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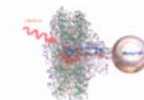
Nanoparticles enhance photosynthesis

7 March 2007

Metal nanoparticles can increase the efficiency of energy produced in photosynthetic systems, according to work by researchers in the US and Israel. The novel hybrid system, which consists of a photosynthetic reaction centre containing chlorophyll bound to gold and silver nanocrystals, produces ten times more excited electrons thanks to plasmon resonance and fast electron-hole separation. The enhancement mechanisms could be used to design artificial light-harvesting systems, say the scientists.

Chlorophyll molecules are responsible for the green colour of most plants and play a vital role in photosynthesis – the process by which plants convert carbon dioxide and water into carbohydrates and oxygen, using light as an energy source. Now, Alexander Govorov of Ohio University and Itai Carmeli of Tel Aviv University have made a new type of hybrid structure that combines natural photosynthetic molecular complexes and metal nanoparticles. Using models, the two researchers showed that the chemical production rate in these systems can be greatly enhanced due to plasmon resonance – a classical effect where the electromagnetic field of light drives the collective oscillations of a nanoparticle's free electrons into resonance.

According to Govorov and Carmeli, the plasmon effect increases the generation of electrons inside the photosynthetic complex, so such hybrid systems can enhance the performance of devices based on photocurrents. Moreover, the photosynthetic system efficiently separates the photo-excited electrons and "holes" – the vacancies left by electrons when they have been excited – created inside the photosynthetic reaction centre, so they are not lost due to energy transfer to the metal nanoparticles. (This mechanism is similar to the way electrons and holes are quickly separated in natural systems so that they cannot recombine or dissipate). The photo-excited electrons can therefore be used to produce chemical energy or to create a photocurrent.



[The photosynthetic system](#)

"The exciting result is that, by attaching metal nanoparticles to a photosynthetic molecular complex, we can achieve a tenfold increase in the production of excited electrons inside the molecular complex," Govorov told *nanotechweb.org*. "We hope that this principle and the proposed hybrid system (nanoparticles plus reaction centre) will be used in experiments to design artificial light-harvesting systems."

The researchers say they would now like to model the plasmon enhancement effect for a complex composed of a few nanoparticles and one reaction centre. "For example, we could

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probably achieve much stronger enhancement."

The researchers reported their work in *Nano Lett.*

About the author

Belle Dumé is acting editor of *nanotechweb.org*

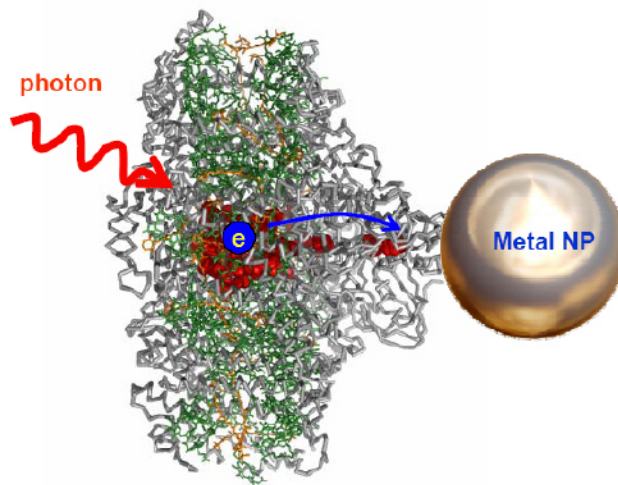
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the photosynthetic system



A system composed of photosynthetic reaction centre and gold nanoparticle. Due to the plasmon resonance, the rate of generation of photoexcited electrons in this system can be strongly increased (image courtesy: A Govorov).