Institut "Jožef Stefan", Ljubljana, Slovenija

center za prenos tehnologij in inovacij
na Institutu "Jožef Stefan"

Licensing opportunity

Rapid deposition of carbon nanowalls (almost 1 µm/s) for fuel cells and batteries

Field of use
Nanomaterials, Micro and Nanotechnology related to Electronics and Microelectronics, Fuel cells

Current state of technology
Available for demonstration

Patent status
Patent pending

Publication
Not published yet

Developed by
Jožef Stefan Institute

Reference
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Background

A Slovenian research institute offers a method for rapid deposition of uniformly distributed and vertically oriented carbon nanowalls (CNW). The method provides industrially relevant deposition rates of the carbon nanowalls, synthesis is highly controllable and scalable to large surfaces. Companies from the field of fuel cells, photovoltaic devices, lithium ion batteries and sensors of specific gaseous molecules are sought for license agreement.

Description of the Invention

Carbon nanowalls (often called "vertically oriented multilayer graphene sheets") are materials of carbon-containing structures with a thickness up to several nm and height between about 100 nm and 100,000 nm. Usually they are formed in a dense array and extend substantially perpendicular from the surface of a substrate. Quite often their orientation is random and they form a network. As a consequence, a very large surface area with superior electrical and chemical properties is established (e.g. compared to smooth carbon materials). Such materials show a potential for use where large surface-to-mass ratios are needed like in fuel cells, lithium ion batteries, photovoltaic devices, thin-film transistors, sensors of specific gaseous molecules, field-emission devices, batteries, light absorbers, enhanced detectors for electrochemical and gas sensors, electric double layer capacitors and scaffolds for tissue engineering.

Various methods can be used to synthesize carbon nanowalls. Common features are use of vacuum systems or reaction chambers under low pressure. Hydrogenated carbon precursors are used to facilitate growth of carbon nanowalls through decomposition upon plasma conditions and depositing on a substrate, where elevated temperature of the substrate is essential. Addition of hydrogen proved to be relevant for a good quality of carbon nanowalls. Main obstacles these techniques have, are (1) low deposition rates (around 1 nm/s) due to deposition of carbon from CH_x radicals, (2) requirement to constantly supply hydrogenated carbon precursor and (3) use of hydrogen.

Researchers from Slovenia and Japan developed a new method to overcome main obstacles or at least to minimize them. For a carbon nanowalls growth on a wide range of solid substrates, C_xO_y molecules in gaseous form are used as a building material. Synthesis takes place in a reaction chamber under pressure, vacuum and alternatively in the oxygen-containing atmosphere, where CO molecules initially interact with a solid carbon-containing material to form CxOy molecules. These molecules diffuse and decompose on a substrate to ensure rapid growth of uniformly distributed and vertically oriented carbon nanowalls. The substrate is heated to a specific temperature. In this regard, carbon nanowalls are considered as a consequence of decomposition of CxOy molecules on the surface of this substrate. This procedure runs for a speciefic time until the desired thickness of a carbon nanowalls coating is achieved.

Main characteristic is that the whole process is performed considerably faster – up to 100 nm/s - than in other known methods. In other words, greater amount of carbon nanowalls can be built in a specific timeframe, but not at the expense of a desired structure of the carbon nanowalls. This is achieved by using CO molecules/radicals instead of CHX molecules/radicals.

A Slovenian research institute is looking for companies engaged in a development and production of fuel cells, lithium ion batteries, photovoltaic devices and sensors of specific gaseous molecules, but also other companies where large surface-to-mass ratios are required for their products. The partners are expected to enter licensing agreements with aim of implementation the invention into the existing or emerging production of their products. Method development is currently on technology readiness level (TRL) 4 stage, but due to advantages, other characteristics and experience of researchers, application should be possible in a relatively manageable and reasonable time.

Main Advantages

- deposition rates of about 100 nm/s can be achieved
- highly controllable synthesis procedure
- hydrogen is not required
- increased hydrophobicity
- extremely low reflectance in the visible range of wavelengths
- carbon nanowalls materials can be used for application where large surface-to-mass ratios are required