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1. http://europa.eu/rapid/press-release_IP-13-54_en.htm

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Graphene's health effects summarised in new guide

A guide has been published on the known and potential health and safety effects of **human exposure to graphene**. It is designed to help inform those working with graphene and graphene-based nanomaterials and could be especially useful as a growing number of industries begin to experiment with and use these materials.

Almost all carbon nanomaterials are based on variations of graphene, a one atom thick honeycomb-like arrangement of carbon atoms. Graphene can be stacked, wrapped or rolled, to form graphite, football-like 'buckyballs' or carbon nanotubes (CNTs), respectively.

These materials have unique properties which may make them useful in industrial processes and consumer technologies, such as flexible display screens, carbon-based microchips and medical applications. Additionally, graphene is also being investigated for environmental applications, such as cleaning up hazardous materials and pollutants in contaminated waters. These properties can be further modified by attaching different chemical groups to the graphene surface.

While the potential use and safety of CNTs has been investigated for some time, much less is known about graphene, partly because of early difficulties in increasing its production and because it is in an early stage of development. Now, with increasing research, the adoption of different types of graphene materials in different industries will increase the likelihood of human exposure to this material.

In 2013, researchers published an overview on possible safety concerns for graphene. The paper summarises the physical and chemical characteristics of graphene and CNTs and the evidence of how they may affect health. Existing knowledge and experience from safety studies using CNTs was used to speculate on the safety of graphene.

The possible effects of graphene on human health were examined at the cellular, tissue and whole body levels in comparison to CNTs. The extent and mechanism by which cells interact and uptake graphene is considered critically important, since once inside a living cell the material could interact with or disrupt cellular processes and cause damage. Exposing the body to carbon nanomaterials could result in either their accumulation in the tissues or elimination through excretion. Accumulated nanomaterials could pose a risk to organ function, and therefore to health.

At the level of the whole body, the authors indicate that there are two main safety factors to consider regarding exposure to CNTs and graphene. The first is their ability to generate a response by the body's immune system; the second is their ability to cause inflammation and cancer.

The authors used the existing evidence to develop a set of three generalised guidelines, which if implemented, could reduce the overall health risk to a minimum for workers involved in developing graphene, and graphene-based technologies.

These can be summarised as follows:
1) Use individual graphene sheets that are small enough for immune cells to engulf and remove from the site where they were found in the body.
2) Use stable, individual graphene sheets which are easily dispersed in water to minimise their clumping and aggregation in the body.
3) Use graphene, or chemically modified graphene material, that can be easily cleared from or biodegraded in the body, to prevent damage from chronic accumulation into tissues.

This study provides useful information to help guide the work of graphene research groups and could help raise awareness of graphene's potential health and safety effects.

The potential promise of graphene is such that in 2013 the European Commission announced[1] that a graphene initiative was a winner in the multi-billion euro 'Future and Emerging Technologies' competition. Furthermore, over 100 research groups will receive funding for up to seven years for graphene-related projects as part of the Horizon 2020 programme.