

Paper-based sensor for on-site detection of hydrogen sulfate in water

In 2013 UNICEF reported that ca. 2200 children below 5 years old die every day of diarrheal diseases. This report also indicates that around 90% of these deaths are the consequence of unsafe drinking water. The detection of pollutants in water is of primal importance as it is the first step in water decontamination process. In occupational settings, the detection of pollutants is usually achieved with inductively coupled plasma mass spectrometry or gas chromatography coupled to mass spectrometry. While excellent limits of detection can be reached, these techniques suffer from the use of expensive instruments and require highly trained operators. Therefore, traditional detection methods are not well suited for developing countries.

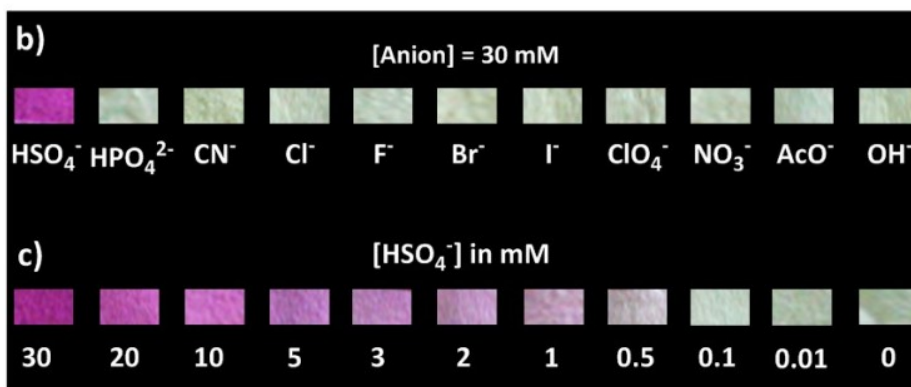
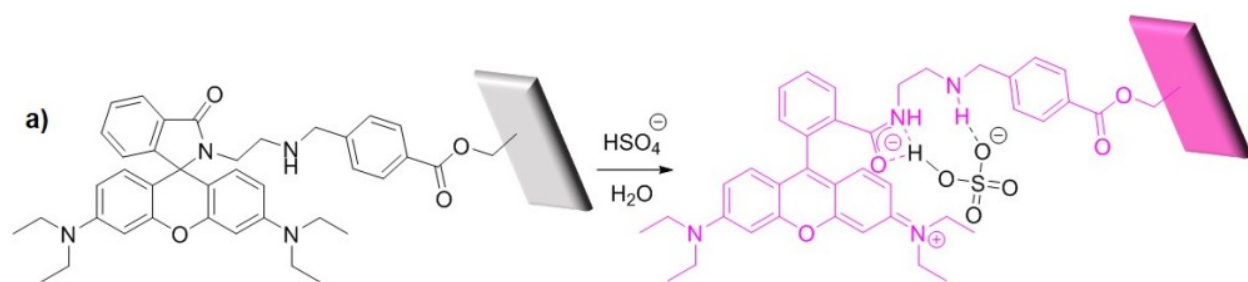


Fig. 1. a) Representation of the general strategy. b) Colorimetric detection of various anions in water at 30 mM through simple naked-eye analysis of the dipped paper strip. c) Effect of the concentration of HSO₄⁻ anions on the color change of the paper strip.

We recently set forth a simple and low-cost paper based sensor, used as a paper strip, for the detection of hydrogen sulfate, a pollutant found in many fertilizers. This simple technology allows portability for direct use on-site and operational simplicity for low-skilled operators. Our device features a rhodamine-based sensor anchored by covalent bonds on hydrophilic cellulose paper for

water compatibility and biodegradability (Fig. 1a). The covalent immobilization, by contrast with physisorption, prevents the sensor from being washed off upon contact of the paper strip with an aqueous liquid. Rhodamine was finely tuned to specifically interact with sulfate anions. Rhodamine exists as a colorless closed form and a deep purple opened one. Upon contact with sulfate anions, the originally closed colorless sensor opens and become strongly colored allowing an immediate naked-eye detection (Fig. 1b). The high specificity for sulfate anions vs other anions is attributed to amphiphilic properties of HSO_4^- that interacts with the sensor by hydrogen bonding (Fig. 1a). A color gradient from deep purple to pale rosy was observed upon decreasing the concentration of hydrogen sulfate allowing a visual limit of detection in the range 10-50 mg/L (Fig. 1c). For more accurate results, the paper strip can be analyzed with specific equipment (i.e. UV-Visible spectrometer) giving a limit of detection as low as 12 mg/L (12 ppm).

This practical technology should find broad applications in environmental and analytical sciences and could be adapted for the detection of other toxic pollutants including mercury, lead and cyanide.

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[Chemically-modified cellulose paper as smart sensor device for colorimetric and optical detection of hydrogen sulfate in water.](#)

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