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FlusiTex RTD 2013

FNSNF

Development of Oxygen Sensing Pads and Fluorescence Life-time Imaging Platforms for Monitoring Wound Healing

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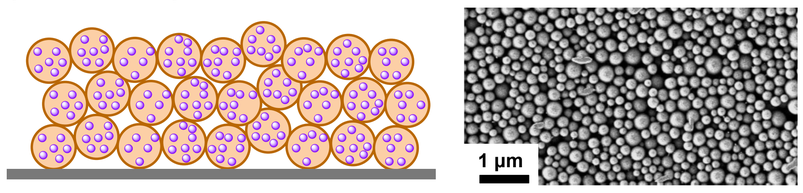
Motivation

Wound healing is a complex process, which, under normal circumstances does not require constant monitoring. However, when wounds are associated with chronic infections and/or underlying diseases such as diabetes, a much more significant threat is presented to the patient that can result in death. FlusiTex is developing a textile based sensing system to monitor wound healing. We combine fluorescence based chemical and biochemical recognition methods with advanced optical readout methods. The coatings will be integrated in a fabric in order to monitor wound healing, where different physical, chemical and biological parameters will be detected simultaneously.

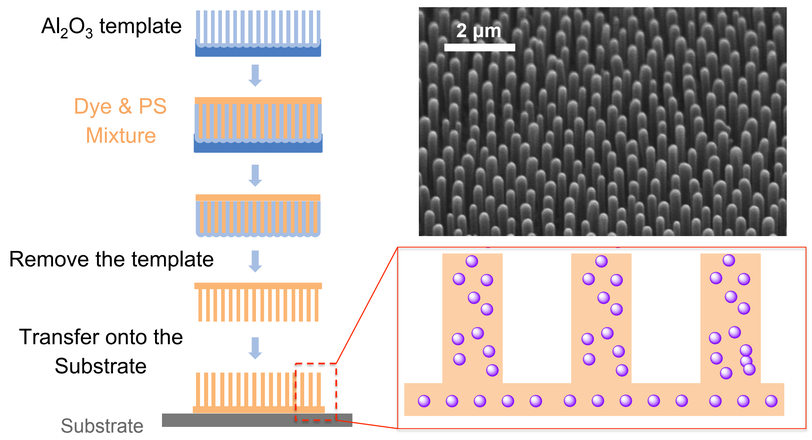
Oxygen Sensing Layer

We are using Pt(II) octaethylporphyrin (PtOEP) as an oxygen sensitive dye, because it has a long lifetime and the excitation/emission wavelengths are in the visible light range. By this choice, we avoid ultraviolet (UV) exposure and background photoluminescence from the tissue. The dye is embedded inside a polystyrene (PS) supporting matrix which is highly permeable to dissolved oxygen and transparent in the visible spectrum. It also has great chemical and photo stability.

Nanosphere Deposition

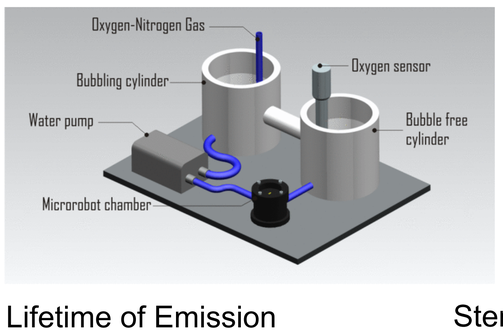


Formation of Nanopillars



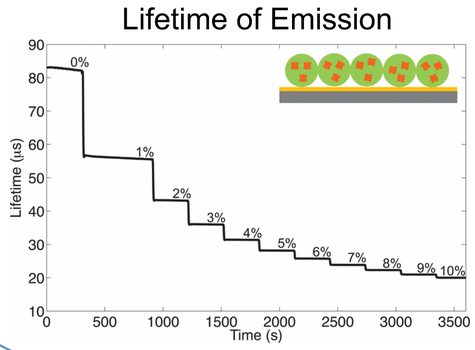
Fluorescence Life-time Imaging

We are applying Fluorescence lifetime imaging microscopy (FLIM) for the mapping of oxygen content on the sensing film. We first characterized the luminescence of the developed sensors using a Cary Eclipse fluorescence spectrophotometer (Varian, Inc., CA).

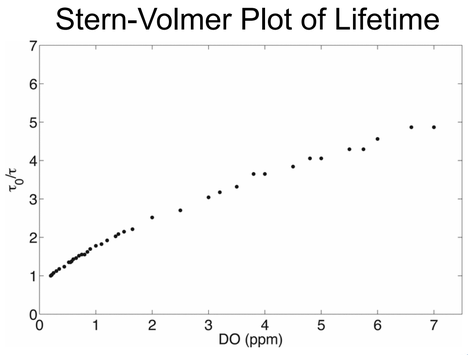


Calibration setup for dissolved oxygen (DO) measurements using a commercial oxygen sensor for monitoring.

Lifetime of Emission



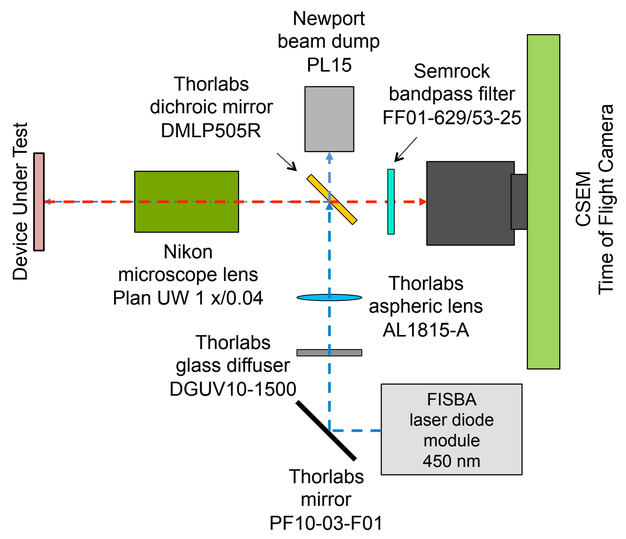
Stern-Volmer Plot of Lifetime

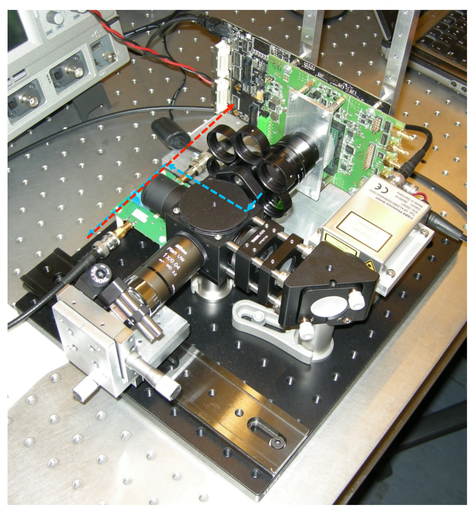


Imaging Platform

We are developing a compact, robust system for real-time wide-field fluorescence lifetime imaging in the ns-µs range (frequency domain). The system is based on CSEM's lock-in pixel technology, which was originally developed for 3D Time-of-Flight (TOF) cameras. The system consists of a modulated solid-state light source (laser diode), a CMOS lock-in imager, optical components, electronics and software interface.

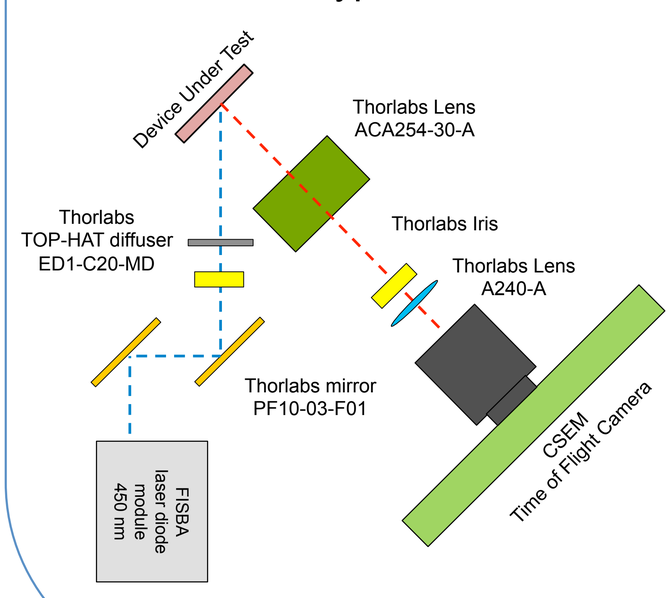
1st Prototype: Collinear Illumination

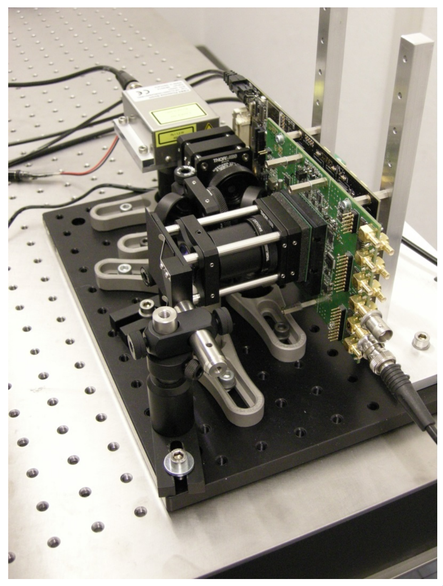




Disturbance due to back-reflections and ghost images

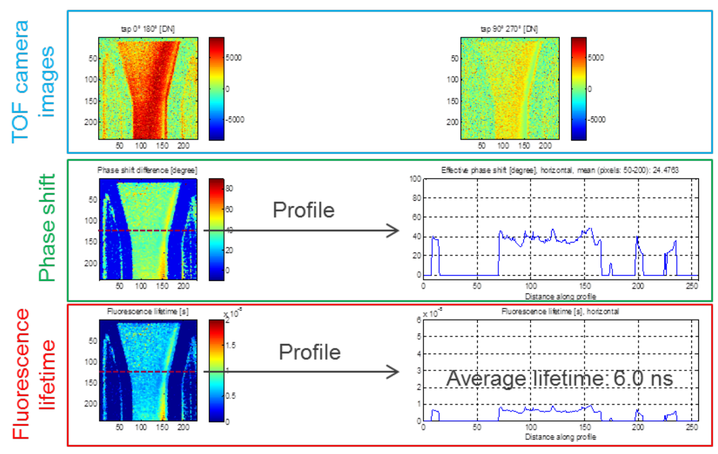
2nd Prototype: Off-Axis Illumination





Preliminary results

The fluorescence lifetime imager was tested with rhodamine/ dichlorofluorescein mixtures, with an expected lifetime in the low nanosecond range. A 2D map of the fluorescence lifetime could be obtained, as shown below. A more detailed characterization of the system is ongoing.



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