# Quick, easy and early diagnosis with rare earth ions

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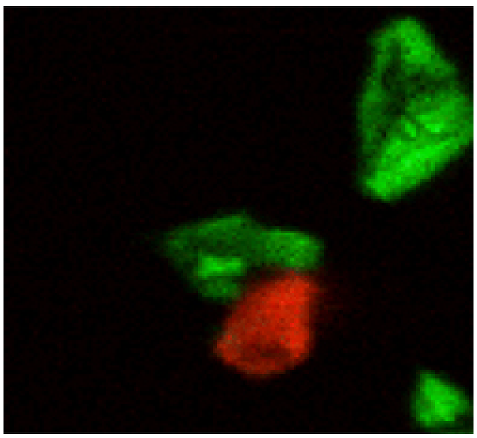

These are two light emitting lanthanides working in unison to reveal oxygen levels in living tissue. Credit: Microscopy Zhiyu Liao, University of Copenhagen

Lack of oxygen in cells is an indicator of diseases as serious as cerebral haemorrhages, stroke and cancer. Regrettably measuring real-time oxygen concentration in living tissue is difficult with current technologies. Now a chemist from the University of Copenhagen in collaboration with chemists from Oxford University has invented a compound which measures oxygen in cells and other biological material with high precision. The compound is based on rare earths emitting coloured light that vary in colour with the amount of oxygen present in the sample. Because emissions are in the visible range of the spectrum, it will be possible to measure oxygen using the optical microscopes already present in most hospitals.

Thomas Just S&ostroke;rensen is Associate Professor at the Department of Chemistry, Nano-Science Centre, University of Copenhagen. Together with his English team and his Copenhagen partner, Tom Vosch, he has published the articles: "Bimetallic lanthanide complexes that display a ratiometric response to oxygen concentration" in the periodical *Chemical Sciences* and "Spectrally resolved confocal microscopy using lanthanide centred near-IR emission" in *Chemical Communications*. Both are Royal Society of Chemistry publications.

According to S&ostroke;rensen, the two articles constitute proof-of-concept that he is capable of measuring oxygen concentrations in an easy, quick and cheap manner but he is certain that development towards a useful technology will be speedy.

"We have made the microscope work already, and we are getting pretty good at synthesizing the rare earth containing molecules. Before the year is out, I am almost certain that we will see the first medical doctors using our method for measuring oxygen in cells", says Thomas Just S&ostroke;rensen.

Previous experiments have seen molecules, which emit more light as the amount of oxygen diminishes. These, however, were incapable of measuring the amount of oxygen in cells, because one could not tell whether a large amount of light signal was caused by a low oxygen concentration or a large concentration of oxygen sensitive molecules. S&ostroke;rensen's new molecule solves this problem because they have a built in control-function.

The novel oxygen sensitive molecule is built with two rare earths, so called lanthanides. One lanthanide, europium, emits a constant red signal. The other, terbium, emits a green signal that increases with diminishing oxygen concentrations. Most physicians should be able to read the oxygen concentration with the naked eye, explains Thomas Just S&ostroke;rensen.

"You simply deduct the amount of red light from the amount of green to get a precise reading of the oxygen level. Unfortunately I cannot see how well my system works, because I am red-green colour-blind. Lucky for me that optical microscopes are usually kitted out to convert colour values to numerical values", smiles the inventor.

Oxygen-meters are already commercially available, but these are based on technologies which are poorly suited for biological samples, useless in a microscope and quite incapable of showing where the oxygen is located in a cell. Because S&ostroke;rensen's molecules work by way of a simple colour shift, they give a very exact indication of quantity as well as location of oxygen in a tissue sample or inside a cell. Furthermore, the microscopy technology developed by Vosch and S&ostroke;rensen utilizes near infrared light which is highly compatible with biological studies, because it penetrates deeply into tissue, explains S&ostroke;rensen.

"This is not just a method which is somewhat better. With this method you will be able to see things which used to be beyond measure. One example would be the difference in oxygen concentration inside and outside a cell", says Thomas Just S&ostroke;rensen.

S&ostroke;rensen is particularly proud that the light signals are visible in an ordinary optical light microscope. Even though he readily admits that the microscope used for the initial testing is normal only for a when considered as individual components.

"The detector and light source was the same as on light microscopes found at any hospital, but my colleague Tom Vosch has optimized the microscope to the point where everything is almost beyond the possible. They said it couldn't be done, but it works", says Thomas Just S&ostroke;rensen.

Provided by University of Copenhagen

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