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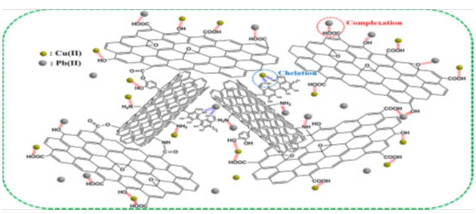
separation methods like filtration, centrifugation, or sedimentation due to its good dispersibility. Hence, magnetic nanoparticles have been suggested to be incorporated into GO and its composites to facilitate their separation from the solution under a magnetic influence instead of using the conventional methods. Fig(4) showed excellent performance of EDTA-mGO) on Pb(II), Hg(II) and Cu(II) adsorption.



Fig(2)

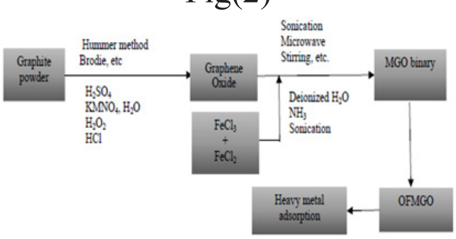
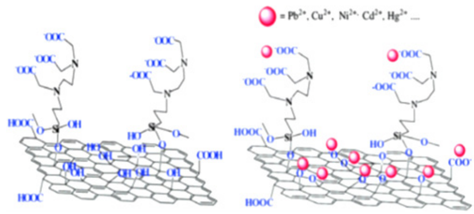


Fig (3)

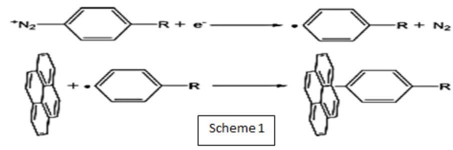


Fig(4)

CONCLUSION

This review discusses the applications of organo-functionalized graphene composites for the adsorption of heavy metals. The aspects reviewed include the commonly used organic materials for modifying graphene, the performance of the modified composites in heavy metals adsorption, effects of operational parameters adsorption mechanisms and kinetic, as well as the stability of the adsorbents.

billion people will be living in water-scarce regions as estimated by the World Water Council. The rapid development projects, agricultural activities, and industrialization have made issue. Several metals are beneficial at trace amounts but become human and environmental threats at high concentrations. These metal accumulate over time due to their non-biodegradability[3]. Several adverse effects have been associated to accumulation, exposure, and transportation of heavy metals, Hg+2, Cd+2, As+3/+4, Pb+2, and Cr+4 . The carbon nanomaterials have positioned them at the front burner of nanotechnology. Many forms of carbon nanomaterial, especially graphene, have found application in the removal of heavy metals like and other heavy metal from aqueous solutions[16]. The prepared MWXNT-PDA was applied to heavy metal ions adsorption and reported to be highly efficient Fig (2). ultra-lightweight and robust 3D through a viable green pathway [17]. And the organo-functionalized magnetic graphene oxide (OFMGO) composites for heavy metals adsorption. Fig(3) presents the reported pathway for the OFMGO synthesis and heavy metal ions adsorption. [18]. studied [19] how to enhance the adsorption capacity heavy metal selectivity to facilitate spent graphene oxide separation from water. Several materials have reportedly been used for graphene oxide functionalization, including ethylene diamine tetraacetic acid (EDTA). Nano-sized graphene oxide is difficult to be separated from water using conventional been achieved through aryl diazonium treatment. This is achieved by the grafting of aryl groups on graphene surface. Grafting aryl groups via the reduction of the respective diazonium salts has been utilized for glass carbon (GC) electrodes, CNTs, pyrolytic graphite, etc[12]. includes two steps: the generation of aryl radicals through an electrochemical process; and the subsequent reaction of the later with the carbon surfaces. This form of functionalization is done via either thermal or electrochemical reactions. As shown in Scheme 1, to liberate N2, resulting in the formation , which later couple with the substrate and aryl radical[13]. The prepared Ar- graphene was applied to heavy metal ions adsorption and reported to be highly efficient [14].



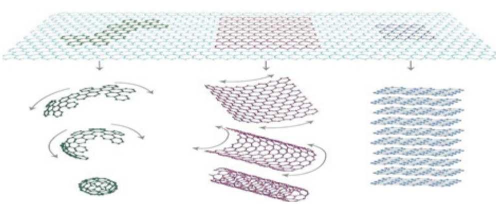
1-4 The role of functionalized graphene in water purification

The most important and essential component of life is water. The last century witnessed an increase in human demand for water (over sevenfold) due to the great increase in the global population[15]. Since 1990, about 2.6 billion people have an improved source of drinking water, while about 663 million people still do not have access to improved drinking water sources in 2015 as reported by (WHO) report on “Progress on Sanitation and Drinking Water-2015 Update and MDG Assessment”. It is expected that by 2013, about 3.9

leading to secondary pollution[5]. graphene-based materials have shown potentials as promising adsorbents for heavy metal removal due to their excellent electrical and mechanical properties Other excellent proper- ties of graphene include its lamellar structure and high surface area[6]. Although the synthesis of graphene-based adsorbents poses a significant challenge considerable, progress has been made as a result of extensive research on the topic. However in many applications surface modification is necessary as pristine graphene may be ineffective in some specific applications such as adsorption of heavy metal ions[7]. So, graphene has been modified by different means such as oxides/hydroxides[8].

1-3 Electrochemical functionalization of graphene nanosheets and their applications in heavy metals adsorption.

The development of high-performing graphene-based nanocomposites is a tedious task due to the owing to the strong agglomeration tendency of graphene and its surface inertia. High thermal conductivity, mechanical strength, and flexibility. These properties project graphene as a promising alternative to the other nanofillers in composites[9]. The delicate morphological organization, ease of processing, and -based nanocomposites are necessary to the performance of graphene-containing composites[10]. These features are mostly reliant on graphene's surface properties, and such properties can be modified via a chemical process for specific applications[11]. Graphene surface modification has recently of graphene in a spherical shape, was discovered in the 20th century. Fullerene molecules consist of 60, 70, or more carbon atoms. C60 has the form of football and is also called Buckyball, made up of 20 hexagons and 12 pentagons. Thus, graphene has taken an intermediate position between the three-dimensional graphite and the one-dimensional carbon nanotubes[2], as shown in Fig. (1).



Fig(1)

1-2 Adsorption of heavy metals

Several metals are beneficial at trace amounts but become human and environmental threats at high concentrations. These metal accumulate over time due to their non-biodegradability[3]. Several adverse effects have been associated to accumulation, exposure, and transportation of heavy metals, specifically Hg+2, Cd+2, As+3/+4, Pb+2, and Cr+4 [4]. The carbon nanomaterials have positioned them at the front burner of nanotechnology. Many forms of carbon nanomaterial, especially graphene. Several methods such as chemical precipitation, ion-exchange coagulation, reverse osmosis, electrochemical processes and adsorption have been used for the removal of heavy metals Most of these processes have some limitations which hinder their applications For instance, chemical precipitation requires alkaline conditions, which is usually achieved through the addition of lime. As a result, a large amount of sludge is produced

1-Introduction

Graphite has a planar and layered structure; it consists of stacked graphene layers and each layer consists separated by a distance of 0.142 nm. The inter-planar distance is 0.335 nm. The atoms in each plane are covalently bonded, with only 3 of the 4 potential bonding sites satisfied. The ability of the 4th free electron conferred with electrical conductivity. However, graphite cannot conduct at a right angle to the plane. Graphite can be easily separated because the inter-layer bonding is via weak van der Waals bonds[1] . from graphit we can made geaphene . It is made up of pure carbon bound in an sp2 hybridized hexagonal pattern, forming a 2D structure and is described as the building block for all graphitic materials. The theoretical specific area of monolayer graphene is about 2630 m2•g-1 due to its 2D structure. This is a much larger area compared to that of carbon black and carbon nanotubes. Before its discovery, the diamond was known to be one of the strongest materials due to the strong and abundant covalent bonds between carbon atoms[2]. However, the structure of graphene has been shown to be extremely strong with breaking strengths up to 42 N•m-1 Graphene has a metallic character and consists solely of carbon and hydrogen. Graphene can be used as a basis not only of graphite, but also the carbon nanotubes and fullerenes. The CNT were discovered in 1991 in electrode during an arc discharge, while fullerenes, a new allotrope of carbon formed by the three-dimensional folding

Abstract

Graphene is a promising material due to its unique mechanical, electrical, and thermal properties. chemical properties that are similar to those of graphite surface and can adsorb/desorb numerous atoms or Weakly attached adsorbates .and NH٣ ,molecules such as OH, NO٢ often behave as acceptors or donors, leading to fluctuations in the carrier concentration . This review discusses the applications of organo-functionalized graphene composites for the adsorption of heavy metals. The aspects reviewed include the commonly used organic materials for modifying graphene, the performance of the modified composites in heavy metals adsorption, effects of operational parameters adsorption .mechanisms and kinetic, as well as the stability of the adsorbents

الملخص

يعتبرالكرافيين مادة واعدة لما تتمتع به من خصائص ميكانيكية وكهربائية وحرارية فريدة التي تشبه سطح الكرافيت حيث يمكن ان تتمييز كميات من الجزيئات والذرات مثل مجاميع الهيدروكسيل والامونيا والثائي اوكسيد الناتروجين بقابليتها على الارتباطات الضعيفة له وغالبا مايتصرف كحامل او مستقبل . في هذا الاستعراض نوقش بعض تطبيقات الكرافيين النانوي المحور للارتباط بالمركب العضوي وامتزازه للعناصر الثقيلة والجوانب التي تمت مراجعتها تشمل عادة مواد حورت للارتباط بالكرافيين وتأثيرات ميكانيكيات أمتزازها وحركياتها وأستقراياتها.

A review of the applications of organo-functionalized graphene nanocomposites for heavy metal adsorption

استعراض لتطبيقات النانوكرافيين المحور للأرتباط بالمركبات العضوية وأمتزازها للعناصر الثقيلة

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