One Dimensional Photonic Crystals for Enhanced Fluorescence Based Sensing, Imaging and Assays

Key Investigator

- Joseph R. Lakowicz
- Ramachandram Badugu

Field

- Biomedical diagnostics
- Biochemical assays
- Fluorescence microscopy

Technology

- Fluorescence enhancement
- Sensing
- Imaging
- Assays

Advantages

- Thousand-fold enhancement of evanescent fields
- Tunable fluorescence emission

Status

Available for licensing

Patent Status

US 10,107,807 (Issued)

UMB Docket Reference

JL-2013-117

External Reference

Grand View Research, 'Fluorescence In Situ Hybridization (FISH) Probe Market Size, Share & Trends Analysis Report By Technology (Q FISH, Flow FISH), By Application (Cancer Research, Genetic Diseases), By End Use, By Region, And Segment Forecasts, 2021 - 2028,' Grand View Research, 2021. [Online]. Available: Link

Summary

This patent presents a leap in photonic devices, using one-dimensional photonic crystals (1DPCs) to amplify fluorescence in biological assays. The innovation promises a thousand-fold enhancement of evanescent fields, tunable emission, and cost-effective production. It has application in medical diagnostics, research, and pharmaceuticals, with a growing fluorescence probe market indicative of its potential impact.

Market

The market for fluorescence-based biological detection, imaging, and assays is a dynamic and growing field. The patent discloses an improved techniques for measuring fluorescent emission. This innovation is poised to meet the increasing demands for precision in various biological applications, from medical diagnostics to agricultural biotechnology. The enhanced sensitivity and specificity of fluorescence imaging can lead to breakthroughs in detecting diseases such as cancer and genetic disorders. The ability to accurately pinpoint biological markers with improved fluorescent techniques can revolutionize diagnostic processes, making them more reliable and less invasive. High-resolution fluorescent imaging is indispensable in studying cellular and molecular processes. In drug discovery, the precision of fluorescent assays is crucial for identifying and validating targets. Improved techniques can expedite this process, reducing time and costs associated with drug development.

The fluorescence in situ hybridization (FISH) probe market, a subset of this broader market, was valued at over $700 million in 2020 and is expected to grow steadily. This growth is indicative of the overall market trend, where there is a clear trajectory of expansion driven by technological advancements, regulatory changes, and shifts in consumer behavior towards personalized medicine and non-invasive diagnostics. Unmet needs in the market, such as the demand for higher sensitivity and specificity, faster and more efficient assays, and cost-effective solutions, present opportunities for the patented technology.

Technology

The innovation revolves around the utilization of one-dimensional photonic crystals (1DPCs) to amplify the fluorescence signals used in various sensing and imaging applications. The core of the technology lies in its ability to enhance local fields through Bloch Surface Waves (BSWs) on 1DPCs, which can be increased by a factor of 1000 or more. This enhancement is attributed to the reduced losses in the dielectric materials used in the construction of these photonic crystals. The key features of this invention include the ability to tune the fluorescence emission from different dyes by altering the substrate parameters, which can be done in a straightforward manner. This tuning capability allows for the customization of the photonic crystals for specific wavelengths or types of emissions, making the technology highly versatile. The substrates designed as part of this invention can be mass-produced at a minimal cost, offering a large working area suitable for various assay formats. From a technical standpoint, the advantages of this technology are manifold. The significant enhancement of the evanescent fields not only improves the sensitivity and specificity of fluorescence-based assays but also opens the door to real-time quantification of analytes at very low concentrations. This is particularly beneficial for the detection of biomolecules like cytokines, which are present in minute quantities in biological samples. Additionally, the substrates' adaptability for multicolor directional fluorescence imaging and molecule-specific bio-sensing underscores the technology's potential for multiplexed assays, where simultaneous detection of multiple targets is required. In terms of applications, the primary

Contact: Mark Wozniak
Mark.Wozniak@umaryland.edu
410-706-7293

University of Maryland, Baltimore
620 W. Lexington St., 4th Floor
Baltimore, MD 21201

use of this technology is in the development of sensors and imaging systems that rely on fluorescence signals.

The materials and components used in this technology are pivotal to its performance. The 1DPCs are constructed using low-loss dielectric materials, which are known to be suitable for different wavelength regions, including the ultraviolet (UV) spectrum. The precise control over the refractive index of these materials, such as silicon nitride (Si_3N_4), allows for the fine-tuning of the photonic crystal's properties. Performance metrics of the technology are highlighted by the degree of fluorescence enhancement, the tunability of the emission spectra, and the cost-effectiveness of substrate production.

Contact: Mark Wozniak
Mark.Wozniak@umaryland.edu
410-706-7293

University of Maryland, Baltimore
620 W. Lexington St., 4th Floor
Baltimore, MD 21201