ABSTRACT

The widespread application of hazardous agrochemicals, including pesticides, in contemporary agricultural practices has generated significant concerns pertaining to food safety, environmental contamination, and human health. Conventional detection techniques, including chromatography and spectroscopy, are characterized by high sensitivity; however, they are associated with significant costs, complex sample preparation processes, and limited portability, which pose challenges for on-site monitoring. Two-dimensional materials, characterized by their high surface-to-volume ratio, adjustable properties, extensive active sites, and favorable interactions with analytes, have come to prominence as a promising platform for sensing applications. The current thesis provides an in-depth investigation of the characteristics of synthetic two-dimensional tellurides, particularly $CoTe_2$ and MnTe, in conjunction with an analysis of the phosphate mineral Phosphoferrene, which originates from the natural ore Phosphoferrite. The sophisticated techniques of Atomic Force Microscopy (AFM) have been utilized to investigate the mechanical properties, magnetic characteristics and surface charge distribution of these two-dimensional materials. The findings indicate that the characteristics of these properties are markedly influenced by the thickness of the 2D nanoflakes. In the category of 2D tellurides, 2D $CoTe_2$ has been evaluated for its potential in detecting Mancozeb pesticide, attributed to its uniform structure, increased surface charge, and enhanced electrical conductivity. The sensing electrode exhibits a linear range spanning from 0.184 mM to 18.48 μM, accompanied by a detection limit of 0.18 μM. In contrast to 2D $CoTe_2$, the natural 2D phosphate mineral phosphoferrene exhibited enhanced adhesion, surface charge, higher sensitivity and a greater affinity for these pesticides in the linear range spanning from 0.185 mM to 0.92 μM, and a detection limit of 0.085 μM. Thus, sensors based on 2D materials have considerable promise for sustainable environmental monitoring due to their minimal power consumption, high efficiency, and capacity to detect contaminants in air and water systems in real time.

Keywords: 2D-tellurides, Phosphoferrene, Phosphates, electrochemical detection, spectroscopy, pesticide, Mancozeb.