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A critical review of novel applications of combinations of graphene-based materials and meso/microporous materials

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INTRODUCTION

Is well known that carbon structures can be classified in different ways, among them by their morphological characteristics, by structural dimensionality and by the types of covalent bonds that link the carbon atoms. Graphene is an allotrope of carbon and is considered as the building block of all graphitic material[1], is a two-dimensional structure with hexagonal shape and has unique physicochemical properties.
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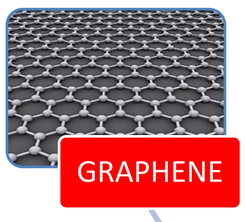


GRAPHENE

GENERAL PROPERTIES

The thinnest material[2].
- Electron high mobility[3]
- High surface area / mass ratio (2600 m^2/g)[3]
- Strength (Young modulus 1.0 TPa)[4]
- Highest thermal conductivity (5.3 $x10^3 WmK^{-1}$)[3-5]
- Impermeable to gases[1].
- Highly transparent (absorbs about 2% in the visible).

Aplications
- Aerogels[6–8]
- Sponges[7]
- Other

To produce graphene there are several methods that can be organized into two categories with different methodological approach and are called as "Bottom-up" and "Top-down".

How to obtain graphene?
- Bottom-up approach
  - Chemical Vapor deposition
- Top-down approach
  - Exfoliation
  - Oxidation-reduction

In Bottom-up methods atoms are used to create structures, and this is very important because high-quality graphene is obtained.

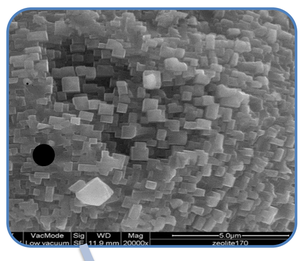
In the top-down methods, graphite is used as raw material to obtain the layers (graphene layers). Exfoliation and oxidation are part of this category. The first stages of these processes produce new materials with characteristics and functionalities slightly different from those of graphene that can be used where graphene properties cannot be exploited to the maximum and because of their low production cost they are attractive for the scientific community.

A molecular sieve is a material that has uniform pores (which can be measured in nanometers).

- Microporus materials (Porous < 2nm)
- Mesoporous materials (Porous 2 nm - 50nm)
- Macroporous materials (Porous >50 nm)

Zeolites are the most important family of microporous materials. The use of zeolites (especially natural and modified forms) has many advantages including low cost, abundant occurrence in many parts of the world and the fact that they are environmentally friendly[9]

CRYSTALLINE ALUMINOSILICATE



PROPERTIES
- Natural or synthetic
- Uniform pore dimensions
- Chemical stability
- The capacity of modification
- Ability to develop internal acidity.
- High thermal stability

APPLICATIONS
- Water treatment
- Wastewater treatment[10,11]
- Oils and spills
- Gas separation
- Agriculture, Horticulture and others[9]

Numerous studies focus on the manufacturing processes of these nanomaterials and their derivatives using different components that optimize certain properties of the final products. Among these components are crystalline aluminosilicates[12], which are used in industry and domestic activities[13–15].

Why do we mention these materials that we have mentioned that are microporous? In 2000, one of the difficulties that zeolites presented when used as heterogeneous catalysts was the fact that the micropores of the zeolite impose limitations on the reaction rate[16].

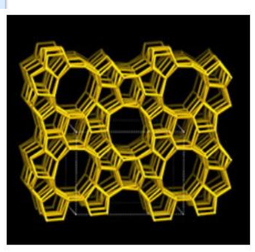
To solve this problem, several strategies were proposed:

1. increase the pore size of the zeolite,

2.Use mesoporous molecular sieves even if they do not have a high acidity like zeolite.

3.Decrease the zeolite crystal size.

By preparing zeolites in small spaces (confined) in mesoporous structures of a carbon matrix, the individual zeolite crystals encapsulate the carbon when there is an excess of zeolites (this process is done by combustion), an example of this are some zeolites type ZSM5 (see image).



Viewed along [010]

This means that some modified zeolites can also be considered mesoporous materials.

In view of the wide variety of mesoporous materials available for this work, special mention should be made of silica gel on the one hand and mesoporous zeolite on the other hand in combination with graphene-derived materials.

In the current literature, combinations of carbon-based materials and new porous materials are presented that are used to improve their adsorption capacity, usually using some of them as substrates or templates[15,17–23] and few studies on the formation of nanomaterials where these porous materials are included in the first stages.

Micro and mesoporous materials in complex combinations offer new opportunities in various fields of engineering, Physics, Chemistry and even in new economic development systems.

However, most of the related research examines properties of the new materials under laboratory conditions, further work should be carried out under environmental conditions also.

REFERENCES

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