Metal-Enhanced Fluorescence (MEF)

The Challenge: Fluorescence has become a dominant technology in medical testing, diagnostics, drug discovery, cellular imaging and basic science research over the past decade, as it allows the detection of specific biomolecules that are often present in vanishingly small amounts. However, this methodology suffers from an inherent need for increased sensitivity and the rejection of unwanted background signals. One way to increase fluorescence sensitivity is through metal enhanced fluorescence (MEF). MEF is a phenomenon where the quantum yield and photo-stability of weakly fluorescing species are dramatically increased when fluorophores are brought in close proximity to free electron-rich metals. Therefore, the MEF system can be a powerful tool for fluorescence-based applications in drug discovery, high throughput screening, immunochemistry and in the analysis of protein-protein and or DNA-RNA interactions.

UMBI Solution: Scientists at UMBI have developed a platform technology for ultra-fast and ultra-sensitive clinical and bio-agent sensing. This new technology combines the use of Metal-Enhanced Fluorescence (MEF) that amplifies fluorescence signatures up to a million fold with the use of low power microwaves or ultrasound waves. The resultant technologies, Microwave-Accelerated Metal-Enhanced Fluorescence (MAMEF) or sonication-assisted metal enhanced fluorescence (SAMEF) respectively, significantly reduces bioassay time and increases bioassay sensitivity when applied to bio-agent or clinical analyte detection.

At the surface of metals, electrons move more freely than in other solids and sometimes behave like vibrating or oscillating particles at frequencies similar to those of light and are referred to as plasmons. The special properties of plasmons and fluorescent dyes can be harnessed to act as rapid and sensitive detection devices for molecules of biological interest. This technology enables one to detect fluorescence and chemiluminescence directly without the need for expensive detectors as the signal obtained can be digitized in real time. Several modes of metal deposition have also been developed and the technique can be applied to glass, plastics, paper and even electrode surfaces. This technique can also be extended to chemiluminescence, called Metal-enhanced Chemiluminescence. This phenomenon has been observed for a variety of chemiluminescent species in the visible spectrum, ranging from blue to red, and also on a variety of metals, including, aluminum, silver, nickel, iron, platinum, palladium and gold.

Commercial Applications:

- This technology may allow first responders to assess on-site without the need for time consuming laboratory processing and amplification, such as real-time PCR.
- Multiple fluorescence detecting system - laboratory operations on small scale using miniaturized (lab-on-a-chip) devices – for protein-protein, DNA-protein, RNA-Protein, DNA-RNA, chemical-protein and chemical-DNA detection.

- Technology can be applied to a variety of fluorescence detectors: spectrofluorometers; microplate readers; fluorescence microscopes; fluorescence scanners; flow cytometers; instrumentation that use fluorescence detection including capillary electrophoresis apparatus, DNA sequencers and microfluidic devices.
- As a direct measure of fluorescence, phosphorescence or chemiluminescence signatures.
- Can provide digital read out without the need for additional analogue to digital conversion processes.
- In immunoassays, as a direct measurement of surface analytes by measuring induced current and not fluorescence or other luminescence signature.
- As a new class of detectors, directly converting fluorescence to plasmonic electricity.
- As devices for converting light into electricity for electronic circuits, e.g. in solar powering devices, with or without fluorophores or other nanoparticle labels.
- In multiplexed and high throughput screening applications.

Advantages:

- Increased sensitivity based on metal-enhanced fluorescence use in a controllable manner by applied voltage.
- Digital signals in real time.
- A method for increasing the reaction kinetics of molecules within the detection system by applying low intensity microwave energy.
- Polymeric substrates can be used for metal deposition instead of glass as they are much more flexible.
- Low sample quantities, ease-of-use, speed of analysis.

Relevant Publications:

1. New Tools for Rapid Clinical and Bioagent Diagnostics: Microwaves and Plasmonic Nanostructures, Kadir Aslan and Chris D. Geddes, Invited Review for the Analyst, (2008), 133, 1469-1480.
2. A review of an Ultra Fast and Sensitive Bioassay Platform Technology: Microwave-accelerated Metal-Enhanced Fluorescence, Kadir Aslan and Chris D. Geddes, Plasmonics, (2008), 3, 89-101.

Patent Status: Several issued and pending patent applications.

Licensing Potential: UMBI is seeking exclusive or non-exclusive partnership for developing a new controllable voltage-gated metal enhanced fluorescence platform. The UMBI inventor would welcome the opportunity to collaborate with any licensee to further refine the invention to a fully developed product.

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