Comment on: "Dissolved oxygen sensing characteristics of plastic optical fiber coated with hydrogel film" - The wider context of fibre optic oxygen sensing.

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Abstract:

A recently published article by Bian et al. [1] presents a novel plastic optical fibre coated with hydrogel film to measure dissolved oxygen via luminescence quenching. The article concludes that *“The sensor with biocompatible material is expected to be applied to the monitor of dissolved oxygen in the domain of biomedicine”*. However, the oxygen sensor presented contains ruthenium, a toxic material that is considered unsafe for clinical applications. It is unclear whether the hydrogel film coating may be sufficient to prevent direct contact between ruthenium and human tissue in clinical applications. However, platinum porphyrin has been used in fibre optic oxygen sensors in pre-clinical applications. This Comment article provides a brief overview of some platinum porphyrin-based fibre optic oxygen sensors that, despite an advanced degree of maturity and biocompatibility, were overlooked in the recently published article.

The recently published study *Dissolved oxygen sensing characteristics of plastic optical fiber coated with hydrogel film* [1] presents a novel methodological approach to manufacture a plastic optical fibre oxygen sensor based on the luminescence quenching principle, with a response time of 10 s. This response time is sufficient for some applications, but thick hydrogel coatings limit the rate of oxygen diffusion; in this sense, thin sol-gel coating films offer a shorter response time, enabling the monitoring of biological phenomena that change within less than one second [e. g. 12]. The study mentions that the oxygen sensor is composed of biocompatible materials, and concludes that it *"is expected to be applied in biomedical field"*. However, the luminescence indicator used in this new oxygen sensor is ruthenium that, being toxic, was reported as unsafe in the clinical setting [2]. The toxicity risk could be mitigated with the application of protective coating to the fibre (when rapid response time is not crucial for the application), and successful completion of leaching studies in the biologically relevant context, for example at the relevant temperature and humidity. This limitation has so far impeded the translation of this promising technology to a clinical setting [3,4], where rapid and/or continuous oxygen sensing could be helpful, for example for patient monitoring [5]. Indeed, several other luminescence-based fibre optic oxygen sensors have been developed (e. g. [6–9]).

To overcome the translational limitation associated with the use of ruthenium in fibre optic oxygen sensors, different research groups have employed a platinum porphyrin luminophore [10] aiming at different clinical applications, for example the assessment of the compartment syndrome [11], and to determine ventilatory oscillations in arterial blood oxygen tension [12]. These studies employing the platinum porphyrin luminophore have demonstrated a very rapid response time ~100 ms and maturity beyond the initial bench testing [13], including experiments to determine the sensors' resistance to clotting in blood [14], and several pre-clinical experiments that enabled unprecedented measurements *in vivo* in sheep [15] and pig models of the acute respiratory distress syndrome [16], providing a new tool to measure lung volume [17], and with the potential to investigate cardiopulmonary function [18,19].

The novel fibre optic oxygen sensor coated with hydrogel film [1] was presented largely in the context of ruthenium-based oxygen sensors (e. g. [20,21]). Whether the hydrogel film is sufficient to isolate the ruthenium from human tissues appeared unclear, as did the potential risks associated with the disconnection of the film from the fibre. The studies employing the platinum porphyrin luminophore for oxygen sensing, which appear to have reached relative maturity, were overlooked. The majority of these studies, the sensors' development and some of their potential clinical applications have been recently reviewed [22,23].

Overall, to facilitate translation of studies to the clinical setting, a greater interaction between photonics technology developers and clinicians is required.

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