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# Graphene, an Outstanding Nanomaterial, Applicable in Glycan Profiling in Combination with Lectin Biosensors

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## Extended Abstract

Glycans, along with lipids, proteins and nucleic acids, are one of the four fundamental classes of molecules that form all living systems. Moreover, it is estimated that more than 80 % of human proteins are glycosylated. However, in comparison to the advances made in the field of proteomics and genomics, glycomics remains relatively understudied. This is a very disturbing fact because glycans play a major role in the etiology of all human diseases. It has been proven that changes in glycosylation pattern of proteins are closely related to origin and development of various types of cancer or autoimmune disorders. This means, that monitoring of glycan alterations can distinguish healthy from sick patients and can be successfully applied in early stage diagnostics.

Lectins are carbohydrate-binding proteins isolated from natural sources, able to recognize free, mono- and oligosaccharides or even whole cells. They have complex specificities that not only recognize incorporated sugar monomers such as galactose, mannose or fucose but also carbohydrate branching, spacing, and multivalency. Therefore, lectins are very promising candidates for glycan analyses and they can be used even in case the target is unknown (e.g. to find potential biomarker). There are many bioassays reported and most of them are destructive and require labelling of the target molecules. Lectin biosensors represent an elegant way how to overcome mentioned drawbacks and they also allow the work with intact glycoproteins in label-free mode (e.g. electrochemical detection).

Nowadays, the term of biosensors is inextricably linked with the concept of nanotechnology. Since 2004, graphene - one-atom thick layer of $sp^2$ carbon atoms arranged in a honeycomb lattice structure - attracts worldwide attention in the field of nanoscience. It was discovered by a very simple method that became known as the ‘‘Scotch-tape method’’. Currently, the graphene family contains pristine graphene ($sp^2$ hybridised atoms without defects in electron structure), graphene oxide (mainly $sp^3$ hybridised atoms, high content of defects) and reduced graphene oxide ($sp^2$ and $sp^3$ hybridised atoms, partial recovery of electron structure), which differ in the level of oxidation. Despite their short history, graphene-based materials are commonly used in (electro)biosensing thanks to their exceptional electrical, thermal, optical and mechanical properties. Moreover, graphene related materials can be easily functionalized through non-covalent or covalent interaction depending on specific purpose.

There is no doubt, that biosensors, which combine specific qualities of lectins and unique features of graphene materials, would be a powerful tool in glycoprofiling, yet this concept is still rare.

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