PATENT

Procedure for the exfoliation and transfer of graphene from a doped silicon carbide substrate to another substrate

Market sector: nanothecnology, sensors, optics

Type of opportunity: licensing and/ or co-development

Scope of the problem

Graphene is a two-dimensional material with a one-atom-thick layer of closely packed carbon atoms, and its unique physical properties allow for ground-breaking biomedical applications as targeted drug delivery, improved brain recording, PoC health-testing kits and 'smart' implants.
The two preferred strategies for the production of graphene of high crystallinity, and technological relevance for industrial adoption, are chemical vapor deposition (CVD), and epitaxial graphene on silicon carbide (EG-SiC), the latter is based on a process based on preferential sublimation of atomic silicon at high temperatures. Graphene CVD is obtained in catalytic substrates such as metals, it has a good cost-quality ratio however it has the disadvantage that it typically requires its transfer to a certain insulating substrate. EG-SiC is valued for its superior crystalline quality plus readiness for the manufacture of electronic devices, however the use of SiC wafers, as a substrate, and the own very processing involves a high cost for the application of graphene with scalability drawbacks being difficult for certain applications at industrial level.
In this context, the exfoliation and transfer of graphene of high crystalline quality, for example from one substrate to another, is a fundamental processing step so that graphene can be widely used in devices at industrial level. Although various methods of exfoliation and transfer of graphene have been developed, none of them is able to fulfill all requirements in terms of simplicity, cost or quality of graphene.

Patient need addressed: nanoelectronics, biomedical devices

Our innovation:

- New procedure to delaminate epitaxial graphene from a doped SiC substrate to another substrate by means of mechanical separation, or exfoliation of the graphene wafers.
- The separation is induced by an electrochemical method, specifically the hydrogen bubbling at the graphene-SiC interface produced during the water electrolysis into the graphene-SiC interface.
- An adjustment of the minimal mechanical stress allow to maintain the high crystalline quality of the initial epitaxial graphene.
- Single-step process: single steps-exfoliation without necessity of other additional mechanical traction.
- A polymeric layer with controlled thickness (commercial materials) is used as transfer material.
- The types of substrates that can be used to transfer the EG-SiC are many and known to any expert in the field.

Competitive advantages: cheaper, simpler, one-step exfoliation without previous hydrogenation or multilayer deposition, versatile method applicable to various SiC substrates, reusable SiC substrate after graphene exfoliation, easy scale-up, fast, and economically sustainable process.

Market size/ opportunity: The global graphene market is expected to reach USD 278.47 Million by 2020, with a growth rate of 42.8% from 2015 to 2020 (Markets and Markets, 2018). An important segment will be graphene being explored as potential building block for nanoelectronics and medical devices.
In 2022, the global health care equipment & supplies market is forecast to have a value of €435.7 billion (18.6% for Other equipment segment). Geographical segmentation: USA 38.3%, Europe 31.7%, Asia-Pacific 24.2%, Middle East 0.8%, Rest of the World 5.1% (Marketline 0199-2067, November 2017).

Intellectual property

Spanish patent granted: ES2677157B1
National phases: USA granted (US 11,407,642) and Europe

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