Platinum, silver, and gold-doped zinc oxide nanoparticles as a solid contact in nitrate-selective electrodes

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The use of ZnO nanoparticles doped with noble metals (Pt, Ag, Au) as a solid contact in ion-selective electrodes sensitive to nitrate ions was investigated. The nanoparticles were obtained as a result of a two-step synthesis combining the fabrication of targets using the pulsed laser deposition (PLD) technique (where thin layers of doping metals have been deposited on a zinc oxide bulk substrate) and production of doped nanoparticles (Pt:ZnO, Ag:ZnO, and Au:ZnO) by the pulsed laser ablation in liquid (PLAL) technique.

A series of physicochemical analyses was performed to characterize the obtained materials, and to assess the electrical and analytical properties of electrodes modified with these nanomaterials. The most effective modification was the addition of Pt:ZnONPs, as these ISEs exhibited the widest linearity range of 1×10^{-1} to 5×10^{-6} M and low detection limits (3.2 μM), despite having a characteristic slope higher than the theoretical (−62.5 mV dec^{-1}). The ISEs with Pt:ZnONPs achieved a capacitance of 22.18 μF (nearly four times higher than that of ISEs, with pure ZnONPs, 5.95 μF). Additionally, the charge transfer resistance for this electrode (0.58 MΩ) was nearly four times lower than that of the electrode based on undoped ZnONPs (2.18 MΩ).

Moreover, the obtained electrode has been tested for practical purposes and successfully used for the potentiometric determination of nitrate content in soil [1].

[1] Morawska K., Pietrzak K., Car J., et al (2026) A New Type of Nitrate Potentiometric Sensor Prepared Using Hybrid Metal Oxide/Metal Nanoparticles. Materials 19:847. https://doi.org/10.3390/ma19050847.