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A Review

Green electrochemical sensors based on ionic liquid nanocomposites for detection of environmental pollutants

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Industrialization and globalization have caused a huge burden on the limited natural resources, which releases various environmental pollutants such as toxic metal ions and pesticides. World Health Organisation (WHO) has set a maximum permissible limit for these toxic pollutants in water, above which, it is unsuitable for drinking purpose. There are various techniques available for the determination of such pollutants like ICP-MS, HPLC, FAAS *etc*. that are costly, cumbersome, and time consuming. Whereas, electrochemical sensors are portable, fast and can perform multi-analyte sensing. Electrochemical sensor can be made selective by fabricating with nanocomposites having different functional groups. Nowadays, trend of utilizing greener materials in research field is being highly appreciated in accordance with the principles of green chemistry for the application and development of electrochemical sensors. Ionic liquids having non-volatility, low toxicity, wide potential window, high electrochemical stability and conductivity have shown sustainable electrochemical sensing applications. Nanocomposite of these ionic liquids as a sensing platform have been extensively used in electrochemical detection of various pollutants. This work provides a literature survey of different ionic liquid nanocomposite based sensing platform for electrochemical detection of toxic pesticides and heavy metals. They have demonstrated good sensitivity with detection limit below WHO guidelines.

Keywords: Green electrochemical sensors, Ionic liquid, Nanocomposites, Pollutants

Introduction

Ionic liquids (ILs) are low-melting salts typically consisting of huge asymmetric organic cations with organic or inorganic anions. The inclusion of positive and negative ions, combined together in a liquid state is the main characteristic of ILs. An arbitrary definition frequently used for ILs describe them as molten salt shaving melting point below 100°C. ILs with melting point below room temperature are often called room temperature ionic liquids (RTILs). It is important to note that ionic liquids are not simple liquids, their ions are generally asymmetric with delocalized electrostatic charges. ILs include various types of organic cations such as imidazolium, pyridinium and phosphonium *etc*. with a relatively small anion which can either be a single atom like Cl^- or larger molecules like ethyl sulphate, tetrafluoroborate, hexafluorophosphate *etc*. First IL was prepared by Walden in 1914 having a melting point of 12°C. These ILs have additional benefits over conventional organic solvents as they have very low vapour pressure and higher temperature range. The ionic components induce polarity which help in dissolving wider range of organic and inorganic compounds. The ionic interactions such as electrostatic attraction and repulsion decides their solubility with polar compounds whereas the alkyl chain on cationic part control their miscibility for non-polar substances. As the characteristics of these solvents can be tuned based on our requirement they are also famously known as "designer solvents". Because of their charged nature they are being efficiently used in both synthesis as well as electrochemical field. Their high solvation ability, along with good thermal and ionic conductivity have attracted the interest of research community related to chemical synthesis and electrochemical fields[1]. The various applications of ILs in different fields of chemistry can be seen in (Fig. 1).

These ILs can be combined with different materials such as silica, carbon based nanomaterials, zeolites, Metal-Organic Frameworks (MOFs) *etc.* to form composites with desired characteristics. ILs interact with the surface of these porous material and as a consequence, the important characteristics of ILs such as physicochemical, rheological, thermophysical and conductivity can be tuned. In such hybrid systems, the

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