On-fiber chemiluminescence biosensing system

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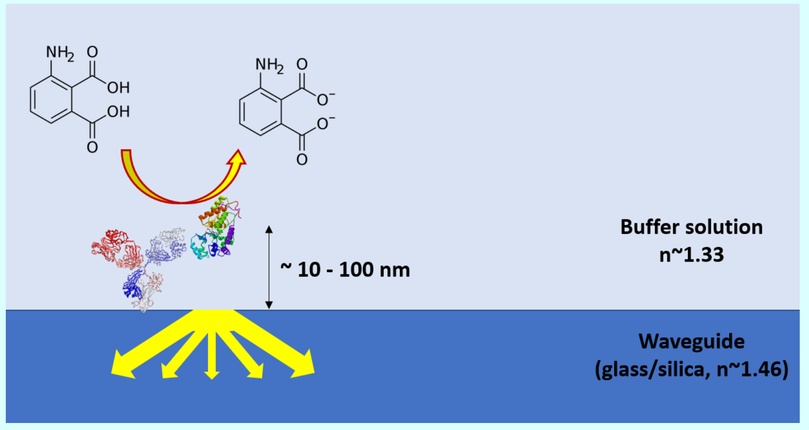
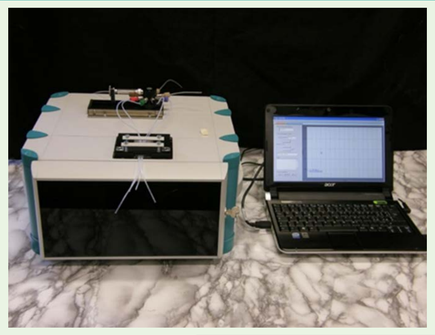
AIM. The aim of the present work is the preliminary investigation of optical fiber-based platforms for the optimal implementation of chemiluminescence-based biosensing.

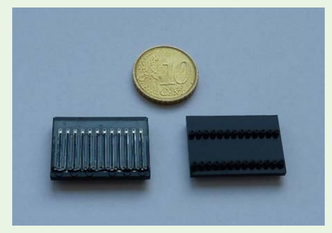
THE IDEA. The common approach in the implementation of a chemiluminescence-based detection system is to have the chemiluminescence reaction and consequent emission of photons from bulk solution inside an assay vial, and to collect the light by “looking at” the vial content.

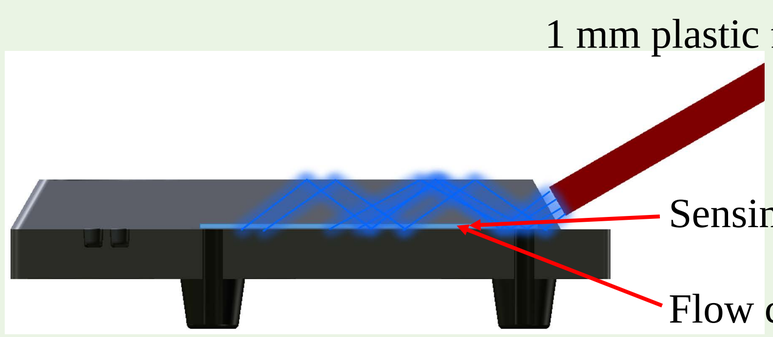
The main idea of this work is to ”force” the chemiluminescence reaction in the close proximity of an optical waveguide that safely contains and guides the generated light up to the detector.

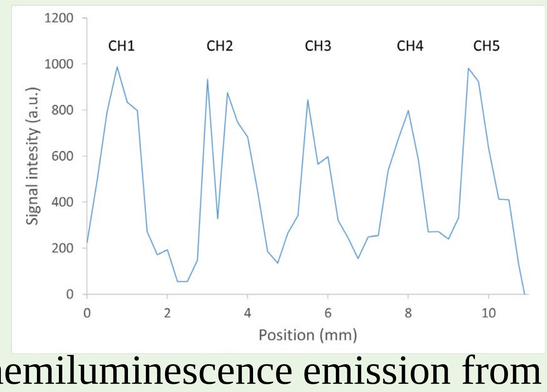


APPROACH 1. Optical platform, originally designed for fluorescence measurements, adapted for chemiluminescence detection. The core of the platform is a NH_2 functionalized microfluidic chip in Topas with 13-microchannels (50 μm high, 600 μm width, 10 mm long).
Implemented assay for preliminary measurements: immobilization of ovalbumin (100 μg/mL) onto 5 adjacent channels via carbodiimide chemistry, binding to anti-ovalbumin-HRP (1:2000), injection of chemiluminescence mix.



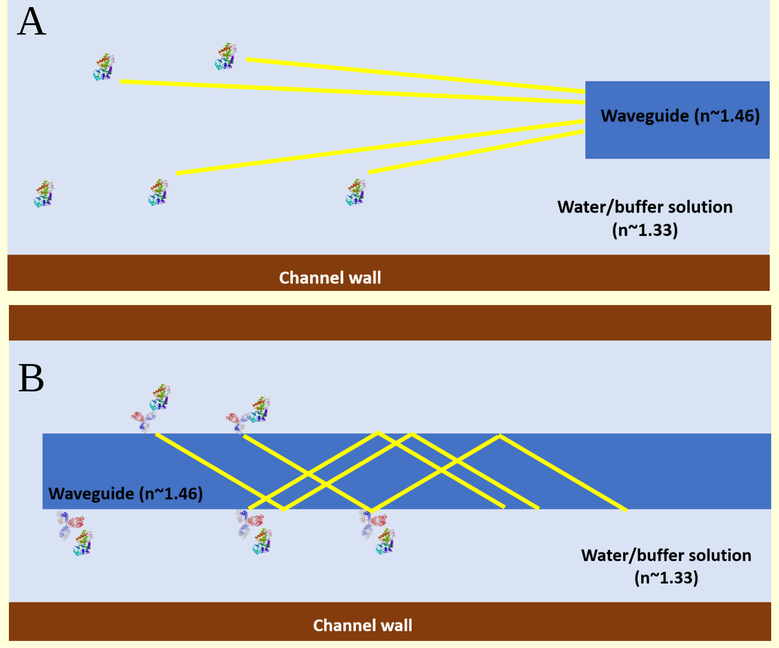


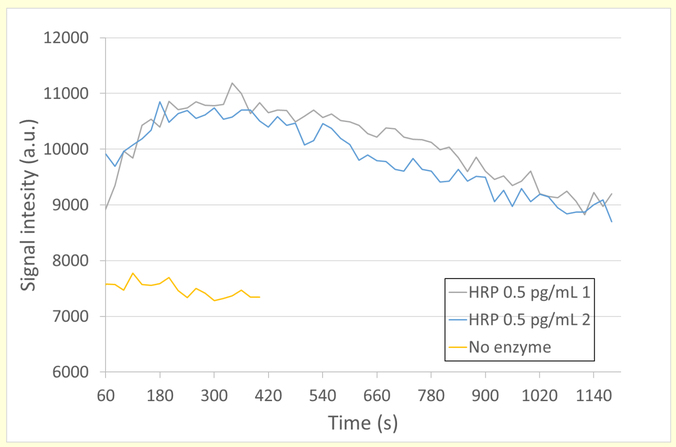




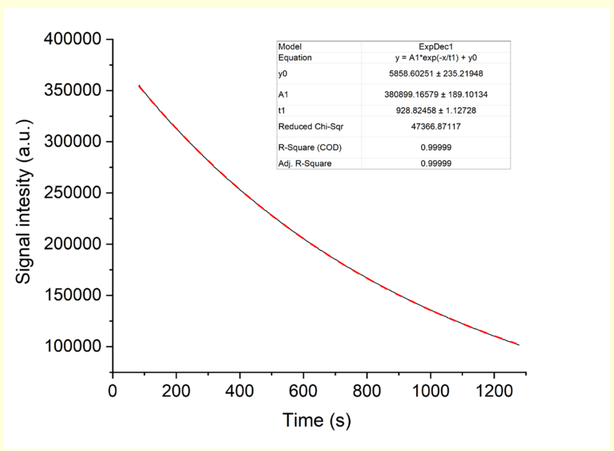
Chemiluminescence emission from 5 adjacent channels

APPROACH 2. The challenging idea is to make the reaction occur directly on (very close to) the external lateral surface of the fiber core. The radiation emission of a dipole in the proximity of a dielectric interface (water environment – fiber silica/glass/plastic core) happens mainly in the material with higher refractive index (RI), the fiber core, and with a slope that allows the guiding by total internal reflection. The optical fiber cannot be used as it is but must be strongly modified to avoid the loss of optical signal: the core must be exposed in the reaction region, the numerical aperture of the fiber must be the higher as possible, possibly the cladding and coating must be removed in the whole length of the fiber. The aim of these preliminary measurements is the evaluation of the possibility of realizing an optical fiber chemiluminescence biosensing system in which the reaction occurs very close to the external lateral surface of an optical fiber core. Preliminary data were obtained by a modified multimode fiber inserted in a capillary used to monitor a chemiluminescence signal generated in solution (A) or after an ovalbumin immunoassay onto the fiber surface (B).
Implemented assay for preliminary measurements: immobilization of ovalbumin (100 μg/mL) onto a COOH-polymer coated fiber via carbodiimide chemistry, binding to anti-ovalbumin-HRP (1:2000), injection of chemiluminescence mix.

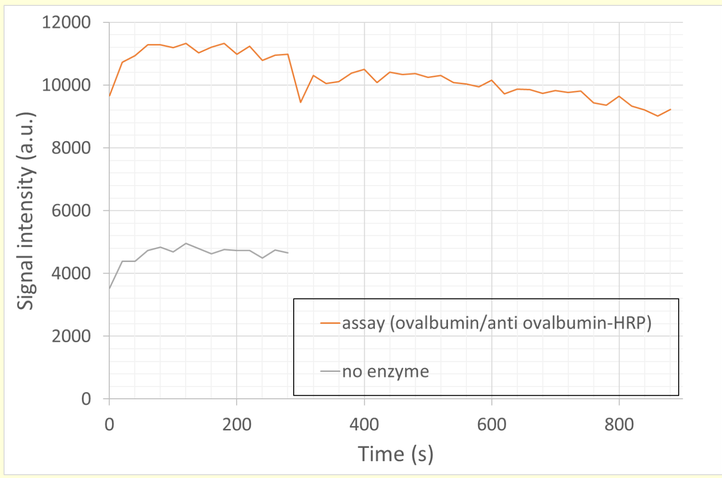




Chemiluminescence mix + HRP in solution



Kinetics of the chemiluminescence reaction in solution



Ovalbumin assay onto the fiber surface

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