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Section

Nanotechnology and Applied Nanosciences

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Section Editor-in-Chief

Prof. Dr. Philippe Lambin

Department of Physics, University of Namur, Belgium

Section Information:

This section is intended for accounts of works pertaining to nanotechnology or to nanosciences oriented towards applications. More specifically, papers dealing with the production, manipulation or assembly of nanostructures, the construction or characterization of nano-architectures, the design of nanoscale devices, the use of nanoparticles or nanostructures to improve macroscopic properties of materials and systems ... are welcome. By contrast, works focusing on toxicity of nanomaterials, nano-biological research involving living cells, viruses, bacteria ... and works involving bio-ethical issues should be addressed to more specialized journals.

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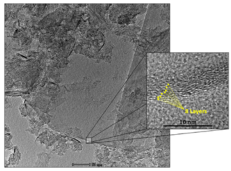
Section Nanotechnology and Applied Nanosciences

Content Highlights

DOI:10.3390/app12020720

Graphene Nanoplatelets: In Vivo and In Vitro Toxicity, Cell Proliferative Activity, and Cell Gene Expression

Authors: Ángel Serrano-Aroca, Juan Andrés, Marcelo Assis, Alba Cano-Vicent, Alberto Tuñón-Molina and Beatriz Salesa

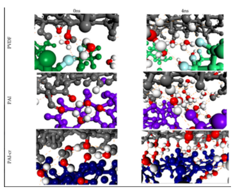


Abstract: Multi-layer graphene (2–10 layers), also called graphene nanoplatelets (GNPs), is a carbon-based nanomaterial (CBN) type with excellent properties desirable for many biomedical applications. Despite the promising advantages reported of GNPs, nanoscale materials may also present a potential hazard to humans. Therefore, in this study, the in vivo toxicity of these nanomaterials at a wide range of concentrations from 12.5 to 500 μg/mL was evaluated in the Caenorhabditis elegans model for 24 h (acute toxicity) and 72 h (chronic toxicity). Furthermore, their in vitro toxicity (from 0 to 10 μg/mL for 12 and 24 h), proliferative activity at 72 and 96 h, and their effect on the expression of thirteen genes in human keratinocytes HaCaT cells were studied. The physico-chemical and morphological aspects of the GNPs used in this study were analyzed by Raman scattering spectroscopy, electron microscopy, zeta potential as a function of pH, and particle size measurements by dynamic light scattering. The results of this study showed that GNPs showed in vivo non-toxic concentrations of 25 and 12.5 μg/mL for 24 h, and at 12.5 μg/mL for 72 h. Moreover, GNPs present time-dependent cytotoxicity (EC50 of 1.142 μg/mL and 0.760 μg/mL at 12 h and 24 h, respectively) and significant proliferative activity at the non-toxic concentrations of 0.005 and 0.01 μg/mL in the HaCaT cell line. The gene expression study showed that this multi-layer-graphene is capable of up-regulating six of the thirteen genes of human keratinocytes (*SOD1*, *CAT*, *TGFB1*, *FN1*, *CDH1*, and *FBN*), two more genes than other CBNs in their oxidized form such as multi-layer graphene oxide. Therefore, all these results reinforce the promising use of these CBNs in biomedical fields such as wound healing and skin tissue engineering.

DOI:10.3390/app12073460

Stability of Graphene Oxide Composite Membranes in an Aqueous Environment from a Molecular Point of View

Authors: Elena Tocci, Enrica Fontananova, Anastasios Gotzias and Chiara Muzzi

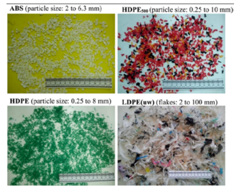


Abstract: We used molecular dynamics to investigate the stability of graphene oxide (GO) layers supported on three polymeric materials, namely a polyvinylidene fluoride (PVDF), a pristine and a crosslinked polyamide–imide (PAI and PAI-cr). The membrane configurations consisted of a few layers of GO nanosheets stacked over the specified polymeric supports and submerged in water. We monitored the position, the tilt angle, and the radial distribution function of the individual GO nanosheets in respect to the plane of the supports. We showed that the outermost GO nanosheets were more distorted than those attached directly on the supports. The greatest distortion was observed for the GO nanosheets of the PVDF-supported system. Next, we recorded the density profiles of the water molecules across the distance from the layers to the polymer and discussed the hydrogen bonds between water hydrogens and the oxygen atoms of the GO functional groups.

DOI:10.3390/app12042146

Influence of plastic waste on workability and mechanical behaviour of asphalt concrete

Authors: Luís Picado-Santos, Arminda Almeida, Silvino Capitão and Mariana Fonseca

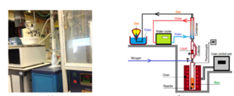


Abstract: The use of plastic waste as a bitumen extender added throughout the manufacturing process of asphalt concrete contributes value to that type of waste. Moreover, this type of polymer can improve some mechanical properties of asphalt concrete without weakening its workability and other mechanical characteristics too much. The study aimed to address these issues for four types of plastic waste, using different plastic contents added by the dry process and compared the results with a conventional mixture without plastic. A set of laboratory tests, such as volumetric parameter evaluation, the Marshall, gyratory compactor, and indirect tensile tests, repetitive four-point bending; and repetitive compression, assessed the workability and mechanical behavior of the studied materials. The results show that, although the addition of plastic waste reduces workability, the asphalt concrete retains satisfactory handling conditions. By adding plastic waste, the asphalt concrete becomes more elastic, and the stiffness values of the material are adequate to apply the material in a pavement surface layer. The resistance to fatigue cracking was at a suitable level for the asphalt mixtures studied. Adding the plastic waste in the study generally improved resistance to permanent deformation, although the performance was plastic type and content dependent.

DOI:10.3390/app12052526

Using plastic waste in a circular economy approach to improve the properties of bituminous binders

Authors: Everton R. F. Santos, Maria Amélia N. D. A. Lemos, Francisco M. S. Lemos, Luís G. Picado-Santos and Fernando C. G. Martinho

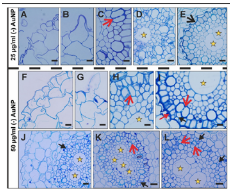


Abstract: This work aims to use wax to modify a binder employed in the paving industry. This wax can be obtained either directly or as a by-product from plastic waste's thermal cracking (pyrolysis). The study characterizes this sustainable material and the binders resulting from blending it with conventional or modified bitumen with other additives applied in the manufacture of bituminous mixtures. Different tests were used: thermogravimetric and spectroscopic analysis; consistency tests; testing of dynamic viscosity at various temperatures; and assessment of the rheologic properties of binders. As a result, several crucial findings were reached: this sustainable wax promotes changes in the viscosity of the binders, their handling temperatures can be reduced, and it contributes to some goals of the U.N. 2030 Agenda. In summary, this work allowed us to conclude that the positive effects of a suitable modification of the bituminous binders, which incorporated this wax and other additives, led to improved consistency and rheological behaviour, having provided, for example, lower temperature susceptibility and higher permanent deformation resistance.

DOI:10.3390/app12073265

Morphological and ultrastructural changes in *Hordeum vulgare* (L.) roots that have been exposed to negatively charged gold nanoparticles

Authors: Ewa Kurczyńska, Maciej Zubko, Weronika Gepfert and Anna Milewska-Hendel



Abstract: In recent years, there has been an impressive development of nanotechnology. This has resulted in the increasing release of nanomaterials (NM) into the environment, thereby causing the risk of an uncontrolled impact on living organisms, including plants. More studies indicated the biotoxic effect of NM on plants, including crops. The interaction of nanoparticles (NP) with food crops is extremely important as they are a link to the food chain. The objective of this study was to investigate the effect of negatively charged gold nanoparticles (-) AuNP (at two concentrations; 25 µg/mL or 50 µg/mL) on barley (*Hordeum vulgare* L.) root development. Morphological, histological and ultrastructural analyses (with the use of stereomicroscope, bright filed microscope and transmission electron microscope) revealed that regardless of the concentration, (-) AuNP did not enter into the plant body. However, the dose of (-) AuNP proved to be important for the plant's response because different morphological, histological and ultrastructural changes were observed in the treated roots. The NP treatment caused: red root colouration, a local increase in the root diameter and a decreased formation of the root hair cells (on morphological level), damage to the rhizodermal cells, vacuolisation of the cortical cells, a detachment of the cell files between the cortical cells, atypical divisions of the cells, disorder of the meristem organisation (on the histological level), the appearance of periplasmic space, numerous vesicles and multivesicular bodies, electron-dense spots in cytoplasm, alterations in the structure of the mitochondria, breakdown of the tonoplast and the plasmalemma (on the ultrastructural level).

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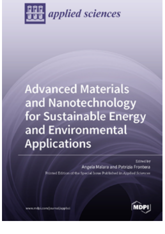

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