Chapter 6
A Review on Chemsensors: A Versatile Tool to Detect Environmentally Toxic Metal Ions

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ABSTRACT

Chemsensors have been playing a crucial role in various aspects of biomedical science, analytical and environmental chemistry. The toxic metal ions like Zn, Cd, Cu, Pb and Hg have increased gradually but now have reached an alarming situation, crossing the threshold value. Due to high toxicity of these heavy metals there is an obvious need for a sensor system to detect their presence. Chemsensors including surface acoustic wave sensors, enzymes, carbon nanotubes, nanoparticles, and chromophore-based sensors have attracted increasing attention over the last few years. Chemsensors prove very promising as the system is rapid, selective, sensible, low-cost, easy-to-use, and has the ability to provide real-time signals. However, recently, considerable effort has been devoted to the synthesis of sterically encumbered selenium containing species reported to display strong affinities with Hg2+ or Ag2+. This chapter reviews the basic principles involved in the design of chemsensors, their variety and applications in various established and emerging fields.

INTRODUCTION

Till today a great variety of sensors has been synthesized by man, few of which are those that allows us to detect chemical species, this particular type is called a chemical sensor, and is defined by IUPAC as, a device that transforms chemical information, ranging from the concentration of a specific sample component to total composition analysis, into an analytically useful signal (Seyma, Fueki, Shiokawa et al., 1983). This device can be either macroscopic (e.g. a pH measuring electrode) or microscopic, it

DOI: 10.4018/978-1-5225-7635-8.ch006

refers to those molecule (or an assembled supra-molecular unit) that could selectively bind the target analyte and furnish information about this binding, therefore acting as a microscopic chemical sensor.

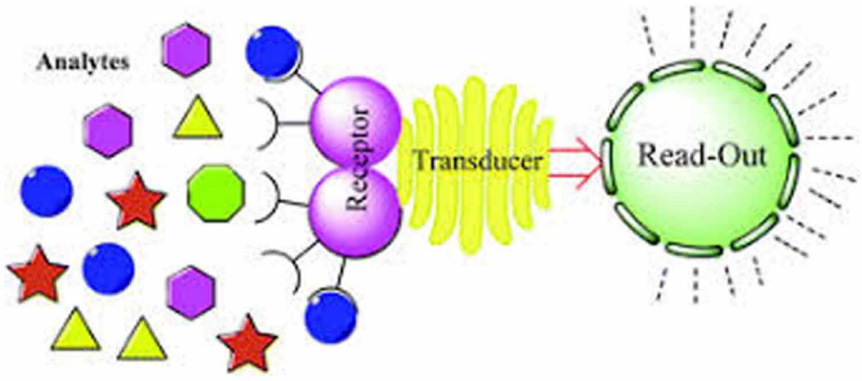
Molecular recognition and signal transduction are the two different processes that take place in chemical sensing through analyte detection. A chemsensor usually constitute three parts: A receptor (which is responsible for the selective analyte binding), an active unit (whose properties should change upon the aforementioned binding) and, in few cases, a spacer that is able to modify the geometry of the system and tune the electronic interaction between the two other components (White, 1996).

Actually, chemsensors are sensory receptors that transduce a chemical signal into an action and have vast potential as detecting units and thus, are continuously emerging as a tool for industrial, research, scientific, and pharmaceutical markets. In this series coordination compounds are also emerging as a potent tool in which chalcogen (O, S, Se and Te) containing compounds plays a significant role. Selenium is one of the elements from chalcogen series which is a naturally occurring element considered a link between metals and non-metals. It is found in nature in small concentration in rocks, plants, coal and fossil fuels (Shapira, 1973). One of such sterically encumbered selenium compound, tetrakis(iso-propyl seleno methyl benzene) on complexation with Hg^{2+}, Ag^{2+}, Pb^{2+}& Cd^{2+} showed selectivity towards Hg^{2+} ions though coordination to selenium is not an exclusive feature for mercury. As confirmed by physico-chemical data the presence of multiple soft selenium donor, the flexibility of the arms, steric bulk and open exterior geometry make these molecules potent tool for trapping Hg (II) selectively. Thus, there is a great potential in designing of sterically hindered organoselenium molecule to bind environmentally toxic metal ion selectively. Hence such tailored ligand and complexes could serve a great potential for trapping environmentally toxic metal ion and thus has application as sensors.

BACKGROUND

Large number of solid-state sensor devices based on various principles and materials are known which detect gaseous components for example semiconductor gas sensors which uses metal oxides, which detect the presence of inflammable gases in air such as CH_4, LPG and H_2 are therefore are used in large scale as gas leakage alarms domestically (Yamazoe & Miura, 1992). Sensors have also become increasingly

Figure 1. Working of a Chemsensor
Source: White, 1996



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Nahlaa Abdelwahab Khalifa (2020). *International Journal of Applied Research on Public Health Management (pp. 27-39).*
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