ABSTRACT

Heavy metal pollution in water has a serious impact on the environment, so a sensitive and rapid detection method is needed. This study developed an optical sensor based on nitrogen-doped carbon quantum dots (N-CQDs) to detect, identify, and quantify heavy metals such as Chromium (Cr^{3+}), Lead (Pb^{2+}), and Arsenic (As_2O_3) in solution in the range of 1-100 ppm. N-CQDs were synthesised and characterised using PSA and FE-SEM, with a baseline absorbance of 0.585 (primary peak at 470 nm) and PL of 0.844 (primary peak at 545 nm). UV-Vis data showed that at 1 ppm, the absorbance value of Cr reached 1.005 (408 nm) and decreased to 0.440 at 100 ppm. Similar data were recorded for Pb (1.055-0.532) and As (1.072-0.400). PL measurements revealed that the emission intensity of Cr stabilised around 0.73 at 1-10 ppm, but dropped drastically to 0.374 at 100 ppm, while Pb and As showed a moderate decrease (Pb: 0.871-0.649, As: 0.919-0.696). Energy gap calculations, for example for Cr, show values of 4.155 eV at 1 ppm and 4.205 eV at 100 ppm. The quantum yield (QY) data also indicates different changes, the QY of Cr at the primary peak increases from 0.001 at 1 ppm to 0.850 at 100 ppm, while Pb reaches 1.379 at 10 ppm and As reaches 1.740 100 . The energy gap and quantum yield data provide a typical optical "fingerprint" for each metal. Calibration curves based on the Lambert-Beer equation were constructed to quantify the metal concentrations. The results show that the initial interaction of metals with N-CQDs increases absorbance and emission, while at high concentrations quenching and aggregation effects occur that decrease the intensity of the optical signal.

Keywords: Heavy Metals, N-CQDs, Fluorescence, Absorbance, Energy Gap