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Impact of rare earth doping in transition metal oxide nanoparticles and electrochemical sensing of aromatic alcohols in polluted wastewater

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Transition metal oxides generally possess excellent chemical-physical properties, including mechanical strength, chemical inertness, thermal stability, and electrical conductivity.[1] Between them, pure ZrO2 typically shows a monoclinic crystalline phase that exhibits a limited number of oxygen vacancies. This, in turn, causes low conductivity. To address this issue, tetragonal and cubic phases of zirconia have been stabilized by doping with rare earth elements like Yb, Eu, Y, and Sc and enhanced conductivity has been observed.[2-6] Phenol isomers (DHBs), including catechol, resorcinol, and hydroquinone, are hazardous environmental pollutants. They are water-soluble and can severely harm animals, plants, and humans, leading to issues such as cancer, kidney problems, and even death. Hence, developing devices that can quickly, easily, and sensitively detect DHBs in water is crucial.[7] Several examples of rare earth-doped zirconium oxide for the development of gas sensors have been reported.8 In our study, we utilized zirconium oxide doped with 10% scandium to obtain an electrochemical sensor capable of monitoring the presence of phenols in water. In particular, we examined both morphological and electrochemical properties of pure and scandium-doped zirconium oxide using various techniques (SEM, XRD, FT-IR, CV, EIS, etc.). Specifically, we evaluated the ability of pure ZrO2 and 10 mol% Sc-doped ZrO2 to detect different phenols in solution. Our findings demonstrated that the ZrO2 10Sc/SPCE sensor achieved excellent detection performance for DHBs, showing good selectivity, sensitivity, and stability, even in real tap and mineral water samples. To summarize, we have obtained a low-cost, user-friendly sensor for the direct detection of phenolic pollutants at contamination sites.

References

1. A. Ferlazzo, C. Espro, D. Iannazzo, A. Bonavita, & G. Neri, Mater. *Today Commun*. **2023**, *35*, 106036.
2. A. Gulino, G. Compagnini, R.G. Egdell, I. Fragalà. *Thin Solid Films* **1999**, *352*, 73-76.
3. A. Gulino, R.G. Egdell, I. Fragalà. *J. Am. Ceram. Soc*. **1998**, *81*, 757-759.
4. A. Gulino, R.G. Egdell, G. Baratta, G. Compagnini, I Fragalà. *J. Mater Chem.* **1997**, *7*, 1023-1027.
5. A. Gulino, R.G. Egdell, I Fragalà. *J. Mater Chem*. **1996**, *11*, 1805-1809.
6. A. Gulino, S. La Delfa, I Fragalà, R.G. Egdell. *Chem. Mater*. **1996**, *8*, 1287-1291.
7. H. Filik, & A. A.Avan, Arab. J. Chem., **2020** *13*(7), 6092-6105.
8. A. Ferlazzo, C. Espro, D. Iannazzo, K. Moulaee, G. Neri, Int. J. Hydrogen Energy **2022**, *47*, 9819-9828.