Self-powered potentiometric sensor based on optical signal transduction with liquid crystal display

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Self-powered sensors are attractive because they are environmentally friendly and allow for sensor miniaturization. However, developing self-powered potentiometric sensors is still quite challenging because only limited energy can be harvest by this measurement principle.

A new type of self-powered ion-selective potentiometric sensor is illustrated here that requires very little power. For the first time, the potential of a glass pH electrode of very high impedance (130 M Ω) is directly read out optically. This is accomplished by a liquid crystal display (LCD) as the electrochromic transduction principle. The LCD gives a significant change of transmission upon applying an external voltage within a certain range. The transmission process requires a very small charge on the order of 100 pC to be transferred across the membrane owing to its low capacitance of ca. 50 pF.

For the LCD to be turned on, the cell voltage needs to be boosted by the addition of additional Zn/Zn2+ elements placed in series. Also, the LCD is found to give a time-dependent absorbance decrease, which may be due to reversible radical reactions at the underlying ITO electrode as a constant voltage is applied.1 This is mitigated by adding a high resistance element in series to attenuate the associated decay, capturing the optical signal for 4 s and then short-circuiting the LCD for at least 5 s. This results in repeatable recovery of the LCD absorbance for an optical readout of adequate precision. The absorbance is found to decrease with increasing pH, which can be used to measure any sample of interest.

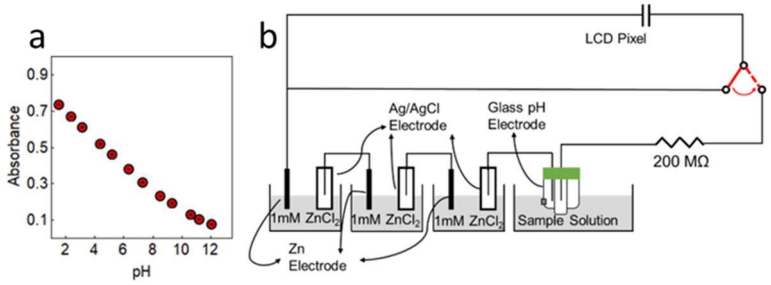

Figure 1. A) Direct LCD absorbance response to pH from a glass electrode. B) Scheme of the sensor circuit.

[1] L. Lu, A. Alagh, P.J. Bos, P. J., In *LCD failure evaluation methods and application to effect of DC drive; LIQUID CRYSTALS XV,* Proceedings of SPIE **2011**, 8114, 811416.