

# Electrochemical Sensing of Dissolved Hydrogen Sulfide on Boron Doped Diamond Electrodes

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Hydrogen sulfide ( $\text{H}_2\text{S}$ ) is a flammable, water soluble and colorless gas with a strong smell of rotten eggs. It is also harmful when emitted into the air<sup>[1]</sup>. Electrochemical sensors have some advantages for  $\text{H}_2\text{S}$  detection. The sensitivity, selectivity, and stability are high, and detection is in real time, with a low-detection limit (LOD) and good reproducibility<sup>[2]</sup>. Thus, many methods require a redox mediator to prevent sulfur from being deposited on the surface. An electron is received from  $\text{H}_2\text{S}$  or  $\text{HS}^-$  and is regenerated on the working electrode and a measurable current can be observed<sup>[3]</sup>. In this work, we attempted to study the electrochemical oxidation reaction of dissolved hydrogen sulfide using BDD electrodes and to detect  $\text{H}_2\text{S}$  or  $\text{HS}^-$  without using a mediator or modifying the surface. Especially, the pH of the electrolyte and the scan rate of the CV measurement were varied to investigate the electrochemical reaction. Then, the performance was examined, and an interference test was conducted. The performance was compared with that of two other commonly used electrodes for hydrogen sulfide sensing: glassy carbon and platinum electrodes.

Here, we report detection of dissolved hydrogen sulfide using boron doped diamond (BDD) electrodes and  $0.1 \text{ mol L}^{-1} \text{ KClO}_4$  as an electrolyte. Oxidation of  $\text{H}_2\text{S}$  and  $\text{HS}^-$  started at potentials of +1.7 V and +0.5 V (vs. Ag/AgCl), respectively. We varied the pH to confirm the oxidation behavior. The electrolyte pH was adjusted to 1.6 and 10.2 in order to individually characterize the CVs for  $\text{H}_2\text{S}$  and  $\text{HS}^-$ .  $\text{H}_2\text{S}$  is the dominant species at pH 1.6 and  $\text{HS}^-$  at 10.25<sup>[4]</sup>. In order to study the oxidation mechanism, CVs at various scan rates were conducted. In this regard, the oxidation current increased linearly with the square root of the scan rate over the range  $0.01 - 0.06 \text{ V s}^{-1}$ , indicating that the process is transport controlled with little or no fouling of the electrode<sup>[5]</sup>. At pH=1.6, the slope as diffusion coefficient was 0.0019 ( $R = 0.998$ ) and the calculated value for  $n$  was about  $\sim 7$  electrons<sup>[6]</sup>. Next, at pH=10.2, the potential range from 0 V to 0.8 V (vs. Ag/AgCl) was used in order to avoid overlapping of the oxidation peak at +1.3 V (vs. Ag/AgCl). The slope as diffusion coefficient was 0.01 ( $R = 0.96$ ) and the value of  $n$  was  $\sim 4$  electrons. A linear calibration curve was observed in the concentration range of  $0.08 - 2.34 \text{ mg L}^{-1}$  ( $R = 0.99$ ) with a detection limit of  $0.82 \text{ } \mu\text{g L}^{-1}$  ( $S/N = 3$ ).

## References

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