Upcon®

Unique Upconverting Nanoparticle System

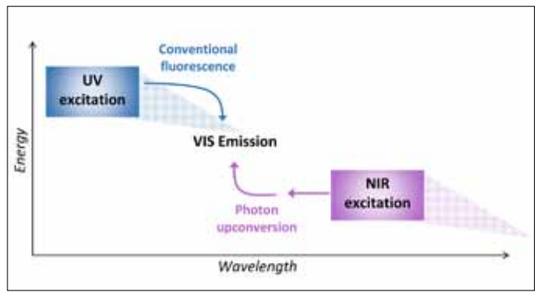
SYSTEM OVERVIEW

Upcon® reader and reagents – introducing an exceptional label technology

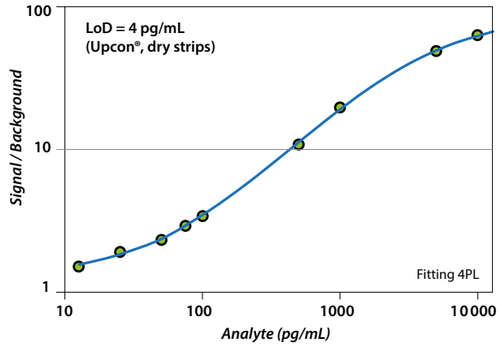
Photon upconversion

The Upcon® is a comprehensive concept built around a novel label technology known as photon upconversion. In this technology, upconverting nanoparticles (UCNPs) convert near-infrared (NIR) radiation to visible light via a unique process that enables the photoluminescence to be measured entirely free of autofluorescence and scattered excitation light.

Autofluorescence is always created as a result of excitation, and it occurs at longer wavelengths than the used excitation wavelength. In conventional fluorescence, autofluorescence obstructs the detection of the emission at visible wavelengths. However, with photon upconversion, the autofluorescence occurring at infrared wavelengths is completely eliminated as the detection takes place at visible wavelengths. This enables high-sensitivity applications and also simplifies the design of the reader.



Conventional fluorescence vs. photon upconversion In photon upconversion, NIR radiation of lower energy is converted into visible light of higher energy. It is a reverse process compared to conventional fluorescence, where the emission is measured at longer wavelengths (lower energy) compared to the excitation. Autofluorescence is represented by dotted shading.



Lateral flow assay Our customer was not able to measure clinically relevant concentrations with their current system (latex beads, sensitivity demand <500 pg/ml). By changing to Upcon technology, they reached targeted sensitivity with minimal optimization work (dry strips 4 pg/ml or wet strips 50 pg/ml).
(Data courtesy of Medix Biochemica, Finland)

Upcon® reader

Due to the highly intense emission of the Upcon particles and the elimination of autofluorescence from other sources, all that is needed for excitation purposes is an affordable continuous-wave laser diode. This facilitates a simple readout design and reliable detection of even a minute amount of particles.

- Measures plate formats up to 1536 well plate
- Shaking and temperature control
- Flexible platform for assay development
- Multiple detection technologies available on the same platform
  - Upcon
  - TRF, TR-FRET
  - Luminescence
  - Absorbance
  - Fluorescence
  - Fluorescence polarisation

A truly flexible platform for assay development, the Upcon reader measures all Upcon assays and also supports other key detection technologies.

For high-sensitivity applications

- Anti-Stokes measurements of Upcon nanoparticles
- Laser diode-based excitation
- Photon counting detection
- < pM detection limit

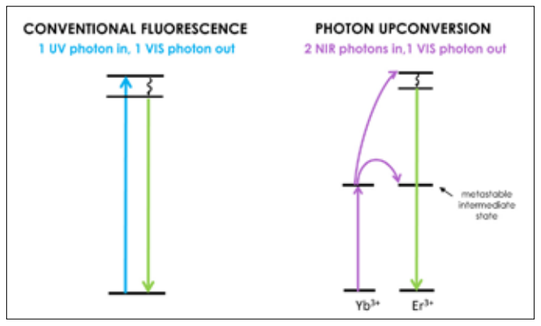
Upcon® LF reader for LF development

- LF-strip holder frame & scanning SW available
- Miniaturizable measurement system
- Cost-efficient design
- Inbuilt temperature control and calibration
- Custom service for your assay needs

Upcon nanoparticles

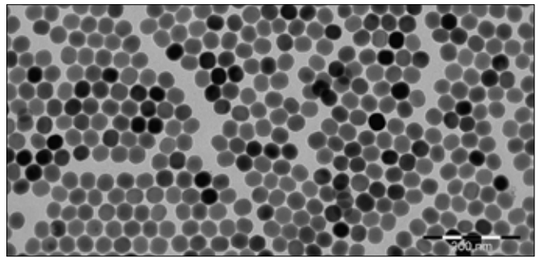
The key to the Upcon-technology is the small upconverting nanoparticles. These inorganic nanocrystals are doped with two kinds of lanthanide ions, the ytterbium (Yb^{3+}) sensitizer ion and the erbium (Er^{3+}) activator ion.

The Yb^{3+} ion absorbs an NIR photon and transfers the energy to Er^{3+}, which stores the energy in a long lifetime intermediate energy state. This allows time for the second NIR photon to arrive and "pump" the energy to a higher energy state, after which a single high-energy visible light photon is emitted. This process requires considerably less excitation power than two-photon excitation (TPA) technology owing to the long-lived intermediate energy states of the lanthanide ions.



Simplified energy level diagrams In conventional fluorescence, one higher energy photon (usually UV) is absorbed, some energy is lost in the process, and a lower energy photon is emitted. In photon upconversion, the absorption of several sequential low-energy NIR photons is followed by emission of only one high-energy photon at visible wavelengths.

The Upcon particles are available either as 'ready-to-use' labels with streptavidin coupling, or with an amine reactive surface for use in customer-specific applications.



Upconverting nanoparticles Transmission electron micrograph of the nanoparticles with an average diameter of 35 nm.

Upcon® for varied applications and user needs

The UCNPs provide several advantages over traditional labels like conventional fluorophores or quantum dots. Due to the NIR-excitation, the autofluorescence of biological samples is totally eliminated, and the particles are detectable through tissue and even in whole blood. The lanthanide ions that are embedded within the particles provide the favorable properties of stable and bright emission, discrete emission bands and long emission lifetime.

Advantages

- Low background due to the elimination of autofluorescence
- Bright luminescence with discrete emission bands
- No photobleaching or self-quenching
- Detectable through tissue and in whole blood
- Particle manufacturing according to ISO 13485

Examples of application areas

Diagnostics and bioanalytics:

- Bioaffinity assays[1], lateral flow tests[2] and sensors[3]

Imaging and microscopy[4]:

- *In vitro, In vivo & In situ*

Therapy:

- Photodynamic therapy[5] and drug delivery[6]

Examples of analytes

- Bioaffinity assays: estradiol[1] , Hg[2] , f-PSA, AFP[7]
- Lateral flow: hCG, pathogens[8], drugs of abuse, anti-HIV antibody[9] , HPV16
- Sensors: pH[3] , NH_3[10] , CO_2, O_2[11], temperature

References

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Joint venture of Kaivogen and Labrox

Upcon® system is a joint venture by two life science companies operating at Turku Science Park, Finland. The reader has been developed by Labrox Oy and the nanoparticles by Kaivogen Oy.

Kaivogen produces components for immunoassays, from coated microplates to labels needed for detection. The company was founded in 2007.

Labrox develops multi-mode readers used with microplates and produces custom components for POC devices. The company has operated since 2011.

The Upcon concept is intended for companies and research institutions working in the life science field. The concept includes both the upconverting nanoparticles and a 'first-of-its-kind' microplate reader.

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