

DU GRAPHENE POUR NOTRE SANTE ?



GRAPHENE
FLAGSHIP

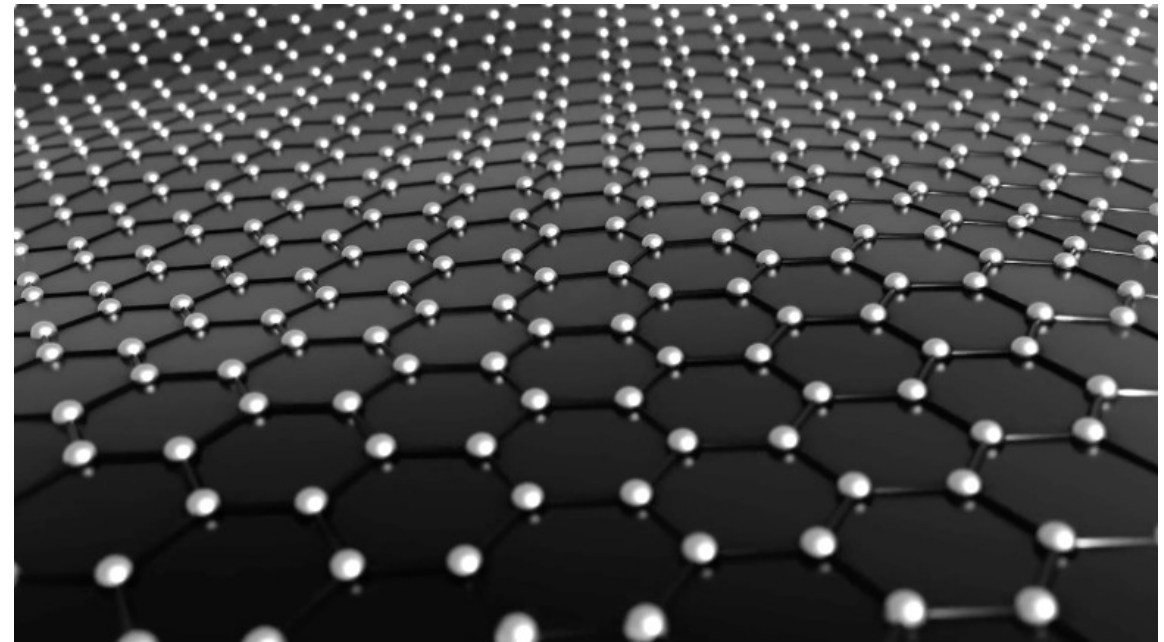


Funded by
the European Union

Qu'est-ce que le GRAPHÈNE ?

Le graphène - une seule couche d'atomes de carbone - est peut-être la substance **la plus étonnante et la plus polyvalente disponible pour l'humanité.**

En termes simples, le graphène est une couche d'atomes de carbone d'une épaisseur d'un atome disposée en un **réseau hexagonal.**



Qu'est-ce que le GRAPHÈNE ?

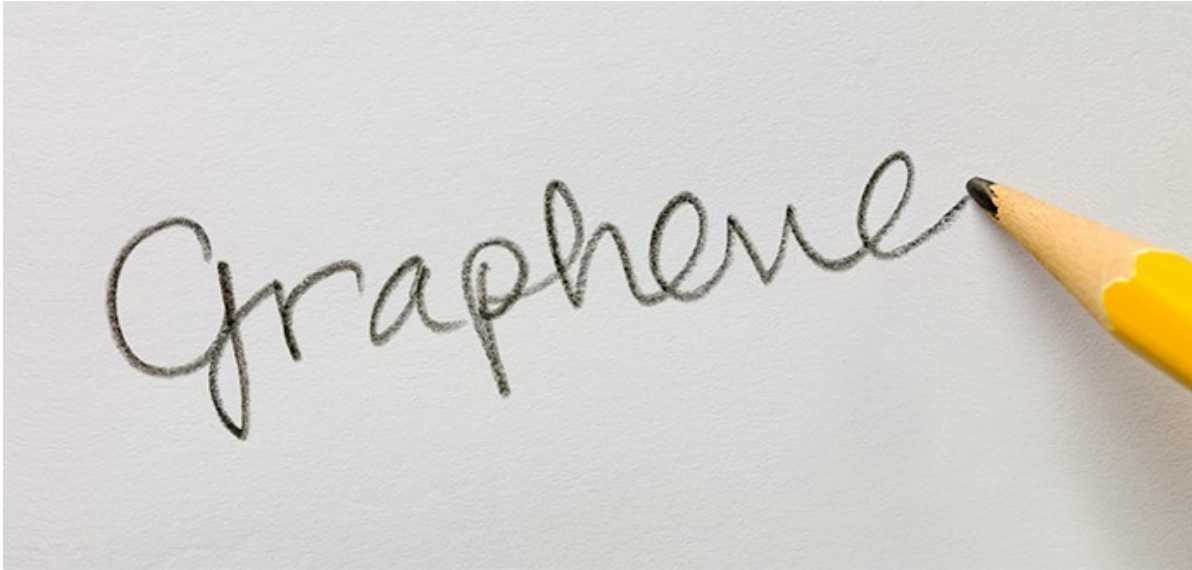
Le graphène a été isolé pour la première fois en 2004. Depuis lors, le graphène a trouvé des centaines d'applications innovantes, des capteurs et de l'électronique au stockage d'énergie et aux soins de santé. En outre, la recherche sur le graphène a permis la découverte **d'une nouvelle famille de matériaux bidimensionnels et stratifiés.**

Combinés au graphène – de la même manière que vous mélangez différents ingrédients dans un sandwich – ils ouvrent un tout nouveau monde de possibilités.

Le graphène est :

- **le matériau le plus fin au monde** (il n'a qu'un atome d'épaisseur), un million de fois plus fin qu'un cheveu humain.
- **très solide**, plus résistant que l'acier et le diamant.
- **très flexible et transparent**, on le trouvera dans les appareils portables et l'électronique pliable.
- **un excellent conducteur d'électricité et de chaleur.**
- Certains producteurs ont utilisé ces deux principes pour fabriquer des encres et des peintures conductrices pour circuits électroniques et des gels qui dissipent la chaleur.

Comment est fabriqué le GRAPHENE ?



Lorsqu'Andre Geim et Kostya Novoselov ont isolé le graphène pour la première fois en 2004, **ils ont utilisé un morceau de ruban adhésif pour « décoller » des couches atomiquement minces du graphite.** Le graphite est l'ingrédient principal des mines de crayon - si vous avez déjà griffonné avec un crayon, il est probable que

Comment est fabriqué le GRAPHÈNE ?

Aujourd'hui, il y a 3 processus pour fabriquer du graphène :

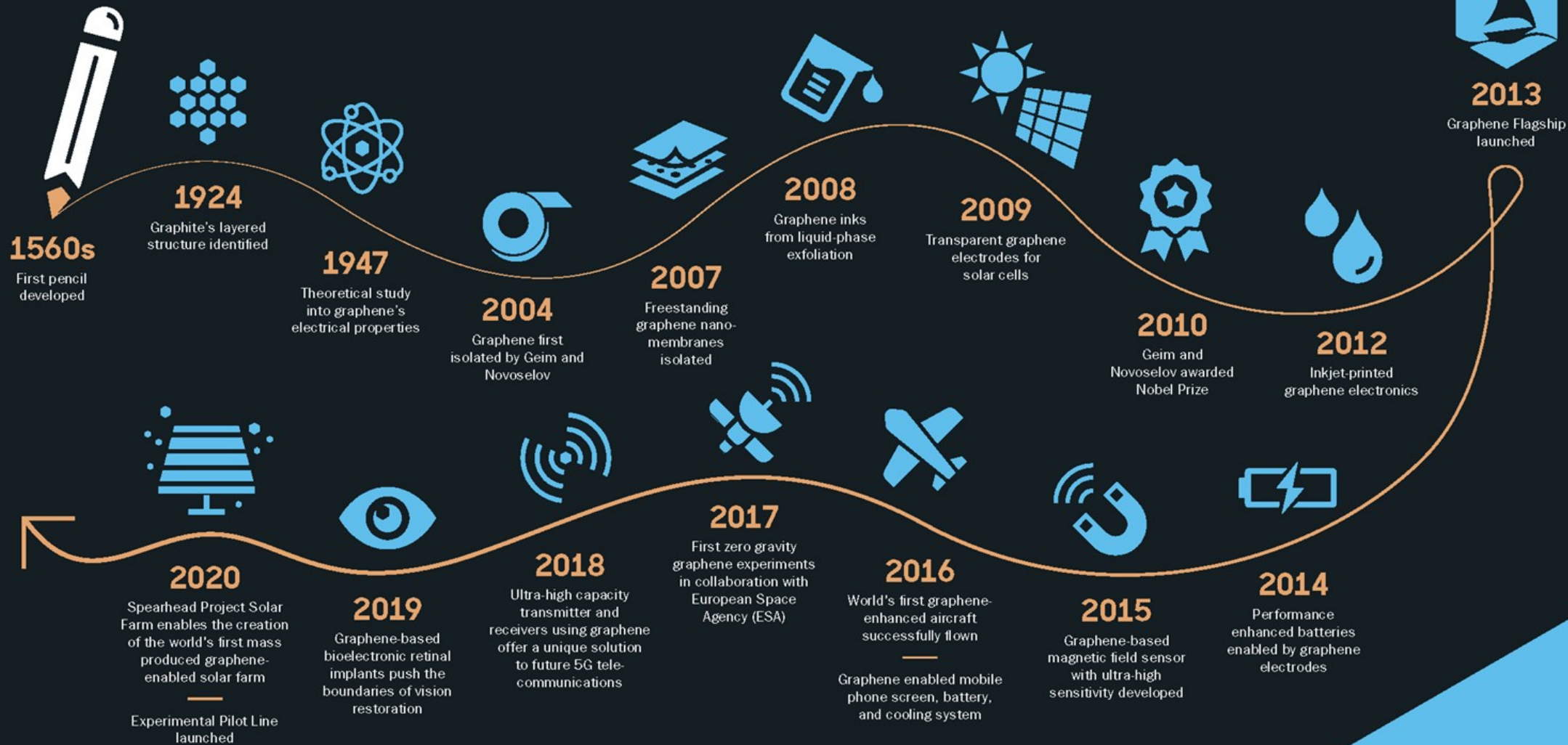
1) Exfoliation en phase liquide.

2) Dépôt chimique en phase vapeur.

Le graphène par dépôt chimique en phase vapeur (CVD) est produit par un processus par lequel les atomes de carbone sont évaporés puis déposés

3) Gommage mécanique.

Le graphène cultivé sur des isolants, tels que le SiO₂



Partenaires phares du graphène

Le Graphene Flagship coordonne environ **170 partenaires académiques et industriels** dans **22 pays** et compte plus de **90 membres associés** dans son projet principal.

PAYS PARTENAIRES :

- ALLEMAGNE
- AUTRICHE
- BELGIQUE
- BULGARIE
- DANEMARK
- ESPAGNE
- ESTONIE
- FINLANDE
- FRANCE
- GRANDE-BRETAGNE & IRLANDE DU NORD
- GRECE
- HONGRIE
- IRLANDE
- ISRAEL
- ITALIE
- NORVEGE
- PAYS-BAS
- POLOGNE
- PORTUGAL
- SUÈDE
- SUISSE

Partenaires phares du graphèn

FRANCE

- ◆ Airbus Helicopters SAS
- ◆ CNRS
- ◆ Commissariat à l'Énergie Atomique et aux Energies Alternatives
- ◆ Fondation Européenne de la Science
- ◆ Institut national de la santé et de la recherche médicale
- ◆ Laboratoire National de Metrologie et d'Essais
- ◆ NAWATEchnologies
- ◆ Pixium Vision
- ◆ Polymem S.A
- ◆ THALES
- ◆ Université de Strasbourg
- ◆ University of Lille

SUISSE

- ◆ CONFINIS AG
- ◆ École Polytechnique Fédérale de Lausanne
- ◆ Eidgenoessische Technische Hochschule Zurich
- ◆ Eidgenossische Materialprüfungs- und Forschungsanstalt
- ◆ Schaffhausen Institute of Technology AG
- ◆ TEMAS Solutions GmbH
- ◆ Université de Zürich
- ◆ Université de Geneve

BELGIQUE

- ◆ Interuniversitair Micro-Electronica Centrum
- ◆ Société Nationale de Constructions Aérospatiales SONACA SA
- ◆ Toyota Motor Europe NV
- ◆ Université Catholique de Louvain
- ◆ Université libre de Bruxelles

Les « semaines du Gra

Événement virtuel
20-24 septembre 2021

La semaine 2021 est la 15^{ème} édition.



Pourquoi?

Notre mission est d'organiser des événements axés sur la sécurité, le bien-être et la diversité. En organisant la Graphene Week 2021 en ligne, nous respectons à la fois notre engagement envers la communauté du graphène et notre responsabilité de créer l'expérience la plus accueillante pour les participants du monde entier.

Les « semaines du Graphène » »



Qui?

Si vous vous intéressez au graphène et aux matériaux en couches, la semaine du graphène est l'endroit où il faut être. Nos participants vont des étudiants et des chercheurs en début de carrière aux professeurs et PDG de renommée mondiale, et vous pouvez être l'un d'entre eux.

Comme il y a eu « la semaine du masque »...



#WorldMaskWeek

7-14 août 2020



July 12-18

#WorldMaskWeek

2021



Tedros Adhanom Ghebre



@DrTedros

.@WHO is launching a new #WearAMask challenge!

By wearing a mask, you are sending a message of solidarity and protecting other people, especially those most vulnerable to #COVID19.

Take a photo or a video of yourself wearing a mask, share it and nominate friends to do the same



6:59 PM · Aug 5, 2020



7.8K



See the latest COVID-1...

BILL & MELINDA GATES foundation

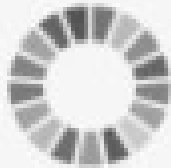


FIND Diagnosis for all

GLOBAL CITIZEN



THE TASK FORCE FOR GLOBAL HEALTH



THE GLOBAL GOALS

Johnson & Johnson



PATH

W welcome



UNITED NATIONS FOUNDATION



GRAPHENE
FOR HEALTHCARE

SPECIAL
EDITION

HEALING WOUNDS WITH GRAPHENE

Grapheal's smart dressing uses graphene to monitor wounds and stimulate healing

Read on to learn about medical technologies brought to life by the Graphene Flagship

GRAPHENE
HEARS YOUR
BRAIN WHISPER

INBRAIN Neuroelectronics receives
1M to develop graphene-based implants



Funded by
the European Union



Funded by
the European Union

HEALING WOUNDS WITH GRAPHENE

GUÉRIR LES PLAIES AVEC LE GRAPHÈNE

THE ROAD TO NEXT-GENERATION HEALTHCARE

By: Tom Foley

G

Graphene and layered materials are paving the way to new technologies in biomedicine, and this is all thanks to the unique properties they have to offer. For example, their exceptionally high surface area makes graphene and many similar layered materials excellent platforms for drug delivery. On top of this, their high conductivity and often tunable electrical properties mean they can be used to make highly sensitive and selective biosensors for medical applications.

The possibilities are broad: from wearable sensors to optimise athletes' performance to implants that can provide artificial retinal vision, graphene and layered materials could provide solutions in many different fields of biomedicine and healthcare.

To this end, several partners of the Graphene Flagship, along with some of our industry-led Spearhead Projects and spin-off companies, are working on exciting developments that could bring new graphene-based medical devices to the market.

One example is the Graphene Flagship's **CHEMSENS** Spearhead Project, an initiative to develop a graphene-based plaster sensor for human skin. In this device, graphene enables the quick detection and analysis of key biological constants, like the levels of sodium, potassium, lactic acid and glucose in the sweat.

The plaster measures biophysical stress and transfers the information to electronic devices, and could help athletes to fully optimise their training. The sensor features four independent devices that can operate separately, and utilises paper-based fluids to improve sweat flow into the sensor, enabling smooth and swift detection – while ensuring operation is safe for the user.

In this mini-magazine, we will look at several more key developments from Graphene Flagship scientists over the past year, and

The possibilities are broad: from wearable sensors to optimise athletes' performance to implants that can provide artificial retinal vision



investigate how they might shape the future of healthcare. To learn more about the new medical technologies brought to life by graphene and layered materials, please read on.

page 3 : LA ROUTE VERS LA PROCHAINE GÉNÉRATION DE

SANTÉ

Le graphène et les matériaux stratifiés ouvrent la voie à de nouvelles technologies en biomédecine, et tout cela grâce aux propriétés uniques qu'ils ont à offrir. Par exemple, leur surface spécifique exceptionnellement élevée **fait du graphène** et de nombreux matériaux en couches similaires

d'excellentes plates-formes pour l'administration de médicaments. En plus de cela, leur conductivité élevée et leurs propriétés souvent réglable

électriquement signifient **qu'ils peuvent être utilisés pour fabriquer des biocapteurs** hautement sensibles et sélectifs pour des applications

page 3 :



One example is the Graphene Flagship's [CHEMSens](#) Spear-head Project, an initiative to develop a graphene-based plaster sensor for human skin. In this device, graphene enables the quick detection and analysis of key biological constants, like the levels of sodium, potassium, lactic acid and glucose in the sweat.

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... des **capteurs portables** pour optimiser les performances des athlètes aux implants pouvant fournir une **vision rétinienne artificielle**.

Un exemple est le projet CHEMSens Spear-head du Graphene Flagship, **une initiative visant à développer un capteur de plâtre à base de graphène pour la peau humaine**. Dans cet appareil, le graphène permet la détection et l'analyse rapides de constantes biologiques clés, telles que les niveaux de sodium, de potassium, d'acide lactique et de glucose dans la sueur. **Le pansement mesure le stress biophysique et transfère les informations aux appareils électroniques**, et pourrait aider les athlètes à optimiser pleinement leur

HEALING WOUNDS WITH GRAPHENE

By: SINC



Chronic or hard-to-heal wounds, those that do not heal after six weeks, place a significant economic burden on health systems around the world, costing around \$30 billion annually. They lead to half-a-million amputations per year globally. In the United States alone, more than 6.5 million people suffer from such wounds.

The costs and prevalence of chronic wounds are both increasing due to the growing number of older people in the population, among whom pressure ulcers and leg ulcers are more common – in addition to the increase in patients with diabetes, who are more prone to foot ulcers.

Faced with this problem and considering that the proper assessment of these wounds is not within the reach of caregivers with the relevant expertise, Graphene Flagship scientists in France have developed a new graphene patch that allows them to be monitored remotely. Furthermore, pre-clinical studies have even shown that they promote healing.

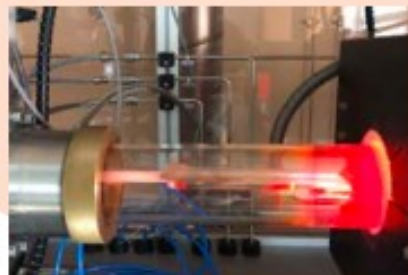
"The conductivity of the graphene electrode varies according to the physicochemical changes in the wound, so we produced films of this material on a polymer, a plastic, and integrated them into a bandage to record biological parameters in direct contact with the wound bed," explains Vincent Bouchiat, CEO of Graphene Flagship Associate Member **Grapheal**, a spin-off from France's National Centre for Scientific Research (CNRS). Grapheal is based at Néel Institute, in Grenoble, where this technology was developed.

Graphene forms an ultrathin and robust conductive layer. Grapheal's patented method of integration produces soft and



The conductivity of the graphene electrode varies according to the physicochemical changes in the wound, so we produced films of this material on a polymer, a plastic, and integrated them into a bandage to record biological parameters in direct

Vincent Bouchiat
CEO of Grapheal



page 4 : GUÉRIR LES PLAIES AVEC LE GRAPHÈNE

Les plaies chroniques ou difficiles à cicatriser, celles qui ne guérissent pas au bout de six semaines, **coûtant environ 30 milliards de dollars par an.**

Face à ce problème, les scientifiques de Graphene Flagship en France ont développé **un nouveau patch de graphène qui permet de les surveiller à distance.**

... nous avons donc réalisé des films de ce matériau sur un polymère, un plastique, **et les avons intégrés dans un pansement** pour enregistrer les paramètres biologiques en contact direct avec le lit de la plaie. explique Vincent Bouchiat, PDG de **Grapheal**, une spin-off du Centre national de la recherche scientifique (**CNRS**).

Grapheal est basé à l'Institut Néel (laboratoire de recherche en physique de la matière condensée)



Graphéal

**Biocapteurs intégrés pour le
diagnostic sur site et la
surveillance à distance des
patients**

Graphéal développe des biocapteurs portables et jetables permettant une surveillance continue et un diagnostic sur site. Il offre aux soignants un outil d'évaluation amélioré et individualisé pour la médecine de précision.

*adaptable to other viruses

GRAPHENE
FLAGSHIP



INTRODUCING
TestNPass

TestNpass.

TestNPass

**BIOSENSEURS NUMÉRIQUES EN
GRAPHÈNE
POUR LES TESTS SUR LE TERRAIN
COVID-19**

GRAPHENE
FLAGSHIP



combined a fast digital COVID-19 test



Graphene Flagship Associate Member Graphene@ produced a graphene patch that records the condition of chronic wounds, such as ulcers suffered by the elderly or those with diabetes, at any time. Credit: Graphene@

Medical and nursing staff can remotely monitor how wounds are healing with this system, receiving alerts for any infection that may arise

A SMART, CONNECTED DRESSING

The graphene dressing is ultra-flexible, adapts easily to any part of the body, and has tiny wireless electronics (with lightweight, fully flexible electrodes) that transfer the data to a mobile application. Then, using a telemedicine software and medical technologies in the cloud, the information can reach the hospital to be monitored and evaluated by a specialist.

Medical and nursing staff can remotely monitor how wounds are healing with this system, receiving alerts for any infection that may arise, which helps to prevent complications.

"This can improve and individualize the treatment of chronic wounds that require long-term care," says Bouchiat, who emphasises: "In particular, it enables the early detection of infections, allowing a hospital solution at home."

STIMULATING HEALING

The incorporation of graphene into skin patches of these types not only does not interfere with wound healing, but in fact can actually promote it, actively stimulating the process – as demonstrated by pre-clinical studies that have already been conducted.

The first human trials are about to begin. The medical device has been classified as class II-b, the same class as insulin pens, and requires the European mark of conformity. Its launch is planned for 2023.

The creators of the patch had intended to present it in February, along with other projects of the major European initiative known as the Graphene Flagship, at Mobile World Congress in Barcelona, which was cancelled to prevent the spread of the coronavirus.

In this context, the researchers point out that the new graphene device will be able to help monitor the chronic wounds of people in isolation due to the ongoing pandemic.



The data can be sent from the home to the hospital using a mobile phone app, meaning doctors can respond quickly if

page 5 :

Le personnel médical et infirmier peut surveiller à distance la cicatrisation des plaies avec ce système, recevant des alertes pour toute infection pouvant survenir...
UN PANSEMENT INTELLIGENT ET CONNECTÉ

Le pansement au graphène est **ultra-flexible**, s'adapte facilement à n'importe quelle partie du corps et **possède de minuscules composants électroniques sans fil** (avec des électrodes légères et entièrement flexibles) **qui transfèrent les données vers une application mobile.**

Ensuite, à l'aide d'un logiciel de télémédecine et de technologies médicales

STIMULATING HEALING

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STIMULANT LA GUÉRISON

L'incorporation de graphène dans des patchs cutanés de ces types non seulement n'interfère pas avec la cicatrisation des plaies, mais peut en fait la favoriser, en stimulant activement le processus.

Les premiers essais humains sont sur le point de commencer. Le dispositif médical a été classé dans la classe II-b, la même classe que les stylos à insuline, et nécessite la marque européenne de conformité.

GRAPHENE ELECTRODES ON THE BRAIN

SPIN-OFF COMPANY INBRAIN RECEIVES €1M TO DEVELOP GRAPHENE-BASED DIAGNOSTIC IMPLANTS FOR BRAIN DISORDERS

By: ICN2

€1M

Four new investors boosted Graphene Flagship spin-off INBRAIN with a total 1 million investment

Graphene Flagship spin-off INBRAIN Neuroelectronics received a 1 million investment from Sabadell Asabys, Alta Life Sciences, ICF and Finaves. This spin-off was born from Graphene Flagship partners the Catalan Institute of Nanoscience and Nanotechnology (ICN2) and ICREA to speed up the development of novel graphene-based implants to optimise the treatment of brain disorders, such as Parkinson's and epilepsy.

According to a 2010 study commissioned by the European Brain Council, the cost of brain disorders in Europe alone reaches approximately 800 billion euros a year, with more than one-third of the population affected. The high incidence of brain-related diseases worldwide and their huge social cost call for greater investments in basic research in this field, with the aim of developing new and more efficient therapeutic and diagnostic tools.

INBRAIN Neuroelectronics, now a Graphene Flagship Associate Member, was established in 2019 with the mission to develop brain-implants based on graphene technology for application in patients with epilepsy, Parkinson's and other neuronal diseases. These smart devices, built around an innovative graphene electrode, will decode with high fidelity neural signals from the brain and produce a therapeutic response adapted to the clinical condition of the specific patient.

Four new investors have recently boosted this spin-off with a total of 1 million. These include Asabys and Alta Life Sciences, collaborating through the Sabadell-Asabys funds, as well as the

Institut Català de Finances (ICF) and Finaves, a venture fund promoted and managed by IESE Business School. The new investment will allow INBRAIN to accelerate the development of these novel intracranial implants for patients affected by brain disorders.

INBRAIN designs the least invasive and smartest neural interface on the market that, powered by artificial intelligence and the use of Big Data, will have the ability to read and modulate brain activity, detect specific biomarkers and trigger adaptive responses to deliver optimal results in personalised neurological therapies. ICN2 and the University of Manchester validated the technology using *in vitro* and *in vivo* biocompatibility and toxicity tests, with the aim of ensuring the devices are safe and superior to current solutions based on metals like platinum and iridium. INBRAIN are currently testing the technology in large animals, and human trials will be led by The University of Manchester.

INBRAIN was founded, among others, by Jose Garrido and Kostas Kostarellos, from Graphene Flagship partner ICN2 and Anton Guimerà, IMB-CNM, an institute within Graphene Flagship partner CSIC.

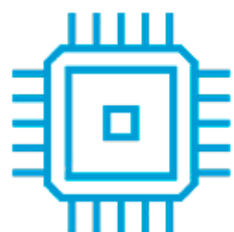
page 6 : ÉLECTRODES DE GRAPHÈNE SUR LE CERVEAU

LA SOCIÉTÉ SPIN-OFF **INBRAIN** REÇOIT 1 M€ POUR DÉVELOPPER DES **IMPLANTS** DE DIAGNOSTIC À BASE DE GRAPHÈNE

INBRAIN Neuroelectronics, désormais membre associé de **Graphene Flagship**, a été créé en 2019 avec pour mission de développer des implants cérébraux basés sur la technologie du graphène pour une application chez les patients atteints d'épilepsie, de maladie de Parkinson et d'autres maladies neurologiques. Ces dispositifs intelligents, construits autour d'une électrode de graphène innovante, décoderont avec une haute fidélité les signaux neuronaux du cerveau et produiront une réponse



INBRAIN
NEUROELECTRONICS



TECHNOLOGIE INBRAIN

VERS DE MEILLEURS ET NOUVEAUX
EFFETS THÉRAPEUTIQUES



GRAPHÈNE ENBRAIN

VERS AUCUN EFFET SECONDAIRE



**INTELLIGENCE ARTIFICIELLE
(IA) INBRAIN**

VERS UNE THÉRAPIE PLUS
INTELLIGENTE



Minimally invasive electronic therapies represent a revolutionary alternative with less potential cost for health systems. In our case, the application of new 2D materials such as graphene represents a real opportunity to understand how the brain works to optimise and

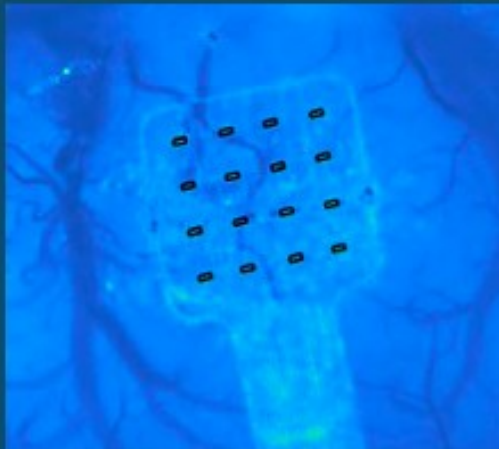
Carolina Aguilar
CEO of INBRAIN Neuroelectronics

INBRAIN Neuroelectronics, a spin-off company from Graphene Flagship partners ICN2 and ICRG, will use the investment to speed up the development of novel

"Within the framework of the EU-funded Graphene Flagship, we were able to develop this novel graphene-based technology that will allow measuring and stimulating neuronal activity in the brain with a resolution much higher than that of current commercial technologies," explains Garrido. During 2019, the incorporation of INBRAIN was a priority project for the ICN2 Business and Innovation Department, which coordinated the technology transfer process and successfully orchestrated the licensing of this high-potential technology.

INBRAIN CEO Carolina Aguilar explains: "Minimally invasive electronic therapies represent a revolutionary alternative with less potential cost for health systems. In our case, the application of new 2D materials such as graphene represents a real opportunity to understand how the brain works to optimise and personalise the treatment."

Graphene Flagship Head of Innovation, Karl Hjelt, adds: "It is great to witness the development of INBRAIN bringing graphene from laboratories to market. Graphene offers unique capabilities to enhance multiple product attributes concurrently. Innovation at INBRAIN showcases the power of graphene in biomedical applications where its biocompatibility, electrical properties and flexibility make it a superior choice over many conventional materials."



The sensor records brain activity at extremely low frequencies and could lead to new treatments for brain disorders like Parkinson's and epilepsy. Credit: ISFO

page 7 :

« Dans le cadre du Graphene Flagship financé par l'UE, nous avons pu développer cette nouvelle technologie à base de graphène qui permettra de **mesurer et de stimuler l'activité neuronale dans le cerveau** avec une résolution bien supérieure à celle des technologies commerciales actuelles », explique Garrido (le PDG d'INBRAIN). **Les thérapies électroniques mini-invasives** représentent une alternative révolutionnaire avec un coût potentiel moindre pour les

HUMAN OF THE FUTURE

Graphene-enabled technology expands the realm of possibility within the biomedical and

By: Melanie Lawson



Wearable health monitoring

ICFO FITNESS MONITORING SKIN PATCH

Graphene-enabled wearable health trackers conform to any surface and deliver accurate measurements of vital signs including heart rate and temperature.

BLOOD SUGAR MONITORING PATCH

A noninvasive graphene-based patch can detect and control glucose levels in sweat by delivering the necessary dose of medication through the skin.

UV SENSOR SKIN PATCH

Graphene delivers a versatile light detection platform enabling the integration of sensors that monitor our exposure to UV light in real-time.

GRAPHENE FOR HEALTHCARE

GRAPHENE FOR HEALTHCARE



BRAIN-MACHINE INTERFACES

Flexible graphene can be used in neural implants which record and stimulate signals on the surface of the brain improving the understanding, treatment, and detection of neural diseases.



VISION RESTORATION

Next-generation retinal prostheses use graphene-based electrodes to provide artificial vision to patients blinded by retinal degeneration.



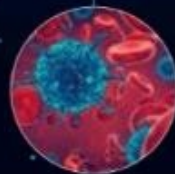
TARGETED DRUG DELIVERY

Drug delivery systems based on graphene and graphene oxide are ultra-efficient, taking advantage of graphene's extremely large surface area.



CUTTING-EDGE PROSTHETICS

Graphene-enhanced pressure-sensitive electronic skin generates and stores electricity for prosthetic devices, improving motor function.



GRAPHENE-BASED BIOSENSORS

Highly sensitive graphene-based biosensors can detect ultra-low concentrations of

page 8 & 9 : L'HUMAIN DU FUTUR

SURVEILLANCE DE SANTÉ PORTABLE



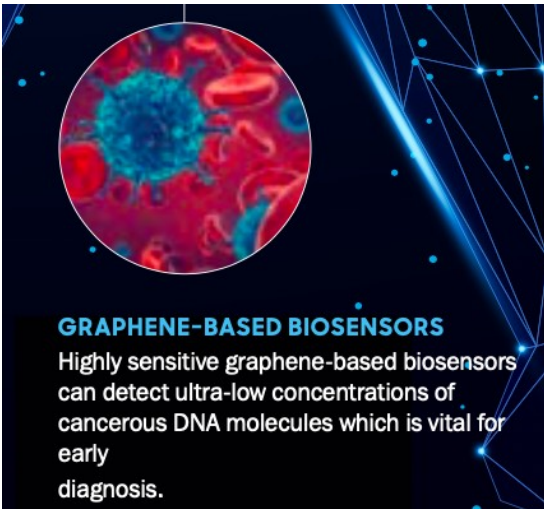
PATCH DE SURVEILLANCE :

- de la peau (signes vitaux)
- du sucre dans le sang
- capteur d'UV
- des signaux biochimiques en temps réel

BIOSENSEURS

biocapteurs

hautement sensibles à base de graphène peuvent détecter des concentrations ultra-faibles de molécules d'ADN cancéreuses



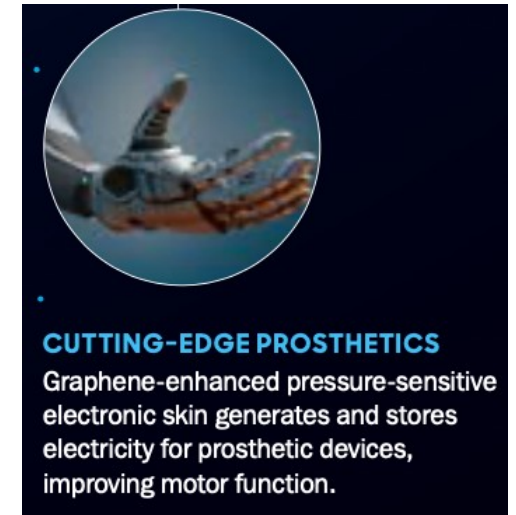
LIVRAISON DE MÉDICAMENTS CIBLÉE

Les systèmes d'administration de médicaments

à base de graphène et d'oxyde de graphène sont ultra-efficaces, tirant parti de la surface extrêmement grande du graphène.

PROTHÈSES

La peau électronique sensible à la pression améliorée au graphène génère et stocke de l'électricité pour les prothèses, améliorant ainsi la



page 8 & 9 : L'HUMAIN DU FUTUR



BRAIN-MACHINE INTERFACES

Flexible graphene can be used in neural implants which record and stimulate signals on the surface of the brain improving the understanding, treatment, and detection of neural diseases.

TERFACES CERVEAU-MACHINE

Le graphène flexible peut être utilisé dans les **implants neuronaux** qui enregistrent et stimulent les signaux à la surface du cerveau pour améliorer la compréhension, le traitement et la détection des maladies neuronales



VISION RESTORATION

Next-generation retinal prostheses use graphene-based electrodes to provide artificial vision to patients blinded by retinal degeneration.

PROTHÈSES RÉTINIENNES

de nouvelle génération utilisent des électrodes à base de graphène pour fournir une **vision artificielle** aux patients aveuglés par la dégénérescence rétinienne

GRAPHENE FLAGSHIP LAUNCHES COVID-19 TASK FORCE

By: Tom Foley

The current pandemic caused by COVID-19 brought to light an urgent need to devise new technologies to protect the human body from its immediate environment. Graphene and related materials are promising candidates for the design of a novel generation of surfaces to help deal with the daily challenges posed by COVID-19, as well as similar future diseases.

The Graphene Flagship Management Panel recognised that it is vital for the Graphene Flagship, as one of the largest Europe Science and Technology projects, to make use of all its collective and accumulated knowledge of graphene and related materials to fight the current pandemic – and those that may come in the future. To this end, it has assembled a targeted and multidisciplinary Working Group, comprising companies and researchers from across the consortium. The group's ultimate objective is to fully exploit the potential of graphene and related materials in order to contribute to the global front against this unprecedented societal challenge.

The Working Group aims to establish new connections between researchers, propose relevant topics for future funding calls, and initiate discussions with funders and stakeholders, with the ultimate ambition of making the best use of graphene and related materials in fields such as virology, biosensing and many others.

The group is led by Alberto Bianco, Graphene Flagship Work Package Deputy for Health and Environment, with deputy leader Paolo Samorì, Graphene Flagship Work Package Deputy for Functional Foams and Coatings, and includes a number of experts in fields such as material/virus interaction and biochemical sensing. For the full list of members, please visit the web page.

The Working Group has a 360-degree approach, covering fundamental to applied solutions. The group will investigate:

- The inhibition of the virus by graphene and related materials dispersed in solutions
- Whether graphene and related materials have the same capacity as antivirals as already demonstrated against bacteria
- How to modify graphene and related materials with antiviral agents
- How to design chemically tailored materials to either promote viruses' adhesion and inhibit their biological activity once adsorbed, or repel viruses
- How to design coated surfaces better able to withstand repeated cleaning cycles
- How to formulate disinfectant solutions and detergents containing graphene and related materials to clean surfaces
- How to design disposable masks, aprons and wearable tissues, with higher impermeability to viruses
- How to develop personal protective equipment technologies able to act as a barrier between the environment and human body
- How to create smart tissue, embedding by design not only anti-viral characteristics, but also with other functions
- How to design new chemical, electrochemical and optical sensors with high specificity for early diagnostics, and for portable point-of-care devices
- The wider challenges posed by global pandemics, such as how graphene and related materials can improve remote working: for example, by improving telecoms and datacoms, or through the development of more efficient batteries for a new green society.

page 10 : LE GRAPHÈNE FLAGS LANCE LA TASK FORCE COVID

La pandémie actuelle de COVID-19 a mis en lumière un besoin urgent de concevoir de nouvelles technologies pour protéger le corps humain de son environnement immédiat.

Le graphène et les matériaux connexes sont des candidats prometteurs pour la conception

d'une nouvelle génération de surfaces pour aider à faire face aux défis quotidiens posés par COVID-19, ainsi qu'à des maladies futures similaires.

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La Groupe de Travail enquêtera sur :

- **Comment concevoir des matériaux chimiquement adaptés** pour favoriser l'adhésion des virus et inhiber leur activité biologique une fois absorbés, ou repousser les virus
- **Comment concevoir des surfaces recouvertes** mieux à même de résister à des cycles de nettoyage répétés
- **Comment formuler des solutions désinfectantes et des détergents contenant du graphène** et des matériaux connexes pour nettoyer les surfaces
- **Comment concevoir des masques jetables, des tabliers et des mouchoirs** en papier, avec une plus grande imperméabilité aux virus
- **Comment développer des technologies d'équipement de protection individuelle** capables d'agir comme une barrière entre l'environnement et le corps humain
- **Comment créer des tissus intelligents**, intégrant par conception non seulement des

REAL-TIME TISSUE IMAGING WITH GRAPHENE

SPIN-OFF COMPANY CAMBRIDGE RAMAN IMAGING LTD TO DEVELOP NEW MICROSCOPE FOR CANCER TREATMENT

By: Graphene Flagship

G

Graphene Flagship spin-off Cambridge Raman Imaging Ltd has received an investment of 275,000 to support the development of graphene-based ultrafast lasers. These devices will be used in a new medical microscope to diagnose and track tumours, among other applications.

The graphene-enabled microscope will generate real-time digital images of tissue samples using Raman spectroscopy to differentiate between healthy and diseased tissue, and show the extent of tumours, their response to drug treatments, and allow surgeons to determine whether a cancer has been completely removed. Graphene and layered materials enable two fibre-based pico-second lasers to be synchronised in time. Furthermore, this architecture is much lower in cost than conventional solid-state systems.

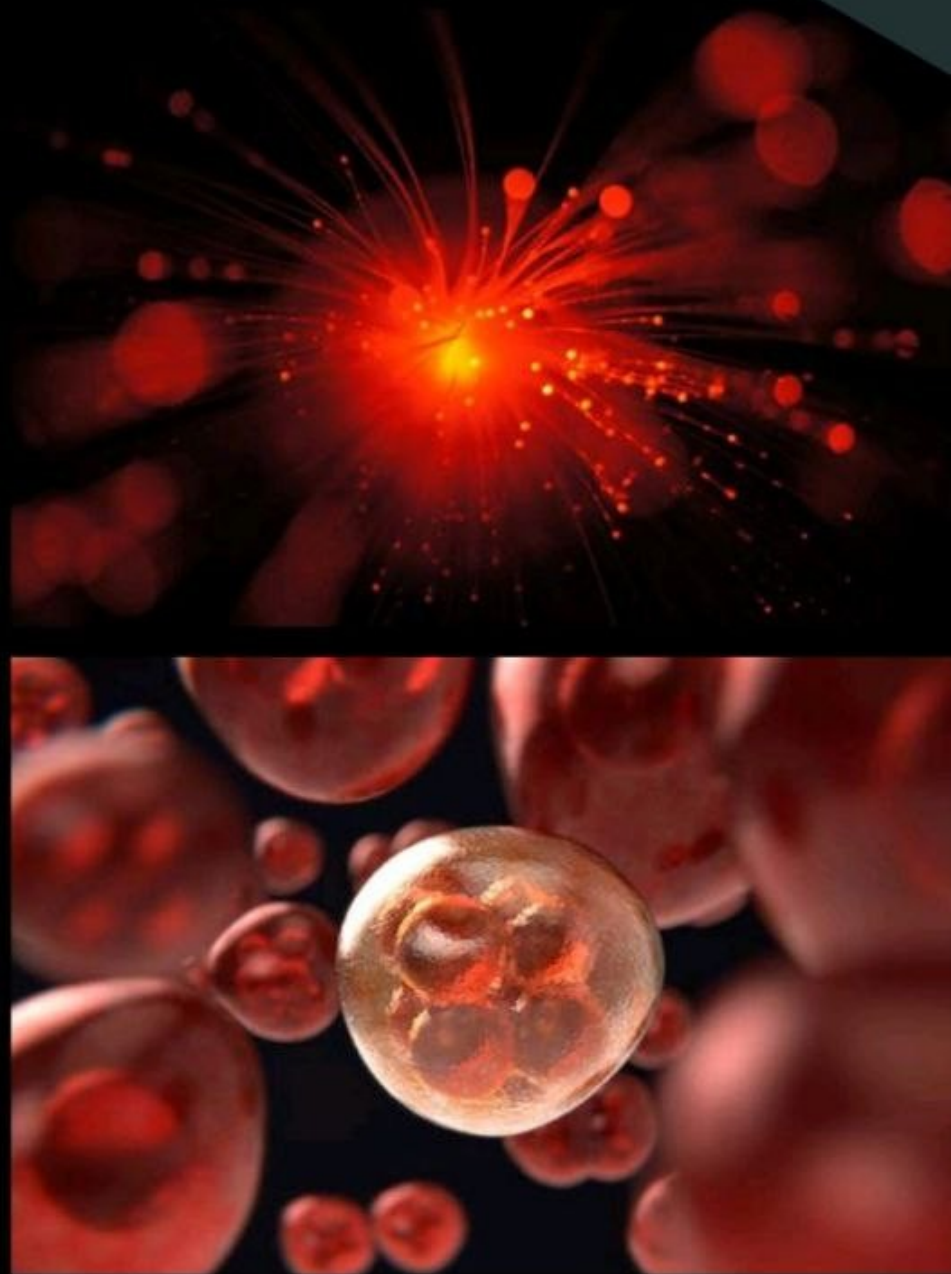
Cambridge Raman Imaging was recognised as an official spin-off from Graphene Flagship partner Politecnico di Milano, Italy, and provided office space and state-of-the-art laboratories. This will also allow Cambridge Raman Imaging to be supported by PoliHub, one of the best university start-up incubators in Europe.



Graphene Flagship spin-off Cambridge Raman Imaging Ltd (CRIL) will develop an innovative graphene-enabled scanning Raman microscope for cancer diagnostics, therapy

Giulio Cerullo, from Graphene Flagship Partner Politecnico di Milano and co-founder of Cambridge Raman Imaging, says: "It is exciting to see how basic research into the optoelectronic properties of graphene can be translated into a commercial product with potential impact on healthcare, enabling improvements to the accuracy of diagnostics and therapy for a variety of diseases."

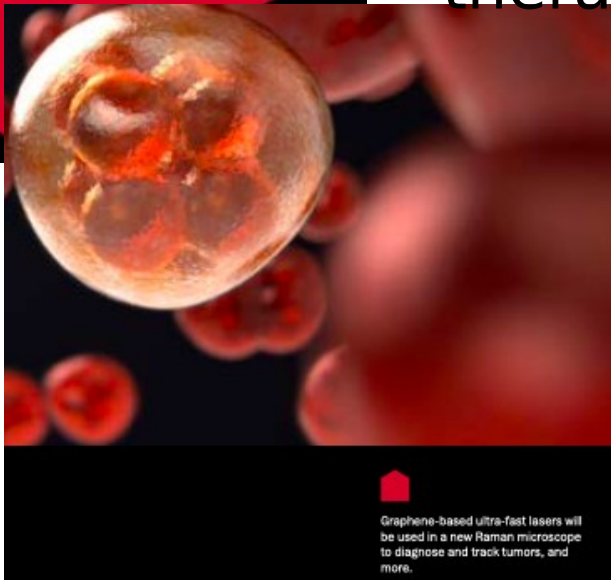
Marco Romagnoli, Leader of the Graphene Flagship Electronics and Photonics Integration Division, comments: "It is noteworthy how graphene can implement the accurate synchronization of two independent ultrashort pulse laser sources, operating at two different wavelengths. And all of this happens without any electronic controls."



page 12 & 13 : **IMAGERIE DES TISSUS EN TEMPS RÉEL AVEC LE GRAPHÈNE**



Cambridge Raman Imaging Ltd (CRIL), spin-off phare du graphène, développera un **microscope Raman à balayage innovant à base de graphène** pour le diagnostic et la thérapie du cancer



Des **lasers ultra-rapides** à base de graphène seront utilisés dans un nouveau microscope Raman pour diagnostiquer les tumeurs et plus encore...

HEALTH AND SAFETY OF GRAPHENE AND LAYERED MATERIALS

By: Sian Fögden

A

As the drive to commercialise graphene continues, it is important to thoroughly research and understand all factors that could influence its safety. The Graphene Flagship project has a dedicated Work Package to study the impact of graphene and layered materials on human health, as well as their impact on the environment.

Because of this, **safety by design** is a core part of Graphene Flagship innovation.

The most crucial factor for assessing the toxicology of a material is to fully characterise it with safety in mind. To this end, the Graphene Flagship published a detailed safety assessment of graphene and layered materials and its effects on human health and the environment. The study investigates various methods of production and characterisation, and considers a number of different materials whose biological effects depend on their inherent properties.

"One of the key messages is that this family of materials has varying properties, and thus displays varying biological effects. It is important to emphasise the need not only for a systematic analysis of well-characterized graphene-based materials, but also the importance of using standardised in vitro or in vivo assays for safety assessment," explains lead author Bengt Fadeel, Professor at the Karolinska Institute a Graphene Flagship partner in Sweden.

"This review correlates the physicochemical characteristics of graphene and layered materials to their biological effects. A classification based on the lateral dimensions, number of layers and carbon-to-oxygen ratio allows us to describe the parameters that can alter graphene's toxicology. This can orient the future development and use of these materials," explains Alberto Bianco, from Graphene Flagship partner CNRS, France, Deputy Leader of the Graphene Flagship Work Package on Health and



Understanding any potential health and environmental impacts of graphene and layered materials has been at the core of all Graphene Flagship

Andrea C. Ferrari
Graphene Flagship Science
and Technology Officer



page 14 : SANTÉ & SÉCURITÉ DU GRAPHÈNE & MATÉRIAUX STRATIFIÉS

Le facteur le plus crucial pour évaluer la toxicologie d'un matériau est de le caractériser complètement dans un souci de sécurité pas tirer de conclusions de travaux antérieurs

sur d'autres matériaux à base de carbone, tels que les nanotubes de carbone, **et extrapoler cela au graphène.**

Les matériaux à base de graphène sont moins cytotoxiques que les nanotubes de carbone et l'oxyde de graphène est facilement dégradé par les cellules du

The Graphene Flagship is Research, Innovation and Collaboration

Funded by the European Commission, the Graphene Flagship aims to secure a major role for Europe in the ongoing technological revolution, helping to bring graphene innovation out of the lab and into commercial applications. The Graphene Flagship gathers nearly 170 academic and industrial partners from 22 countries, all exploring different aspects of graphene and layered materials.

Bringing diverse competencies together, the Graphene Flagship facilitates cooperation between its partners, accelerating the timeline for industry acceptance of graphene technologies. The European Commission's FET Flagships enable research projects on an unprecedented scale. With 1 billion budgets, the Graphene Flagship, Human Brain Project and Quantum Flagship serve as technology accelerators, helping Europe to compete with other global markets in research and innovation.



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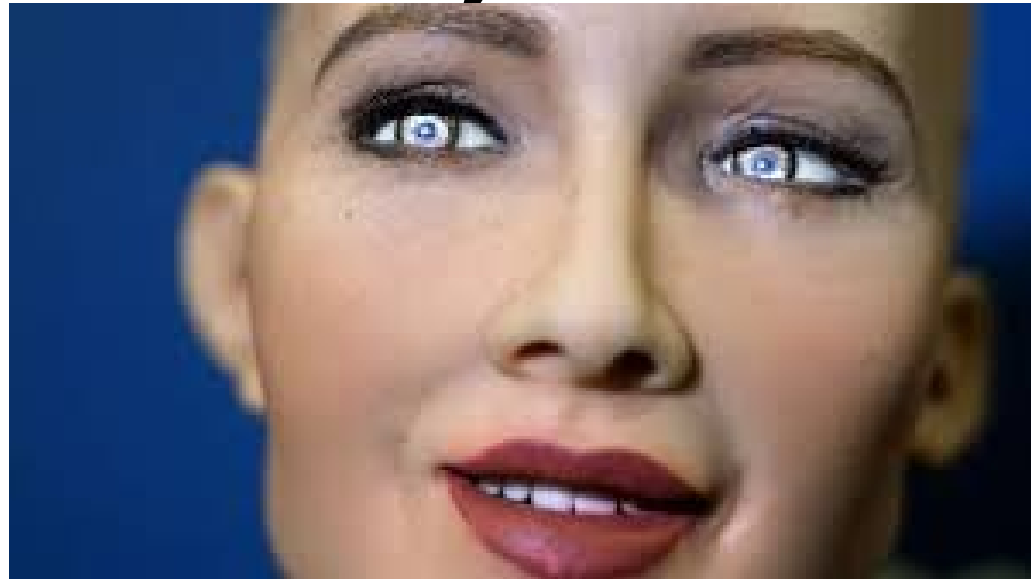
      /GrapheneEU

Financé par la Commission européenne, le Graphene Flagship vise à assurer un rôle majeur pour l'Europe dans la révolution technologique en cours, en aidant à faire sortir l'innovation du graphène du laboratoire et dans des applications commerciales.

Rassemblant diverses compétences, le Graphene Flagship facilite la coopération entre ses partenaires, **accélérant le calendrier d'acceptation des technologies du graphène par l'industrie.**

Avec des budgets d'un milliard d'euros, le Graphene Flagship, le Human Brain Project et le

**SOuRI
Ez,**



vous êtes GRAPHÉNISÉS !