nanotech-foods-will-nanotechnology-change-what-you-eat/">https://nanofixit.wordpress.com/2015/04/28/nanotech-foods-will-nanotechnology-change-what-you-eat/</a>	<a href="http://www.european-coatings.com/Raw-materials-technologies/Technologies/Nanotechnology/What-do-people-know-about-nanotechnology">http://www.european-coatings.com/Raw-materials-technologies/Technologies/Nanotechnology/What-do-people-know-about-nanotechnology</a>	<a href="https://www.101newsmidia.com/news/16693">https://www.101newsmidia.com/news/16693</a>
6	<a href="http://blogs.iu.edu/sciu/2017/03/28/nanomaterials-bacteria/">http://blogs.iu.edu/sciu/2017/03/28/nanomaterials-bacteria/</a>			
7	<a href="https://www.nano.gov/nanotech-101/special">https://www.nano.gov/nanotech-101/special</a>	<a href="https://www.asme.org/engineering-topics/articles/nanotechnology/nano-advancement-repels-liquids">https://www.asme.org/engineering-topics/articles/nanotechnology/nano-advancement-repels-liquids</a>	<a href="https://www.acast.com/pulseoftheplanet/nanoparticles-awholelotofsurface15may17">https://www.acast.com/pulseoftheplanet/nanoparticles-awholelotofsurface15may17</a>	
8	<a href="https://www.cd-bioparticles.com/t/Properties-and-Applications-of-Carbon-Nanoparticles_61.html">https://www.cd-bioparticles.com/t/Properties-and-Applications-of-Carbon-Nanoparticles_61.html</a>			

Slide #	Image 1	Image 2	Image 3	Image 4
9	<a href="http://composite.kaist.ac.kr/cgi-bin/reseng2.pl?metalnano">http://composite.kaist.ac.kr/cgi-bin/reseng2.pl?metalnano</a>			
10	<a href="https://chemeng.adelaide.edu.au/qiao/publications/previous/">https://chemeng.adelaide.edu.au/qiao/publications/previous/</a>			
11	<a href="https://www.laas.fr/public/en/dna-nano-engineered-reactive-materials">https://www.laas.fr/public/en/dna-nano-engineered-reactive-materials</a>			
12	<a href="http://iopscience.iop.org/article/10.1088/2043-6262/6/3/033002">http://iopscience.iop.org/article/10.1088/2043-6262/6/3/033002</a>	<a href="http://pubs.rsc.org/en/content/articlelanding/2013/cp/c3cp43938k/unauth#!divAbstract">http://pubs.rsc.org/en/content/articlelanding/2013/cp/c3cp43938k/unauth#!divAbstract</a>		
13				
14	<a href="http://www.mdpi.com/2073-4344/3/1/189">http://www.mdpi.com/2073-4344/3/1/189</a>			
15	<a href="https://www.birminghammail.co.uk/news/midlands-news/live-why-sun-red-today-13767276">https://www.birminghammail.co.uk/news/midlands-news/live-why-sun-red-today-13767276</a>	<a href="https://www.popularwoodworking.com/wood-working-blogs/flexner-on-finishing-woodworking-blogs/titanium-dioxide-a-carcinogen">https://www.popularwoodworking.com/wood-working-blogs/flexner-on-finishing-woodworking-blogs/titanium-dioxide-a-carcinogen</a>		
16	<a href="http://pubs.rsc.org/en/content/articlelanding/2011/cs/c1cs15065k/unauth#!divAbstract">http://pubs.rsc.org/en/content/articlelanding/2011/cs/c1cs15065k/unauth#!divAbstract</a>			
17	<a href="https://www.researchgate.net/profile/Chin_Wei_Lai2">https://www.researchgate.net/profile/Chin_Wei_Lai2</a>			
18	<a href="https://sciencedatacloud.wordpress.com/2013/11/22/photocatalyst-technology/">https://sciencedatacloud.wordpress.com/2013/11/22/photocatalyst-technology/</a>			
19	<a href="https://www.researchgate.net/figure/Mechanism-of-titanium-dioxide-photocatalytic-degradation-process_fig3_215721240">https://www.researchgate.net/figure/Mechanism-of-titanium-dioxide-photocatalytic-degradation-process_fig3_215721240</a>			
20	<a href="https://www.cdc.gov/healthywater/global/index.html">https://www.cdc.gov/healthywater/global/index.html</a>	<a href="https://www.medexpressrx.com/blog/kids-shouldnt-avoid-using-sunscreen.aspx">https://www.medexpressrx.com/blog/kids-shouldnt-avoid-using-sunscreen.aspx</a>	<a href="https://csl.illinois.edu/news/metagenomic-research-studies-effects-microbial-populations">https://csl.illinois.edu/news/metagenomic-research-studies-effects-microbial-populations</a>	<a href="http://www.voicendata.com/worldwide-semiconductor-revenue-grew-2-6-percent-in-2016-gartner-results/">http://www.voicendata.com/worldwide-semiconductor-revenue-grew-2-6-percent-in-2016-gartner-results/</a>
21	<a href="http://www.lnls.cnpem.br/successful-oxidation-induced-doping-of-nanoparticles-revealed-by-in-situ-xas/">http://www.lnls.cnpem.br/successful-oxidation-induced-doping-of-nanoparticles-revealed-by-in-situ-xas/</a>			