iGii

Guide

How Carbon Nanomaterials Enable Multi-Analyte Diagnostics

The next frontier of diagnostics.

Introduction

Modern diagnostics is undergoing a major transformation. As healthcare systems transition towards personalised, preventive models, the demand for rapid and multiplexed biosensing platforms has never been more critical.

Central to this shift is the emergence of multi-analyte diagnostics, which are technologies capable of detecting multiple biomarkers simultaneously in a single test. Whilst the promise of such approaches is vast, particularly for point-of-care (POC) settings and complex disease states, their widespread implementation has historically been limited by material and engineering constraints.

However, new carbon nanomaterials are redefining what's possible in biosensing. In this guide, we will go into detail over the challenges with multi-analyte detection and how novel carbon nanomaterials are leading a new frontier in diagnostics.

What is multi-analyte diagnostics?

Multi-analyte diagnostics describes the ability of a single biosensing platform to detect and quantify multiple distinct biological targets (e.g. proteins, cytokines, metabolites) within a single sample. These platforms are especially powerful in scenarios where disease states are defined by complex biomarker profiles, such as sepsis, cancer, autoimmune disorders, and neurological conditions. For example, a cardiac event may be diagnosed more accurately when both troponin I and B-type natriuretic peptide are measured in tandem.

This capability helps streamline diagnostics, reduces the need for multiple tests and delivers a more holistic view of a patient's condition. In critical care environments, time saved can directly translate to lives saved.

Barriers to widespread adoption

Despite its clinical relevance, the development of robust multi-analyte biosensors has faced substantial obstacles. Chief among them are material limitations. Traditional electrode materials such as gold, platinum and glassy carbon have proven inadequate due to their:

- **Limited surface functionalisation flexibility**
- **Poor bioreceptor loading densities**
- **High cost and environmental footprint**
- **Inconsistent batch-to-batch performance**

Additionally, ensuring selective binding of multiple biomarkers and minimising cross-reactivity at the same time has presented major bioengineering hurdles.

Carbon nanomaterials as enablers of multi-analyte capabilities

The demand for multi-analyte biosensing pushes materials to perform in ways that single-analyte sensors never required. Selectivity, sensitivity and stability must coexist in dense, multifunctional architectures. Carbon nanomaterials such as graphene and carbon nanotubes (CNTs) have emerged as uniquely capable in meeting these challenges due to their tunable surface chemistry and electronic characteristics.

High surface-to-volume ratio

Graphene (a single-atom-thick sheet of carbon) and CNTs (rolled cylinders of graphene) possess extremely high surface areas relative to their size. This makes them ideal platforms for immobilising multiple biorecognition elements in close proximity, enabling the parallel detection of different biomarkers on a single sensing interface.

Outstanding electrical conductivity

Both graphene and CNTs exhibit exceptional electron mobility, facilitating rapid and sensitive transduction of biological binding events into electrical signals. This is especially critical in multi-analyte configurations, where individual signal channels must be resolved without interference or loss of fidelity.

So why is multi-analyte still not widespread commercially and clinically?

Even with the potential of traditional graphene and CNTs, the commercial viability of these materials is limited by fundamental challenges. Achieving consistent, site-specific functionalisation (which is essential for immobilising multiple bioreceptors) is difficult due to the chemical inertness of pristine surfaces and the variability introduced by oxidation or doping. Scalable production of these materials also remains expensive and technically complex, making disposable or high-throughput devices impractical. On top of this, non-covalent attachment methods can lack long-term stability, leading to cross-reactivity and unreliable performance in complex biological samples.

These issues are further compounded by integration difficulties with standard device architectures, all of which restrict the translation of graphene and CNT-based multi-analyte sensors into robust, commercial platforms. Simply put, there has been no viable material for biosensing that enables truly multiplexed capabilities until now.

New carbon nanomaterials that are paving the way for multi-analyte capabilities

To overcome the limitations of traditional graphene and CNTs, a new class of carbon nanomaterials has emerged, designed specifically to address the scalability and functionalisation challenges that have held back commercial multi-analyte biosensors. These novel materials retain the high conductivity and surface responsiveness of graphene-based systems but introduce engineered features like built-in porosity and batch consistency that make them far more suitable for multiplexed diagnostics.

Critically, these next-generation materials support reliable bioreceptor immobilisation without the need for harsh oxidative treatments or unstable non-covalent methods. Their surface chemistries allow the simultaneous attachment of multiple, distinct recognition elements with reduced cross-reactivity and excellent signal integrity. They also demonstrate anti-fouling behaviour in complex biological media, which is essential for multi-analyte systems that must discriminate low-abundance targets within real-world samples like saliva, blood, or serum. This new carbon nanomaterial is called Gii.

Gii: A commercially-ready carbon nanomaterial for multi-analyte biosensing

Building on the foundation laid by novel carbon nanotechnologies, Gii represents a step-change in the practical deployment of multi-analyte biosensors. Developed specifically for high-performance diagnostics, Gii is a proprietary three-dimensional carbon nanomaterial engineered to deliver all the technical advantages of graphene-based platforms whilst directly resolving their commercial and manufacturing limitations.

From a commercial perspective, Gii is fabricated through a scalable, ambient-temperature process that avoids harsh chemicals. The result is a reproducible, high-yield material that can be integrated directly into biosensor production lines. This makes it cost-effective for both disposable sensors and high-throughput diagnostic platforms. And most importantly, it is the **first carbon nanomaterial that offers commercial and scalable multi-analyte capabilities for biosensing.**

Choosing the right material for your biosensing application

With its unique combination of performance and scalability, Gii enables the development of next-generation multi-analyte biosensors that are not only technically sophisticated but also commercially viable. To find out more about this innovative material, contact a member of our team today.

Get in touch today