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Chronic exposure to graphene-based nanomaterials induces behavioral deficits and neural damage in Caenorhabditis elegans

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Abstract

Nanomaterials of graphene and its derivatives have been widely applied in recent years, but whose impacts on the environment and health are still not well understood. In the present study, the potential adverse effects of graphite (G), graphite oxide nanoplatelets (GO) and graphene quantum dots (GQDs) on the motor nervous system were investigated using nematode Caenorhabditis elegans as the assay system. After being characterized using TEM, SEM, XPS and PLE, three nanomaterials were chronically exposed to C. elegans for 6 days. In total, 50-100 mg l^{-1} GO caused a significant reduction in the survival rate, but G and GDDs showed low lethality on nematodes. After chronic exposure of sub-lethal dosages, three nanomaterials were observed to distribute primarily in the pharynx and intestine; but GQDs were widespread in nematode body. Three graphene-based nanomaterials resulted in significant declines in locomotor frequency of body bending, head thrashing and pharynx pumping. In addition, mean speed, bending angle-frequency and wavelength of the crawling movement were significantly reduced after exposure. Using transgenic nematodes, we found high concentrations of graphene-based nanomaterials induced down-expression of dat-1::GFP and eat-4::GFP, but no significant changes in unc-47::GFP. This indicates that graphene-based nanomaterials can lead to damages in the dopaminergic and glutamatergic neurons. The present data suggest that chronic exposure of graphene-based nanomaterials may cause neurotoxicity risks of inducing behavioral deficits and neural damage. These findings provide useful information to understand the toxicity and safe application of graphene-based nanomaterials. Copyright © 2017 John Wiley & Sons, Ltd.

Keywords: C. elegans; behavioral deficits; graphene; graphene quantum dots; neurotoxicity.

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