A novel camera phone-based platform for sol-gel-derived fluorescence-based pH sensing

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ABSTRACT

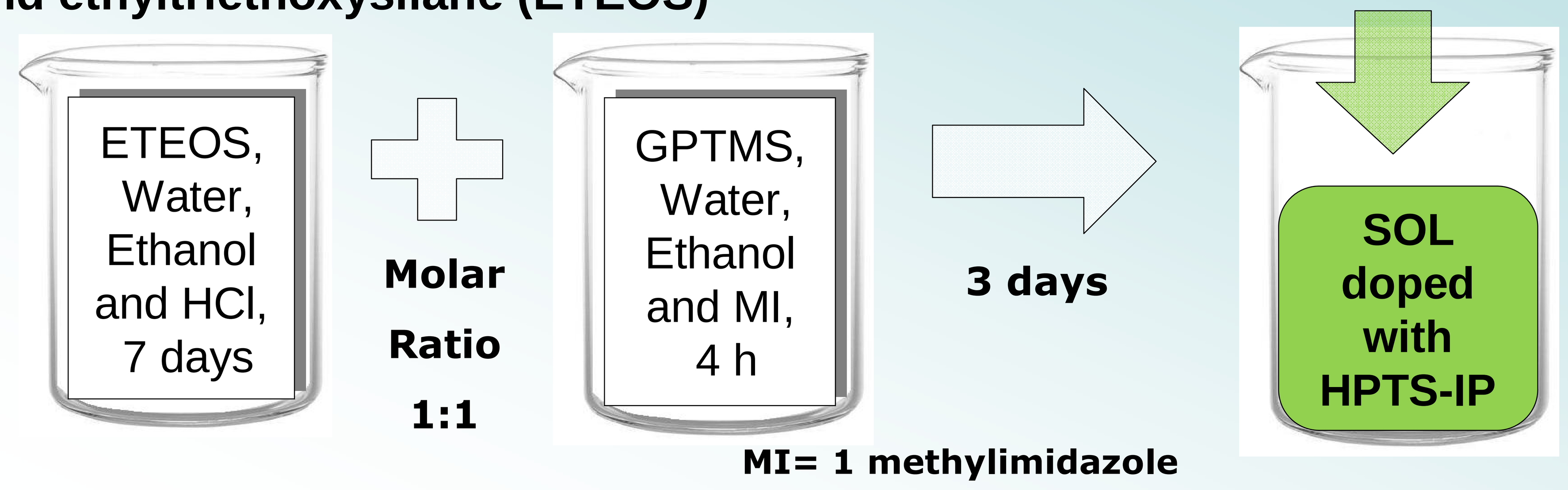
In this work a novel camera phone system for fluorescence-based sol-gel-derived pH sensing is presented. The sol-gel-based pH material, a microfluidic chip and a camera phone have been combined to obtain a fluorescence-based sensing system for fast and easy pH measurements.

STRENGTHS: • Fluorescence-based pH offers sensitivity and selectivity. • Sol-gel encapsulation provides stability and flexibility of coating. • Smart phone detection platform suitable for multiple applications in environmental and biomedical.

Sol-gel preparation

PRECURSORS:
3-glycidoxypropyltrimethoxysilane (GPTMS) and ethyltriethoxysilane (ETEOS)

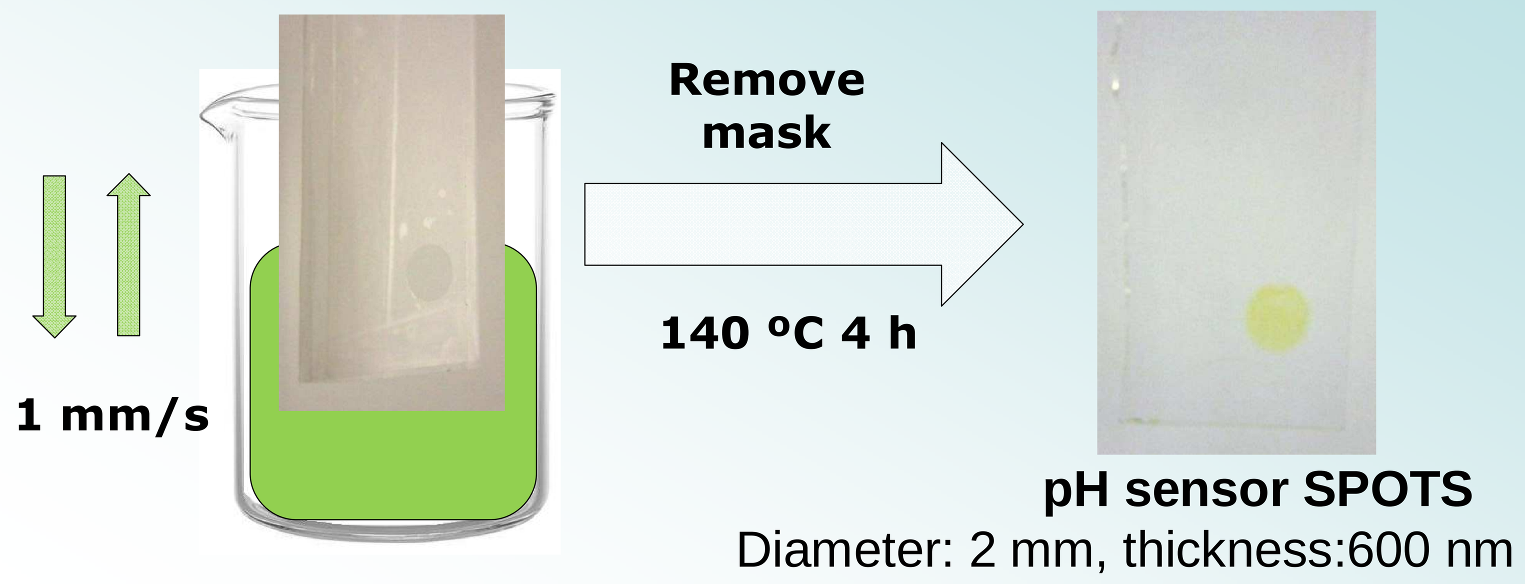
pH-SENSITIVE DYE: 8-hydroxy-1,3,6-pyrene trisulfonic acid ion paired (HPTS – IP)



MI= 1 methylimidazole

pH samples fabrication

DIP COATING METHOD
SUBSTRATES: Masked glass slides

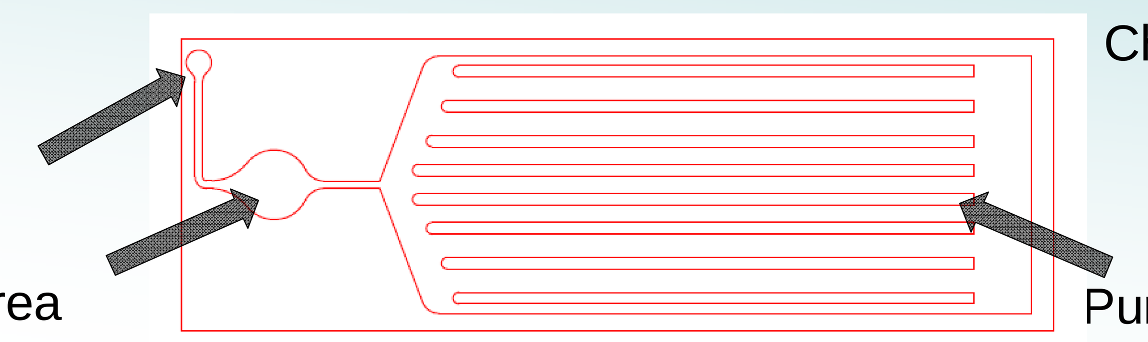


pH sensor SPOTS
Diameter: 2 mm, thickness:600 nm

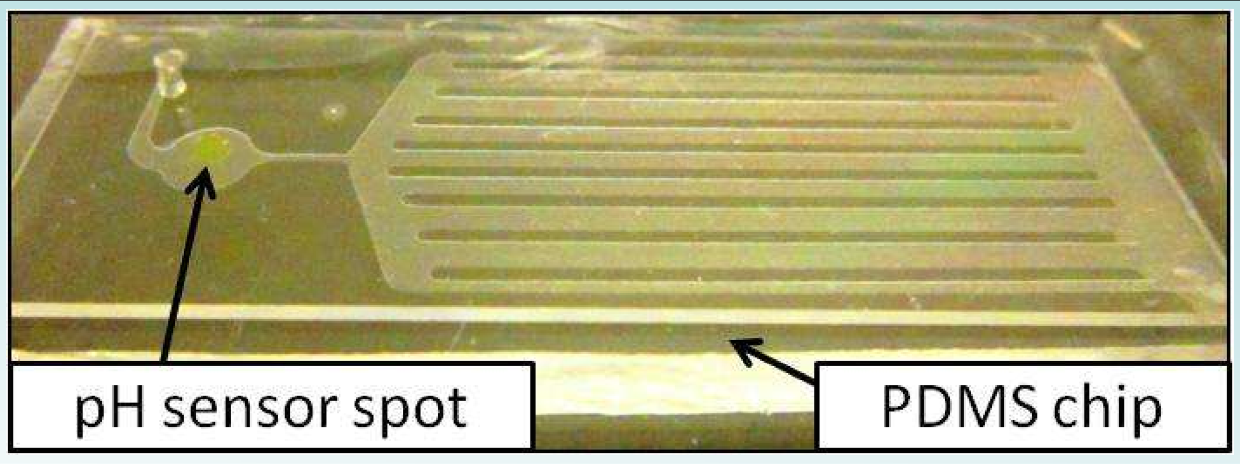
Microfluidic chip

Cast in Polydimethylsiloxane (PDMS)

Channel heigth: 50 µm



Liquid flows from the inlet to the pumping zone, covering the spot



RESULTS

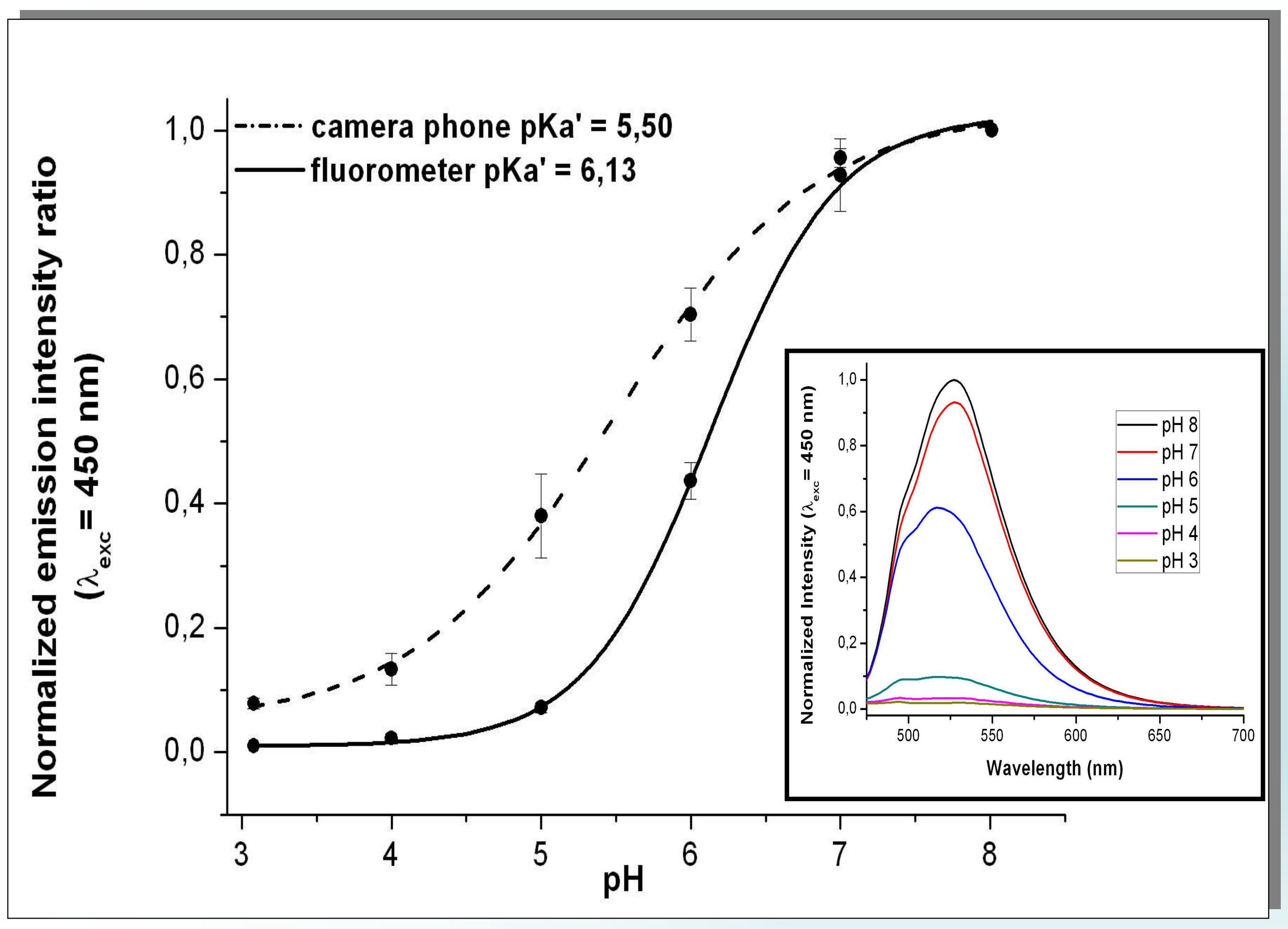


Figure 1

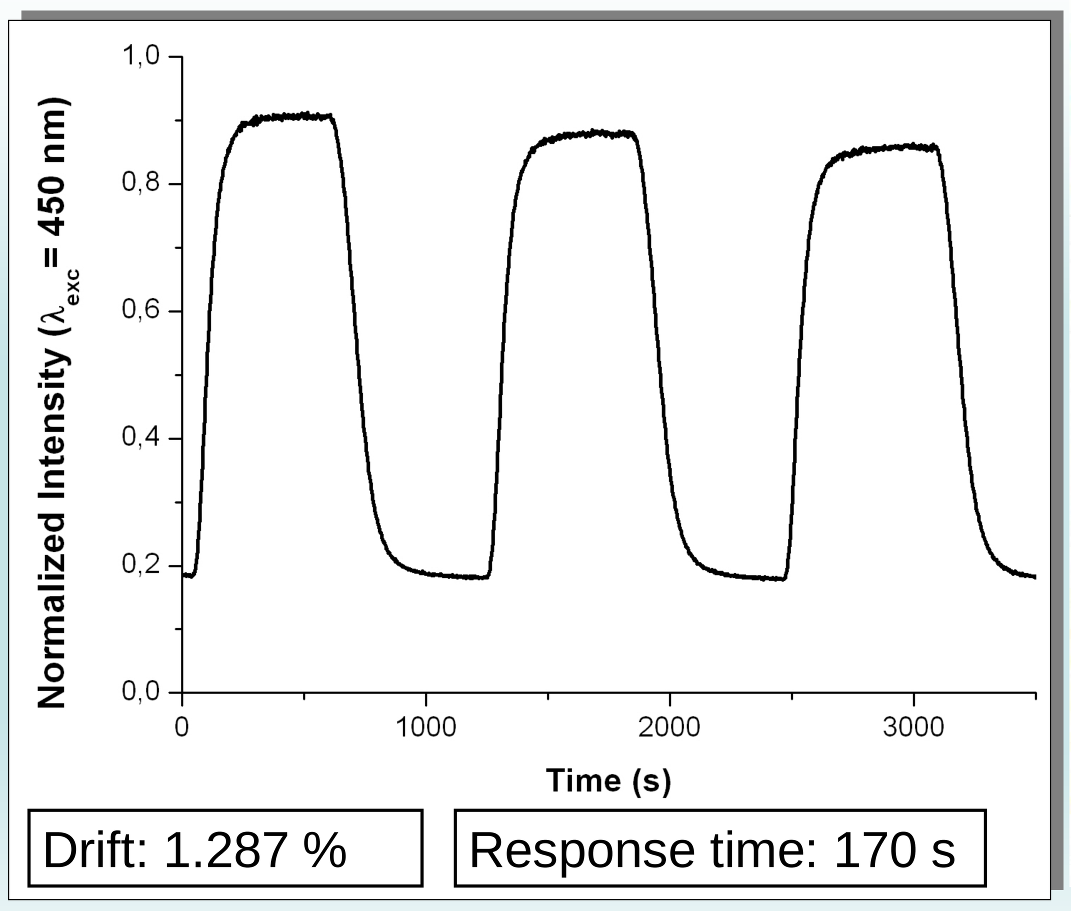


Figure 2

Characterization system

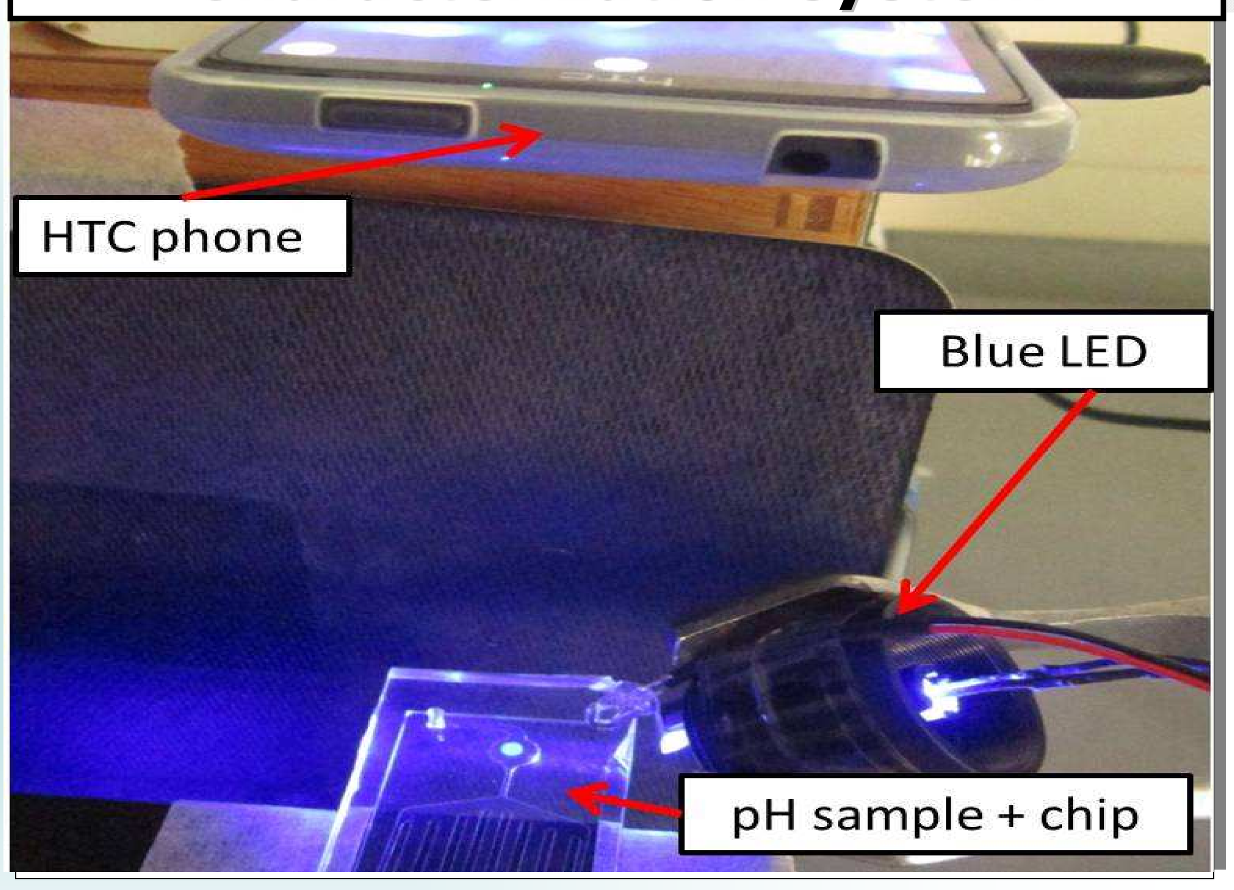


Figure 3

Figure 1: Calibration plot of the pH sensor spots using a Jasco spectrofluorometer and the camera-phone platform. Average for 3 samples. Inset: pH dependent emission spectra.
Figure 2: Reversibility, drift and response time (t rise=170 s and t fall =182 s) was measured using a spectrofluorometer.
Figure 3: pH sensor spot is excited with a 450 nm LED and the pH-dependent fluorescence at 515 nm is monitored with the camera phone-based setup.

CONCLUSIONS

- The pH sensor exhibits very good spot to spot reproducibility, short response time and has a dynamic range from pH 5.0 to 8.0.
- Camera phone dynamic range adequate to measure sensor spot brightness at different pH values.
- pKa' shift caused by the inherent non-linearity of the camera phone electronic image processing.
- This novel low-cost sensor system delivers reliable results in a simple, user-friendly way and is highly suitable for applications in remote or low-resource environments.
- This approach is suitable not only for pH sensing, but also, using appropriate analyte-sensitive dyes, for oxygen, carbon dioxide and ions optical sensing.

FUTURE WORK

- pH sensor spot integration with PDMS chip
- Implementation of dual excitation detection
- Development of an algorithm for an automated correction of mobile phone image sensor non-linearity

Refs

D. Wencel et al, SNB 139 (2009) 208-213
D. Wencel et al, J. Mater. Chem. 22 (2012) 11720-11729
S. O`Driscoll et al, Anal. Methods 5 (2013) 1904-1908

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