Statement of Purpose: pH and oxygen are two basic but important factors in cell biology, cell metabolism, and the formation of diseases and cancer. For example, it has been found that pH and oxygen play significant roles for wound-healing (1,2). We have been working on the development of optical sensors for pH, oxygen, potassium ions, and glucose as new biosensors and biomaterials for understanding cell metabolism (3-6). Herein, we will focus on our development of ratiometric dual pH and oxygen sensors for either extracellular sensing or intracellular sensing.

Methods: For extracellular sensing, the sensors are in the format of crosslinked polymeric hydrogels. For intracellular sensing, the sensors are in the forms of either amphiphilic block copolymer based nanostructured micelles or particles. Figure 1 shows a typical schematic drawing of the preparation of the hydrogel-based extracellular sensors with corresponding materials. The sensors were characterized using spectrophotometer and spectrofluorophotometer in buffer and/or cell culture medium.

Results: Figure 2A shows the emission spectra of a sensor film at different pH values. The blue emission at 421 nm from IRP doesn’t change with pH value. The emission at 521 nm decreased with the increase of pH value, showing a good pH response of the sensing film due to the pHS. The red emission at 650 nm is from OS, which is physically quenched by O2. However, the IRP and pHS were not affected by O2 concentration changes. These results showed that IRP is suitable as an internal reference probe for ratiometric analysis.

Conclusions: We have synthesized and characterized ratiometric dual pH and oxygen sensors with triple emission colors. The use of ratiometric approach has been demonstrated to improve measurement accuracy in biological environments. Applications of these sensors for cell metabolism study and for cellular and molecular responses at the biomaterial-tissue interface are in progress.

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