A Novel Fluorescent Nanosensor for Picomolar Determination of Cu(II)

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In this work, we fabricated an original nano-sensor exploiting chromoionophore; 2-[[2-aminophenyl]imino]methyl]-4,6-di-tert-butylphenol in ethyl cellulose matrix (EC). The sensor design combines unique high sensitivity of fluorescence technique and robust performance of polymers in the same body, performing quenching based sensing of copper (II) ions at pico-molar levels.

The exploited polymer based nanofibers were produced by electrospinning technique. Ethyl Cellulose based nanofibers together with chromoionophore (see figure 1) acted as highly sensitive copper probe and displayed a calibration response for Cu (II) ions over a wide concentration range of 5.0×10⁻¹² to 5.0×10⁻⁸ M. It has a response time of ~ 90 s. The electrospun nanofibers exhibited excellent selectivity and sensitivity for Cu (II) with respect to conventional thin films. The Stern Volmer constants (KSV) calculated for nanomaterial is approximately 10 fold greater than that of obtained from the thin film sensors.

The significant enhancement in the sensitivity of the sensor can be attributed to the nanostructure of the electrospin membranes. Here we demonstrated that sensitivity and response related other sensor dynamics can be manipulated by controlling the quencher diffusion rate to fluorophores encapsulated in the polymer via the microstructural properties of the sensing agent. The offered nano-structure was quite beneficial for both the sensitivity and dynamic characteristics of the sensor due to its large specific area, which has high number of active sites for diffusion of Cu²⁺ ions towards the solid phase with respect to the thin films made up of same material. Figure 2 shows chemical structure of the exploited dye.

Figure 1. SEM images of EC based electrospin nanofibers

Figure 2. Structure of copper sensing fluoroionophore: DMK-OFD-7; 2-[[2-aminophenyl]imino][methyl]-4,6-di-tert-butylphenol

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