

# ReliaSense™

## Optical Sensor

### ...real-time detection via nanolayer binding surface

#### Example Applications

- Food inspection
- Chemical or petroleum production
- Drinking water monitoring
- Point of care medical diagnostics
- Alerting of chemical or biological terrorist attacks

#### Demonstrated Real-time Response

- *E. coli*
- Mycobacterium tuberculosis rRNA
- Influenza A virus
- *Salmonella typhimurium*
- Human chorionic gonadotropin (hCG)
- Ammonia
- Various organic molecules

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nanoEngineered Materials™

#### Real-time Detection's Missing Link

Real-time, reliable detection of chemical and biological agents is necessary in many applications, yet practical or portable sensor systems that are easily operated are either not available or may not have your requisite sensitivity and response. Existing and emerging technologies with appropriate detection sensitivities tend to be too complex, require excessive human intervention by highly trained personnel, and slow.

**Consider the advantages of a system that can detect and identify *in real time* trace levels of targeted biological and/or chemical species.**

#### The Next Generation of Detection

Real-time detection is the premise of the ReliaSense optical sensor. The device is an interferometric waveguide sensor based on an integrated optical chip fabricated using standard photolithographic processes. Each interferometer on the optical chip can be nano-coated with a monolayer of selective chemistry specific to a particular biological or chemical agent, thereby, allowing simultaneous *real time* detection of multiple targeted agents of your choice.

**The ReliaSense optical sensor is designed to meet the new detection challenges emerging in our world today.**

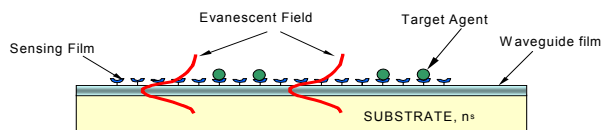
#### Benefits of the ReliaSense Optical Sensor

- Rapid response
- Reliable results with interferant cancellation
- Trace level detection sensitivity via nano-detection surface
- Multiple agent simultaneous detection and identification
- Compact packaging
- Straightforward operation
- Applicability to liquid and gas environments
- Capability for calibration and known agent compensation
- Non-specific binding interference subtracted from signal output
- Cost savings verses sampling and analysis
- Compensation for high agent concentration

A waveguide interferometer configuration provides a simple and sensitive means of quantifying very small phase changes at the waveguide surface by comparing the phase perturbed signal with an unperturbed reference signal. The resulting interferometric output is quantitatively related to the concentration of the target analytes bound to the nanolayer on the waveguide surface and correspondingly to the actual concentration in the ambient medium.

### Optical Waveguides

An optical waveguide typically consists of a thin, optically transparent film capable of confining a light wave through total internal reflection and transporting it over finite distances with negligible losses. In practice, an optical wave confined to a high index thin film (a guided wave) exhibits an exponentially decaying electric field (the evanescent field) that extends beyond the thin film boundaries into the substrate and the cover medium over the waveguide surface.



$n_c$  - sensing film refractive index  
 $n_w$  - waveguide film refractive index  
 $w$  - waveguide film thickness  
 $n_s$  - substrate refractive index  
 $n_c \approx n_s, n_c \approx n_s \ll n_w, w < \lambda$

Due to the presence of the evanescent field in the cover medium, the phase velocity of a guided wave can be made very sensitive to changes occurring at or on the waveguide surface. An optical chip may be designed such that the evanescent field extends a defined distance (approximately 500 nm) into the local environment over the waveguide surface. Biological or chemical species that react with the nanolayer on the waveguide surface or that simply attach through adsorption/absorption will effectively alter the phase velocity of a guided wave.

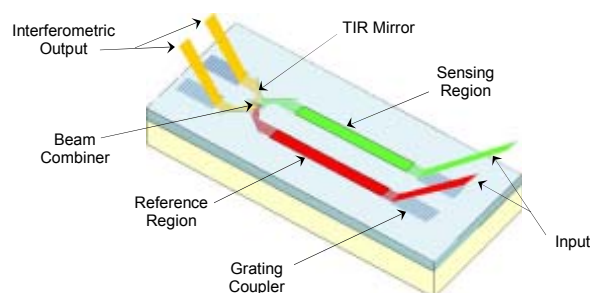
#### ReliaSense Optical Sensor Size Advantages

- Multiple interferometers (~50) are easily placed side-by-side on a compact chip (1 cm x 3 cm).
- Some sensing channels can be devoted to calibration or used for compensation of known interferants. Typically, each interferometer would have a total width (signal arm plus reference arm) of 200 to 450 micrometers, allowing a large number of interferometers to be placed on a one-centimeter wide chip.
- In practice, the width of an interferometer arm is limited primarily by the ability to functionalize or attach the detection chemistry to a specific interferometer arm without tainting an adjacent sensing or reference arm.

**The Company.** nGimat, located inside the perimeter of Atlanta, is an intellectual property and manufacturing company that engineers nanopowders, thin films, and devices. Our facilities are equipped with instrumentation to perform cutting edge materials research, development, and manufacturing. The scientists and engineers at nGimat bring backgrounds in materials science, chemistry, physics, mechanical/chemical/electrical engineering, and biochemistry to the challenges of engineering nanomaterials. In addition, our analytical personnel provide rapid turn-around times and state-of-the-art materials analysis to support our materials development.

### ReliaSense Optical Sensor

The ReliaSense optical sensor utilizes a unique combination of input/output grating couplers, total internal reflecting (TIR) mirrors, beam combiners, and other optical elements embedded in a thin, optically transparent film deposited on the surface of an optically transparent substrate to form an interferometer. Target detection is achieved by comparison of the phase properties of a guided light wave traveling through a signal region (coated with nanolayer selective chemistry)



and a guided light wave traveling through an adjacent reference region (environmentally isolated or coated with an interferant canceling chemistry). The TIR mirrors and a Fresnel beam combiner merge the two light waves, forming interference patterns that are extremely sensitive to differences in the phase velocity of the two light waves. The entire device, with the exception of the sensing and reference channel region, is coated with a clad layer (usually of  $\text{SiO}_2$ ) designed to environmentally isolate the optical elements from external perturbations. Note that both the signal and reference light waves are equally susceptible to non-specific binding and other background matrix effects, automatically canceling them out and yielding reliable results.

#### ReliaSense Optical Sensor Real World Advantages

- The ReliaSense optical sensor handles non-specific binding interference with a built-in optical reference to avoid compromising detection limit or performance and precision.
- Non-specific binding interference is subtracted prior to signal output, yielding reliable detection.

**We at nGimat Co. would like to discuss with you how the ReliaSense Optical Sensor can enhance your chemical or biological sensing requirements.**

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The integrated optic chip technology in the ReliaSense™ optical sensor is licensed exclusively to nGimat (N.F. Hartman, Optical Sensing Apparatus and Method, U.S. Patent No. 4,940,328, July 1990; N.F. Hartman, Integrated Optic Interferometric Sensor, U. S. Patent No. 5,623,561, April 22, 1997).