Discovery of a new mechanism for wavelength conversion of light by a plastic material

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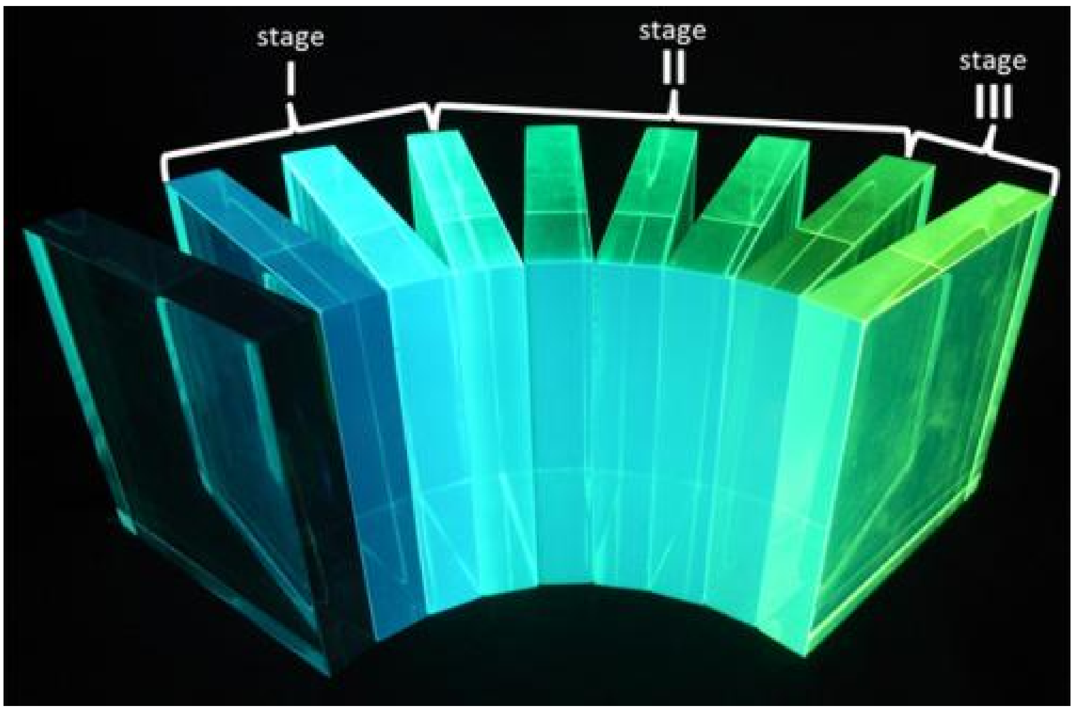

The concentration of fluorescent benzoxanthene (Y11) increases in a plastic from left to right, with the sample at the far left being pure plastic with no added molecules. In each sample, ultraviolet light is absorbed and light ranging from blue to green is emitted as a function of the benzoxanthene concentration.

Researchers from the National Institute of Radiological Sciences have discovered a new mechanism for wavelength conversion of emitted light by a plastic material. The results of these studies appeared in *Scientific Reports* from the Nature Publishing Group on August 26, 2013.

Plastic optical materials have been used to covert short wavelength light to longer wavelengths for a wide range of applications, such as fibre optics and films filtering sunlight for crop cultivation. However, the colour conversion mechanism has not been elucidated in detail. By adding various concentrations a fluorescent molecule to the plastic base substrate, the research team found that new complexed states were formed between the base substrate and the fluorescent molecules at each concentration. In addition, they discovered a new wavelength conversion mechanism in which the initial emitted light is converted in three stages by these complexed states. At high fluorescent molecule concentrations, the wavelength conversion can be extended to the ultraviolet region.

These results are expected to impact industrial technologies, such as the conversion and/or blocking of ultraviolet light, noise reduction in light propagation, and improved efficiency in crop cultivation.

In order to resolve the mismatch in the detection or absorption sensitivity by an object for light emitted from a short wavelength source, a plastic material with low concentrations of fluorescent molecules can convert the wavelength of light to longer, more useful wavelengths. However, because the light conversion mechanism is not thoroughly understood, breakthroughs in material development and applications have stagnated.

As shown in Figure, Dr. Nakamura et al. synthesised a high purity plastic and investigated the responses to light as a function of concentration of the fluorescent molecule benzoxanthene (Y11). It was discovered that a different complexed state is formed between the plastic base substrate and the fluorescent molecules at different concentrations. For each complexed state, a new wavelength conversion mechanism for light was found. The mechanisms are based on three distinct conversion stages, which extend to the ultraviolet region.

Since this research elucidated a new mechanism involved in wavelength conversion of light in a plastic, it is now possible to develop materials utilising this kind of mechanism for converting wavelengths for specific purposes. As a result, the range of applications can be expected to expand to optical technologies, electronics, materials, and agriculture.

More information: Nakamura, H. et al. Mechanism of wavelength conversion in polystyrene doped with benzoxanthene: emergence of a complex, *Sci. Rep.* 3, 2502; (2013). dx.doi.org/10.1038/srep02502

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