Chemists settle debate about conversion of light

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These nanocrystals convert ultraviolet light to green light. Credit: Fundamental Research on Matter (FOM)

Chemists of Utrecht University and of the Foundation for Fundamental

Research on Matter (FOM) have settled the debate about a fundamental question that is relevant to the conversion of one colour into another. They demonstrated how to influence the efficiency of this process, by changing the refractive index around the material in which the conversion takes place, for example. This is relevant for various applications, ranging from light bulbs and solar panels to bio-imaging. Their findings were published in *Nature Communications* on 2 April.

Some so-called luminescent particles can easily absorb certain colours of light, such as UV light and infrared light. The particles can transfer this energy to a neighbouring particle, which converts this light into another, more desired, colour. This occurs in fluorescent tubes, for instance. The fundamental question the chemists wanted to tackle was whether the efficiency of the energy transfer between the luminescent particles is influenced by the photonic properties of the environment, such as the refractive index.

Highly controlled system

Professor Andries Meijerink, Professor of Chemistry at Utrecht University, and Freddy Rabouw, PhD candidate at FOM, wondered whether other researchers had paid sufficient attention to the side effects in previous research into this fundamental question. Therefore, they designed a highly controlled system for their research.

They created nanocrystals that contained the rare earth elements cerium and terbium. By using these crystals, they managed to ensure that the distances between the cerium and terbium atoms were known and fixed. Cerium can easily absorb UV light and is able to either reemit it or transfer it to terbium in the form of energy. After the energy is transferred, terbium emits it in the form of visible green light.

Transparent solvents

The nanocrystals were dissolved in transparent solvents with varying refractive indices. This made the photonic properties of the environment a little different, but in a controlled manner. The researchers then looked how fast and how efficient this system converted UV light into green light.

The researchers had already established that the emission of light from a particle depends on the photonic properties of its environment. And this was confirmed during the experiment: the lower the refractive index, the less UV light was emitted and the more UV light was converted into visible green light.

Hitherto unobserved

The crucial step, the energy transfer from cerium to terbium, appeared to occur at the same rate in each solvent. "This is something that has never been observed before. This means that the efficiency of the energy transfer between the two luminescent particles is not influenced by the photonic of the environment. And that is important information for developing all kinds of applications in which invisible UV light or infrared light is converted into visible light," explains Professor Andries Meijerink.

Applications

Some examples of such applications are new, efficient light sources that emit a pleasant light colour, but also solar panels and medical scans. "Solar panels are unable to absorb a substantial part of the sun's infrared light. With the knowledge we have acquired, we can now develop systems that can efficiently convert the infrared part of the sunlight into energy. For application in medical diagnostics equipment, we are looking for nanoparticles that luminesce with other colours than the body's background signal. Such a nanoparticle is then monitored inside the body to see what happens to it," explains PhD candidate Freddy Rabouw.

More information: 'Photonic effects on the Förster resonance energy transfer efficiency', *Nature Communications*, 2 April 2014.

Provided by Fundamental Research on Matter (FOM)