Graphene-Based Sensors For Mitochondrial Functions

Tech ID: 27145 / UC Case 2016-129-0

BRIEF DESCRIPTION

One of the key identifiers of cancer is an interruption in normal cellular life cycles, including pre-programmed cell death. Researchers at UCI have recently developed a method to monitor this cell death via graphene-based sensors which provide increased accuracy and allow for a higher degree of cancer treatment personalization over traditional techniques.

FULL DESCRIPTION

Multicellular organisms, such as mammals, rely on pre-programmed cell death (apoptosis) for normal cell development and maintenance. Apoptosis is an irreversible process that, once started, cannot be undone and as such is highly regulated within cells. Several diseases, including cancer, can interrupt the natural onset of apoptosis, which necessitates a method for reliably detecting and monitoring its progression. Due to its irreversible nature, most apoptosis sensing techniques detect the first step in the cellular death process. This corresponds to a rush of charge across the outer membrane of the mitochondria, called mitochondrial outer membrane permeabilization (MOMP). MOMP is monitored optically by light-emitting fluorescent molecules that are placed outside the mitochondrial membrane; the intensity of light emitted by these molecules is reduced as the electronic environment changes with the onset of MOMP. Standard fluorescent-based techniques require ~10,000 cells to generate accurate assessments.

Recently, researchers at UCI have developed an inexpensive electronic apoptosis sensing technique. This method utilizes electrodes constructed from graphene, an atomically-thin carbon sheet. The graphene is functionalized with an antibody that binds selectively to a protein on the mitochondrial outer membrane, effectively anchoring the mitochondria to the sheet. By monitoring the electrical charge across the sheet, researchers were able to effectively detect the onset of apoptosis in the mitochondria through a drop in the graphene conductance. Most notably, this platform requires less cells (as little as 7,000 cell in the test area) to generate accurate results. Researchers posit that this number can be even further reduced as the sensor is scaled down to cellular dimensions.

This technology has important implications in tumor biopsies -- with fewer cells needed to accurately profile the tumor, this platform offers a quicker and more accurate method for the crafting of individualized cancer treatments.

ADVANTAGES

§ Higher accuracy – less biological sample (biopsy) required

§ Results obtained faster than optical techniques with high resolution (1 data point per 0.2 seconds)

§ Platform can be easily scaled either up (high throughput assays) or down (smaller biological samples required)

PATENT STATUS

Country	Type	Number	Dated	Case

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OTHER INFORMATION

CATEGORIZED AS

» **Biotechnology**
» Other
» **Sensors & Instrumentation**
» Biosensors

RELATED CASES

2016-129-0

United States Of America	Issued Patent	10,718,756	07/21/2020	2016-129	

STATE OF DEVELOPMENT

Preliminary in vitro tests have been performed. Graphene electrodes have been produced and incorporate in electronic sensing platforms of mitochondrial cellular events.

This technique will be employed in “BH3 profiling”, whereby biopsies are subject to a panel of small peptides within the cell death-related family of proteins, BH3.

RELATED MATERIALS

» Burke, P. J.; Pham, T.; Wallace, D. An electronic assay of cell death. World Mitochondria Society conference, 2015. - 01/01/2015

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