UNIVERSIDADE FEDERAL DE OURO PRETO
INSTITUTO DE CIÊNCIAS EXATAS E BIOLÓGICAS
DEPARTAMENTO DE FÍSICA
MESTRADO EM CIÊNCIAS COM ÊNFASE EM FÍSICA DE MATERIAIS

Processo Seletivo 2019/1

Exame de Proficiência em Língua Inglesa.

Instruções:

- O exame terá início as 14h00min do dia 17 de dezembro de 2018 com duração de 3 (três) horas.
- Esse exame é composto por dois textos em língua inglesa:
  - Texto 1 - Study unlocks full potential of ‘supermaterial’ graphene
  - Texto 2 - Nanotechnology vs. viruses-researchers introduce innovative and cost-effective antiviral compound
- Cada texto possui três questões de caráter dissertativo.
- As respostas às questões propostas devem ser formuladas em português.

Texto 1

Study unlocks full potential of ‘supermaterial’ graphene

November 29, 2018, RMIT University

New research reveals why the “supermaterial” graphene has not transformed electronics as promised, and shows how to double its performance and finally harness its extraordinary potential.

Graphene is the strongest material ever tested. It’s also flexible, transparent and conducts heat and electricity 10 times better than copper.

After graphene research won the Nobel Prize for Physics in 2010 it was hailed as a transformative material for flexible electronics, more powerful computer chips and solar panels, water filters and bio-sensors. But performance has been mixed and industry adoption slow.

Now a study published in Nature Communications identifies silicon contamination as the root cause of disappointing results and details how to produce higher performing, pure graphene.

The RMIT University team led by Dr. Dorna Esrafilzadeh and Dr. Rouhollah Ali Jalili inspected commercially-available graphene samples, atom by atom, with a state-of-art scanning transition electron microscope.

“We found high levels of silicon contamination in commercially available graphene, with massive impacts on the material’s performance,” Esrafilzadeh said.

Testing showed that silicon present in natural graphite, the raw material used to make graphene, was not being fully removed when processed.

“We believe this contamination is at the heart of many seemingly inconsistent reports on the properties of graphene and perhaps many other atomically thin two-dimensional (2-D) materials ,” Esrafilzadeh said.

“Graphene was billed as being transformative, but has so far failed to make a significant commercial impact, as have some similar 2-D nanomaterials. Now we know why it has not been performing as promised, and what needs to be done to harness its full potential.”

The testing not only identified these impurities but also demonstrated the major influence they have on performance, with contaminated material performing up to 50

“This level of inconsistency may have stymied the emergence of major industry applications for graphene-based systems. But it’s also preventing the development of regulatory frameworks governing the implementation of such layered nanomaterials, which are destined to become the backbone of next-generation devices,” she said.

The two-dimensional property of graphene sheeting, which is only one atom thick, makes it ideal for electricity storage and new sensor technologies that rely on high surface area.

This study reveals how that 2-D property is also graphene’s Achilles’ heel, by making it so vulnerable to surface contamination, and underscores how important high purity graphite is for the production of more pure graphene.

Using pure graphene, researchers demonstrated how the material performed extraordinarily well when used to build a supercapacitator, a kind of super battery.

When tested, the device’s capacity to hold electrical charge was massive. In fact, it was the biggest capacity so far recorded for graphene and within sight of the material's predicted theoretical capacity.

In collaboration with RMIT's Centre for Advanced Materials and Industrial Chemistry, the team then used pure graphene to build a versatile humidity sensor with the highest sensitivity and the lowest limit of detection ever reported.

These findings constitute a vital milestone for the complete understanding of atomically thin two-dimensional materials and their successful integration within high performance commercial devices.

"We hope this research will help to unlock the exciting potential of these materials."

Source: https://phys.org/news/2018-11-full-potential-supermaterial-graphene.html#jCp

Questions:

1) List the properties of the graphene presented in the article.

2) What is the main cause of poor efficiency of the graphene-based electronic devices?

3) According to article what are the pros and cons of the two-dimensional property of graphene monolayer?

Texto 2

Nanotechnology vs. viruses-researchers introduce innovative and cost-effective antiviral compound

August 24, 2018, Freie Universitaet Berlin

An international interdisciplinary team of virologists and biochemists that includes scientists at Freie Universität has developed low-cost and "cell-friendly" nanogels that can efficiently prevent viral infections. The flexible nanogels mimic cell surface receptors where several viral families bind. Pathogens adhere to the nanogel molecules, so the likelihood of an infection of cells decreases significantly. [...]

Medical research faces innumerous challenges due to the vast number of viruses that exist. Most drugs available today are effective against only a single virus or a few similar ones because they only block specific viral proteins to disrupt the viral replication cycle in the infected cells. In addition to possible side effects of these substances, the emergence of resistant virus strains represents a serious medical hazard.

Many viruses share some similarities despite their variety of species and morphology. Often, they interact multivalently with specific receptors and co-receptors on cell surfaces, which they use for initial contact and diffusion into the interior of the cells. The breakdown of the complex mechanism of cell–virus interaction is thus a key research area for developing effective broad-spectrum antiviral agents.

Heparan sulfate (HS) proteoglycans form entry ports for a variety of viruses in the cell membrane. So far, various types of nanoparticles have been designed to block viral entry via the HS molecules. They are based primarily on rigid materials such as gold and silver particles. Little research has been done on softer and more flexible substances as an alternative.

The German-Indian research team has now succeeded in developing nanogels with different degrees of flexibility that mimic cellular HS proteins. The active compound based on dendritic polyglycerol sulphate can effectively and permanently bind and shield viruses, thus preventing infections. These nanogels offer the advantage that they can flexibly adapt to the virus surface. This increases their multivalent interactions with the virus particles and reduces the likelihood that the pathogens will be able to detach again. The researchers synthesized two sulfated nanogels that work against herpes and arteriviruses in humans and other animals. The generated nanogels can achieve an inhibitory effect of up to 90 percent. The substances remain active for a relatively long time and also provide protection against virus particles released from already infected cells. Nanogels can be prepared at very low cost compared with the production of conventional antiviral drugs. Thus, they can increasingly also be used to treat animals. In addition, the polymeric gels are harmless and "cell-friendly" – unlike rigid, inflexible materials – and can be broken down into smaller fragments and excreted by the kidneys.

Source: https://phys.org/news/2018-08-nanotechnology-virusesresearchers-cost-effective-antiviral-compound.html#jCp

Questions:

1) Describe the principle of the mechanism of the antiviral drugs available today according to the article.

2) Besides the diversity of virus species the article reports a common behavior among them. Discuss how this behavior can be explored in order to develop efficacious broad-spectrum antiviral drugs.

3) List the advantages presented in the article regarding the use of the dendritic polyglycerol sulphate as an antiviral agent.