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Comparative Study of the Sevoflurane Asorption Capacity on Carbon Media Impregnated with Titanium Oxide Nanoparticles

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Abstract

Introduction: Occupational exposure to sevoflurane as an anesthetic gases in hospitals, dental clinics and veterinary clinics has been reported in various studies. Considering the harmful effects of sevoflurane anesthetic gas on the health of exposed personnel such as reproductive, preterm delivery and fetal abnormalities and increased spontaneous abortion, it is necessary to remove them from the air of the work environment, especially the treatment centers, with inexpensive and optimal methods. This study was aimed to compare two oxide-titanium based on Activated Carbon/ Graphene Oxide Nanosheets in nano and non-nano scales.

Material and Methods: Titanium oxide particles and nanoparticles were coated on actived carbon/ Graphene Oxide Nanosheets adsorbents. The prepared sorbents were characterized by instrumental techniques such as BET, SEM, XRD, FTIR and SEM-EDS to determine their properties .After characterization, the breakthrough and adsorption capacity of sevoflurane on both adsorbents were determined using the modified wheeler equation. Finally, the software of Microsoft Office Excel 2016 and SPSS Statistic version 21 IBM were used for statistical analysis of data.

Results: the results of XRD, SEM-EDAX analysis were confirmed the stabilization of titanium oxide particles and nanoparticles on the sorbents. Furthermore, the FTIR results determined the functional groups on the sorbents. The BET results also were showed the coating of titanium oxide nanoparticles on composite decreased the specific surface area of adsorption in comparison to adsorption containing titanium oxide particles. The adsorption capacity of the activated carbon/ Graphene Oxide Nanosheets coated with titanium oxide nanoparticles and titanium oxide particles were 240.7 and 210.5 mg sevoflurane per gram of sorbent, respectively (p-value<0.001).

Conclusion: The results were concluded that composite of activated carbon/nano oxide graphene coated with titanium oxide nanoparticles has a higher adsorption capacity of sevoflurane than other composite coated with titanium oxide particle, under the same conditions. This increase can be as a result of changes in surface chemistry (increase of the functional groups) in composite.

Keywords: Halogenated Anesthetic Gases, Sevoflurane, Activated Carbon, Graphene Oxide Nanosheets, Titanium Oxide

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1.Introduction

Halogenated anesthetic gases such as sevoflurane, are still an important source of chemical hazard in the hospital environment. Considering the Occupational exposure to sevoflurane and its harmful effects on the health, it is necessary to remove them from the air.

Nowadays, many novel methods based on nanomaterials has been introduced for removal halogenated compounds. The physicochemical properties of nanosorbents such as Graphene(NG), Activated Carbon(AC), Graphene Oxide Nanosheets (NGO), Titanium Oxide (NPsTiO2) were increased the adsorption capacity of sorbents for removal of volatile gases from air [1-5].

This study was aimed to compare two oxide-titanium based on activated carbon/nano graphene oxide in nano and bulk scales.

2.Material and Methods

Titanium oxide particles and nanoparticles were coated on Actived Carbon/ Graphene Oxide Nanosheets adsorbents. The prepared sorbents were characterized by instrumental techniques such as BET, SEM, XRD, FTIR and SEM-EDS to determine their properties. After characterization, the breakthrough and adsorption capacity of sevoflurane on both adsorbents were determined using the modified wheeler equation [6]. Finally ، the software of Microsoft Office Excel 2016 and SPSS Statistic version 21 IBM were used for statistical analysis of data.

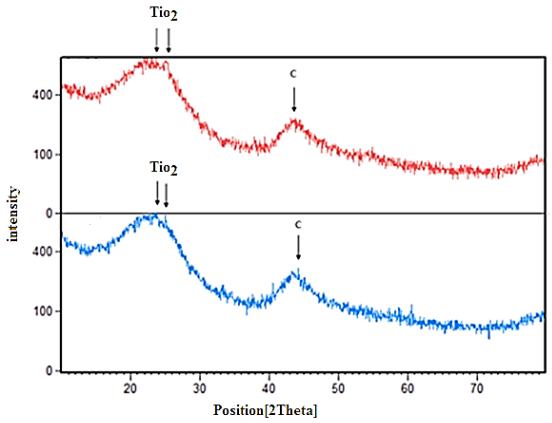


Fig. 1. XRD patterns of Composites (Red profile ACN-nGO-nTiO2 and blue profile: ACN-nGO-bTiO2)

3.Results and Discussion

The results of XRD, SEM-EDAX analysis were confirmed the stabilization of titanium oxide particles and nanoparticles on the sorbents. This result was showed the composites has an intermediary structure between the amorphous and graphite state (Fig. 1, 2).

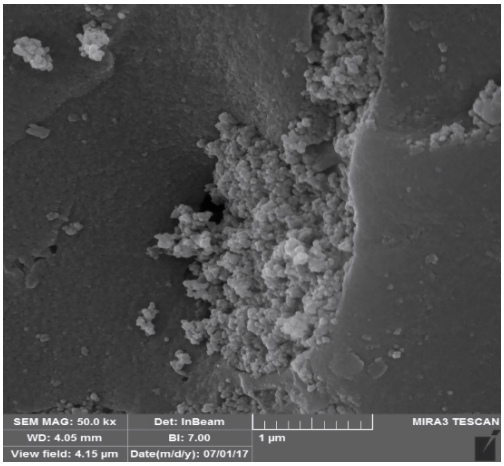
Furthermore, the FTIR results determined the functional groups on the sorbents. As shown in Fig. 3, the bands around 3410 and 1600 cm^{-1} are assigned to the vibrations of O-H that belongs to carboxyl and hydroxyl groups, respectively, while the peak at 1400 cm^{-1} and the around 1060 cm^{-1} belong to band of C-O. Also absorption band at around 600 cm^{-1} is assigned to the stretch vibration of Ti-O bond. Thus, TiO_2 particles are proved to be well-distributed on the surface of the composites.

The BET results also showed the coating of titanium oxide nanoparticles on activated carbon/ Oxide Graphene Nanosheets composite decreased the specific surface area of adsorption in comparison to adsorption containing titanium oxide particles (table. 1). This decrease can be as a result of clumping of nanoparticles and closing of some pores. The results of this study is agreement with previous *studies* of Taji Zadegan et al. and Yang Hong et al. [7, 8].

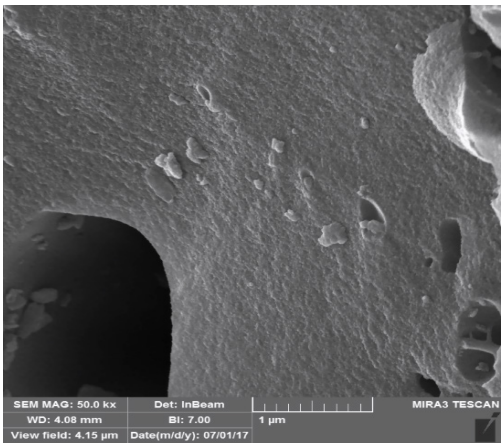
The adsorption capacity of the Activated Carbon/ Graphene Oxide Nanosheets coated with titanium oxide nanoparticles and titanium oxide particles were 240.7 and 210.5 mg sevoflurane per gram of sorbent, respectively (p-value<0.001)

4. Conclusion

The present investigation showed that composite of Activated Carbon/ Graphene Oxide Nanosheets coated with titanium oxide nanoparticles has a higher adsorption capacity of sevoflurane than Activated Carbon/ Graphene Oxide Nanosheets composite coated with titanium oxide particle, under the same conditions. This increase can be as a result of changes in surface chemistry (increase of the functional groups) in composite.



a. SEM image of AC-nGO-nTiO2

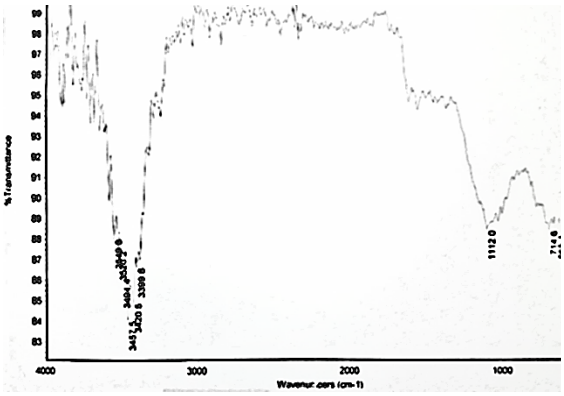


b. SEM image of AC-nGO-bTiO2

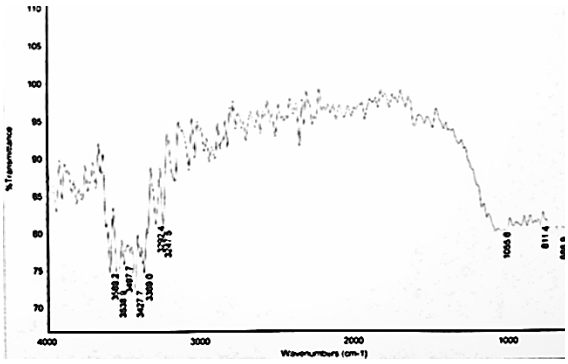
Fig. 2. SEM image of composites

Table 1. BET of composites

D_p	S_{BET} (m^2/g)	$V_{micro\ pores}$ (cm^3/g)	$V_{total\ pores}$ (cm^3/g)	composites
1.75	1039.5	0.42	0.45	ACN-nGO-$nTiO_2$
1.70	1049.5	0.45	0.46	ACN-nGO-$bTiO_2$



FTIR spectra of AC-nGO-nTiO2



FTIR spectra of AC-nGO-bTiO2

Fig. 3. FTIR spectra of composites

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