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Study on Catalytic Adsorption Mechanism of Graphene Surface Oxidized Structure in Aromatic Nitro Compounds

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With constant decrease of the production cost of graphene and constant development of the excellent properties, graphene nanomaterial has more and more application advantages in the control of environmental pollution, and its application prospect has been more and more emphasized by the scientific research working personnel on environmental protection. But it is a new nanomaterial with complex graphene surface oxidized structure in the aromatic nitro compounds, and its oxidation property and surface oxidation debris quantity are always the restraints influencing the application effect of graphene material. For this reason, this study has analyzed the pollution source of aromatic nitro compounds, and carried out the adsorption treatment and catalytic reduction treatment experiments on aromatic nitro compounds, so as to analyze the catalytic adsorption mechanism of graphene surface oxidized structure in aromatic nitro compounds, to provide the theoretical reference for the related studies.

1. Introduction

Graphene is the honeycombed flat film catalyzed by using carbon atom with SP2 hybrid structure. In addition, graphene is one of the main materials in aromatic nitro compounds, and in the single atomic layer thickness, graphene has the basic properties of 2D material, and can the application effect of the monoatomic layer graphite (Wang et al., 2017). The physicists Konstantin Novoselov and Andre Konstantin Geim in University of Manchester used the micro-mechanical stripping method to successfully separate the graphene element from graphite, and won Nobel Prize in Physics in 2010 for this (Xiong and Zhang, 2015). Since graphene has the characteristics of high electrical and thermal conductivity, high flexibility and high strength, it has been widely used in the fields of material science, physics, aerospace and aeronautics, electronic information technology, and computer.

Graphene is a chemical material of aromatic compounds, and has the physical properties similar to those of most aromatic compounds. The commonest graphene material is in the powdery state, and can be obtained through the production by using mechanical stripping method, SiC epitaxial growth method and oxidation-reduction method (Wei et al., 2015). And among the emerging nanomaterials, graphene is one of the materials with the best electrical and thermal conductivity. Since it has many application effects that cannot be achieved by most of other materials, it is called as “black gold” in many fields, and its rapid development as the new material will also support the reform of the new technology and new industry (Zhou et al., 2013). For further understanding of its chemical property and physical property, this study has analyzed the formation mechanism of graphene surface oxidized structure, and from the analysis on the catalytic properties and action mechanism, it is possible to define the application dimension of graphene, and thus provide the theoretical basis for its wide application.

2. Analysis on the pollution source of aromatic nitro compounds

As a new nanomaterial, graphene has many application advantages, but it is easily polluted by aromatic nitro compounds during the preparation, which will even influence the physical property and chemical property of graphene, and thus it is impossible to finish the continuous development and use (He et al., 2013).

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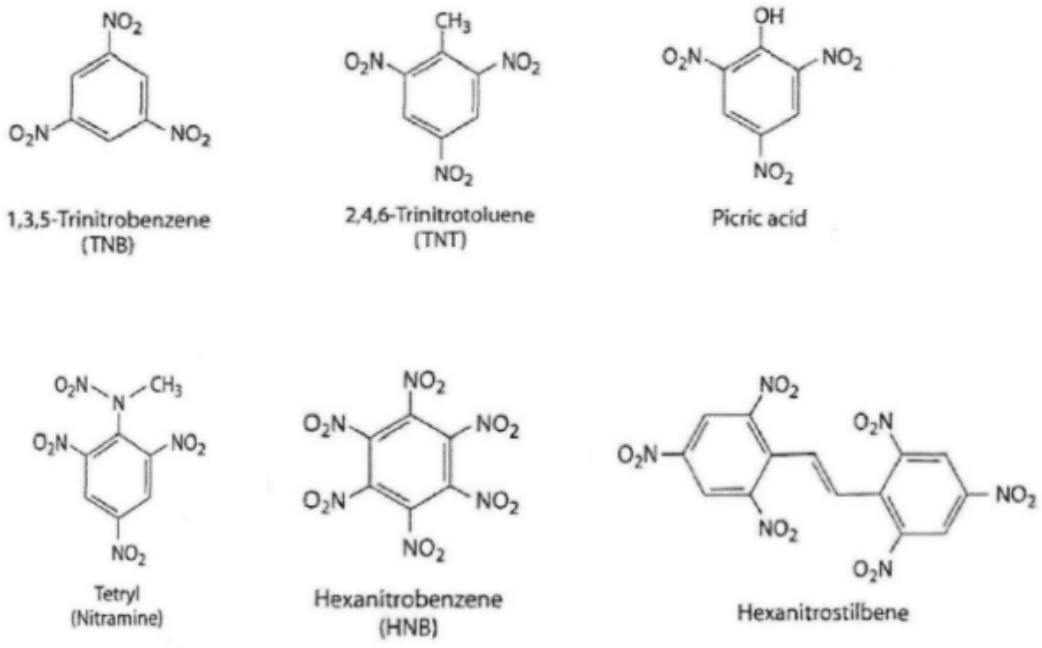

Figure 1: Molecular structure of common aromatic nitro compounds

As shown in Figure 1, for the study of the practical application of graphene material, it is required to analyze the pollution source of aromatic nitro compounds. Aromatic nitro compounds are one of the most widely used industrial chemicals, and the benzene ring of such compounds is linked with organic molecules of one or more nitro functional groups (-NO_2). Since -NO_2 chemical properties have the monomer high-energy characteristics of aromatic nitro compounds, it may be used as the oxidant in the production of the industrial chemicals and will release a huge amount of energy in the oxidation. The most typical example is TNT explosive, but it has very severe adverse impact on the environmental pollution, so its production is prohibited in North American region (Wang and Bu, 2013). But in the current production of most industrial products or the articles for daily life, the aromatic nitro compounds are still used, such as nitro toluene or nitrobenzene. The products produced with aromatic nitro compounds include drug, dye, herbicide, pesticide, military supplies, rubber and so on, and in the industrial synthesis, there will be the pollution to the environment, so the study on its adsorption effect has won wide attention in the academic field.

3. Adsorption treatment and catalytic reduction treatment of aromatic nitro compounds

3.1 Adsorption treatment

To study graphene surface oxidized structure in aromatic nitro compounds, this study has made the adsorption treatment on graphene, to analyze the oxidation of its pollutant source on the graphene surface. Though the actual rate of adsorption process is low, it is possible to properly reduce the restrictions of adsorbent and adsorption capacity by increasing the base number of the graphene experiment samples, thus achieving the best effect of optimizing the adsorption treatment work, and meeting the water body emission standard demand for the experiment samples (Zeng et al., 2017). At the same time, with the simple physical adsorption process, it is possible to observe the transfer of the pollutants on the graphene surface, thus inferring the increasable ratio of adsorbent in the treatment, so as to reduce the adsorption work cost of the pollutant source. In the current wastewater treatment, the common adsorption material for graphene is graphite carbon compound, while as a new carbon nanomaterial, graphene is the main study direction for the adsorption treatment of aromatic nitro compounds. The related data obtained from the treatment in the adsorption experiment is shown in Table 1.

Table 1: Adsorption efficiency and reference quantization index of adsorption experiment

compound	adsorbent	The adsorption ratio Adsorption of numerical	The adsorption efficiency
Phen	Bw-Go	15.67±1.96	0.972
	a-Go	15.26±1.65	0.983
m - DNB	Bw-Go	0.062±0.007	0.996
	a-Go	0.052±0.006	0.925
Cd^{2+}	Bw-Go	0.925±0.116	0.982
	a-Go	2.016±0.257	0.827

3.2 Catalytic reduction treatment

Catalytic reduction of poisonous and harmful nitro-compounds into the widely used amine structure is the effective approach of catalytic reduction treatment, and is also a necessary measure to reduce the influenci effect of the pollutant source (Xu et al., 2017). Aromatic amine is one of the raw materials with the largest consumption in the production of the chemicals, and its production mainly involves the catalytic hydrogenation and synthesis of aromatic nitro compounds. Its synthesis process mainly includes two links, on one hand, it is required to ensure that the nitrification of the benzene ring meets the catalytic reaction conditions under the influence of metallic catalyst; and on the other hand, it is required that the nitro-compounds can be infused into hydrogenation reaction (Xie and Xu, 2017). Therefore, when choosing the experiment samples in this study, the main samples include the experiment samples capable of meeting the production indexes during the production, such as azo dye, rubber, polyurethane sponge, thus improving the objectivity and authenticity of the experiment results of the catalytic reduction. From the related data from the catalytic reduction treatment, the element composition and oxidation surface area of three materials are shown in Table 2.

Table 2: The composition of three materials and the size of surface area (%)ng

The experiment indicators	Azo dye	rubber	Polyurethane sponges
C	49.25	61.05	86.53
H	1.96	1.67	0.82
N	0.15	0.00	0.36
O/C[a]	0.25	0.52	0.12
XPS	0.30	0.16	0.15
O1(530.42eV) [c]	4.52	3.82	2.12
O2(533.18eV) [c]	12.85	7.65	6.25
O3(536.75eV) [c]	2.67	1.95	1.29
BET(m^2/g^{-1})	7.052	139.28	289.36

4. Analysis on the adsorption of graphene surface oxidized structure on the aromatic nitro compounds

4.1 Analysis on the oxidation results of adsorption treatment

From the experiments in this group, it may be found that there is the transformation of the chemical property after the catalysis on the surface structure of graphene material (Li et al., 2017).

As shown in Figure 2, there is the possibility for the expansion of oxidation percentage for the graphene material during the catalysis and adsorption, which is consistent with the experiment results of some studies. The related studies have shown that the oxidation debris is very easy on the surface of the graphene material, and with constant increase of the oxidation debris size, it is easy to reduce the chemical property of the graphene material. Since the current physical techniques cannot directly remove the oxidation debris on the surface of graphene material, reducing the residues by means of chemical catalysis is also one of necessary measures (Chen et al., 2016).

Particularly under the conditions of lacking the direct proof for the holding quantity of oxidation debris, it is impossible to design the “double-component” structure model of the oxidation graphene, so there is always

the dispute in the academic field, and there is no uniform view on the mechanism for the production of oxidation debris for graphene material.

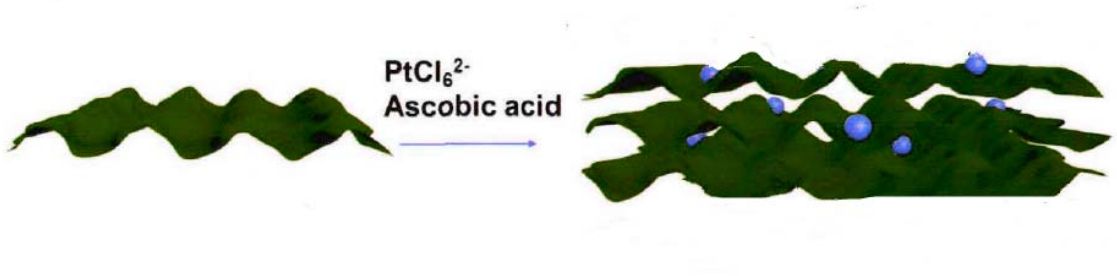

Figure 2: Graphene surface oxidation structure on aromatic nitro compounds surface structure and Pt nucleation growth diagram

At present, some related researches regarding the oxidation graphene have shown that, after the catalytic reduction treatment on the basic graphene, there is unfavorable influence of structural modification for the oxidation debris in the nanolayer surface (Quan et al., 2017). Besides, during the modification of the graphene sheets, it will have certain restricting effect on the surface structure of graphene. Therefore, the application of graphene in this field is still in the experiment stage, and there has not been the detailed optimization strategy. While though the results of this study have proven to a very large extent that graphene can reduce the quantity of oxidation debris during the adsorption treatment, it is impossible to entirely eliminate the unfavorable influence of aromatic nitro compounds in graphene surface oxidized structure directly by chemical means or physical effect, so it can only be used as the theoretical study direction for further investigation of the means and methods for eliminating the oxidants.

4.2 Analysis on adsorption mechanism of catalytic reduction treatment

In this study, it has been found that after catalytic reduction treatment of the graphene material, its adsorption mechanism shows the dependence on oxidation debris. If it is impossible to eliminate such dependence, the unfavorable influence of aromatic nitro compounds will still generate the repeated erosion effect on the graphene materials, and finally reduce the application effect of graphene material (Ma et al., 2015). So in actual use, it is required to further study the optimization effect of graphene material in the effect of chemical catalysis, and the actual effect of removing the oxidants under the effect of physical adsorption, and the related studies have shown that, oxidation debris cannot only effectively regulate the loading quantity and growth size of the precious metal nanoparticle on nanoflake, but also inhibit the restacking of the nanoflakes after reduction (Ou et al., 2017). Though the surface structure of graphene material is largely associated with the chemical behavior, particularly the interface of the pollutant molecule also belongs to the direction of chemical study, it is still required to explore the physical properties of graphene as a widely used multifunctional material in actual application, to determine how this material is used in the environmental protection control field to achieve the optimal use effect of ecological resource materials. Therefore, studying the interaction between the pollutant molecule and the surface structure of graphene material is the necessary study approach on the material currently in use. While oxidation debris, and pollution source of aromatic nitro compounds, are both main factors reducing the graphene surface oxidized structure, so it is required to explore the application results in the actual application, to control the constant catalysis and expansion of the pollutant source.

5. Conclusion

In summary, the experiment results of this study have shown that, for the control of oxidation debris on the graphene surface oxidized structure, it is very difficult to achieve the best effect of reducing the surface oxidation debris directly by physical adsorption or chemical catalysis. So, it is still necessary to verify whether graphene surface oxidized structure has met the application index through the surface modification of nanoflake or electrochemical pollutant test (Tan et al., 2017). While for catalytic adsorption mechanism of graphene surface oxidized structure in aromatic nitro compounds, the key content is still the interaction between the surface point position of graphene nanoflake and the pollutant molecule. And it is required to make further experiment analysis, and take more experiment samples as the study object, to objectively

evaluate the catalytic adsorption effect of graphene surface oxidized structure, to lay the theoretical foundation for the wide application of graphene material.

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