METHOD FOR IMAGING NEUROTRANSMITTERS IN VITRO AND IN VIVO USING FUNCTIONALIZED CARBON NANOTUBES

Tech ID: 27057 / UC Case 2017-019-0

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,357,872	06/14/2022	2017-019

BRIEF DESCRIPTION

Neurotransmitters play a central role in complex neural networks by serving as chemical units of neuronal communication. Quantitative optical methods for the detection of changes in neurotransmitter levels has the potential to profoundly increase our understanding of how the brain works. Therapeutic drugs that target neurotransmitter release are used ubiquitously to treat a vast array of brain and behavioral disorders. For example, new methods in this sphere could provide a new platform by which to validate the function of drugs that alter modulatory neurotransmission, or to screen antipsychotic and antidepressant drugs. However, currently in neuroscience, few optical methods exist that can detect neurotransmitters with high spatial and temporal resolution *in vitro* or *in vivo*. Brain tissue also readily scatters visible wavelengths of light currently used to perform biological imaging, and neuronal tissue and has an abundance of biomolecules that are chemically or structurally similar and therefore hard to specifically distinguish. Furthermore, neurotransmission relevant processes occur at challenging spatial and temporal scales.

UC Berkeley investigators have developed polymer-functionalized carbon nanotubes for *in vitro* and *in vivo* quantification of extracellular modulatory neurotransmitter levels using optical detectors. The method uses the fluorescent optical properties of polymer-functionalized carbon nanotubes to selectively report changes in concentration of specific neurotransmitters. The scheme is novel in that the detection method applies to wide variety of specific neurotransmitters, it is an optical method and therefore gives greater spatial information, and enables the potential for imaging of one or more neurotransmitters. The optical method also produces less damage to the surrounding tissue than methods that implant electrodes or cells and allows high resolution localization with other methods of optical investigation. The invention takes advantage of favorable fluorescence properties of carbon nanotubes, such as carbon nanotube emission in the near infrared and infinite fluorescence lifetime. The near infrared emission scatters less than shorter wavelengths, enabling greater signal recovery from deeper tissue, and allows greater compatibility with other techniques. The optical properties also enable long term potentially even chronic use.

SUGGESTED USES

Quantification of neurotransmitter levels and dynamics in tissue or in fluid. These measurements may be performed in the brain or peripheral nervous system of anesthetized or awake animal subjects, or in reduced biological preparations that contain neurotransmitters (e.g. brain slices of any species or cerebro spinal fluid). Individual neurotransmitter levels may be quantified or multiple combinations may be

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OTHER INFORMATION

CATEGORIZED AS

- » **Optics and Photonics**
  - » All Optics and Photonics
- » **Biotechnology**
  - » Other
- » **Materials & Chemicals**
  - » Composites
- » **Medical**
  - » Imaging

RELATED CASES

2017-019-0

quantified simultaneously.

It may also be applied to measure and image neurotransmitter concentrations in tissue or fluid samples that may contain neurotransmitters outside of the nervous system. For example as a tool to monitor neurotransmitter levels in biological solutions or preparations, such as in saliva blood, serum or muscle.

Application in commercial brain imaging.

Quantitative evaluation and or validation of the mechanism of action and/or efficacy of new and or established drugs or other therapeutics that target neurotransmission. Neurotransmitter measurements may be achieved in either blood, saliva, CSF, brain tissue, brain slices, and or anesthetized or awake and behaving animals.

To monitor the progression of various brain diseases.

To identify parts of the brain that have suffered trauma (i.e. traumatic brain injury) and can be used to determine if (and to what extent) that injury site has affected its ability to undergo normal neurotransmission behavior.

ADVANTAGES

Selectivity enables differentiation between molecules of similar redox potentials.

Selectivity enables discrimination of multiple neurotransmitters simultaneously.

Enables quantification of extracellular levels and dynamics.

Enables observation with appreciable spatial resolution.

Compatible with other optical methods.

Enables observation with appreciable temporal resolution.

No fouling or photobleaching to limit experimental data acquisition.

Potentially less damaging than methods that require implanting a device or a cell into tissue due to the small (nano) size of the sensors.

Long wavelength emission and infinite fluorescence lifetimes are features that add functionality and unique utility to quantitative imaging methods.

RELATED MATERIALS

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Gene Delivery Into Mature Plants Using Carbon Nanotubes
- Simultaneous High-efficiency Editing of Multiple Alleles in Plant Cells
- Cell Penetrating Peptides For Nucleic Acid And Protein Delivery In Plants