Technologies Available for Licensing

ELECTRICAL AND COMPUTER ENGINEERING TECHNOLOGIES
## Technologies Available for Licensing

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Technology Description:
This invention involves a solid state device to detect broadband electromagnetic waves. The invention miniaturizes present electromagnetic wave receivers used in detection or manipulation of electron spin. It can be used as an on-chip electromagnetic wave receiver or detector for the future telecommunications development at the chip level. Furthermore, it can be used to generate a pure spin current which is desired in the future of spintronics and to analyze dynamic structures of composed of ferromagnetic and normal metal. The device is also capable of converting energy of electromagnetic waves into dc charge or spin current. This invention could be useful in information processing devices such as quantum computers and spin logic systems, and other spintronic devices.

Benefits:
The invention can dramatically miniaturize whole microwave receiver such that it can be integrated on the chip-level. Because the invention converts electromagnetic wave energy to a dc voltage, it works without any power supply to the device.

Patent Status:
The technology is patented with fully preserved U.S. patent rights available for licensing opportunities.

• U.S. Issued Patent (No. 8,669,762)
Microwave Detection in High Radiation Energy Environments
(UD09-16)

**Technology Description:**
This invention presents a series of novel microwave components that can be realized using spintronic devices. Spintronic devices refer to a class of electronic devices in which electron spins are controlled to provide additional functionality to existing electronic devices. Among all the spintronic devices, magnetic tunnel junction (MTJ) offers the largest magneto-resistance, and therefore, can be used as microwave detector, modulator, and demodulator under certain configurations.

**Benefits:**
- Conventional microwave detection uses RF diode. It has a good sensitivity and wide dynamic range, but poor tolerance to high power microwave pulse, since the microwave voltage is directly imposed on the diode. The MTJ based microwave detector is instead sensing microwave magnetic field. Thus it will have much better chance to survive in high power microwave pulse. Metallic devices are intrinsically radiation resistance. The devices can thus be used in space application where high energy radiation is present.

- Most of interference based microwave devices such as microwave vector network analyzer, spectrum analyzer usually has a large size, at least comparable to microwave wavelength. In the design we described previously, we can realize microwave phase and frequency detection and spectrum analyzing using a miniaturized circuit. In this type of applications, we may beat the wavelength limit.

**Patent Status:**
The technology is patented with fully preserved U.S. and Taiwan patent rights available for licensing opportunities.

**Technology Description:**

In recent years, more attention has been focused on microwave properties of magnetic nanowire arrays for high frequency applications. Conventionally, microwave filters based on ferromagnetic resonance possess frequency tunability by continuously applying an external field or continuous voltage. This invention presents a method to tune ferromagnetic resonance in magnetic nanowire arrays without sustaining external field or voltage supply. The external field is only necessary when the operation frequency has to be changed, needing current pulses in the order of a microsecond, without overheating the coils of the electromagnet, lowering the requirement for a cooling system and, consequently, reducing the size of the device. The other applications of the invention are a detector of magnetic field pulses and extreme electromagnetic waves, either ultra-short or ultra-strong electromagnetic fields.

**Benefits:**

**Tunable Ferromagnetic Resonance**
- Reduces power consumption
- Reduces the size of the microwave device

**Magnetic Field Pulse Sensor**
- Can detect ultra-short and/or ultra-strong EM fields

**Patent Status:**

The technology is patented with fully preserved U.S. patent rights available for licensing opportunities.

- **U.S. Issued Patent (No. 8,432,164)**
Rare Earth Composite Magnets With Increased Resistivity
(UD10-13)

Technology Description:
This invention relates to rare earth permanent magnets for use in rotary equipment, motors and generators. Addressing eddy current losses represents one of the important factors in the design of motors and high speed generators. Reduction of these eddy current losses in permanent magnets used with rotary equipment is best achieved by increasing their electrical resistivity. When the magnets are subjected to variable magnetic flux, if the electrical resistivity is low, a large amount of heat due to eddy current is generated, which in turn reduces their magnetic properties and therefore the efficiency of rotary equipment. High resistivity is achieved by using various insulating means to increase the electrical resistivity of rare earth magnets.

Benefits:
• It achieves full density and high resistivity composite magnets that effectively reduce the eddy currents
• It attains increased resistivity while improving coercivity of composite magnets with only a small reduction in residual induction by the addition of resistivity enhancing agents

Nd-Fe-B rare-earth magnets.

Patent Status:
The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.

• Published U.S. (No. 2011-0057756)
• Published U.S. (No. 2011-0200839)
Technology Description:
This invention presents a microwave detector based on metamaterials (e.g. split ring resonators) and its combination with spintronic devices (e.g. magnetic tunnel junctions). Due to the miniature size and strong resonances in microwave frequency range, split ring resonators (SRR) can be successfully applied in microwave imaging. Furthermore, due to some properties of spintronic devices, the coupling between them and SRR makes a unique free space microwave detector with several advantages over regular microwave detectors. Pre-existing technology of microwave detection is using antennas to collect microwave, waveguide to transmit and semiconductor diodes to detect the microwave. While in this invention, the waveguide part is eliminated. Moreover, the detection is resonance based, thus having a strong frequency sensitivity. This system has an advantage of better spatial resolution than regular antenna arrays for microwave imaging due to the use of SRR. Additionally, microwave phase may also be measured with this device when a coplanar feed in circuit is added.

Benefits:
• Better spatial resolution (miniature size) than regular antenna arrays
• The detection has good frequency sensitivity
• The detection is sensitive to both electric field and magnetic field in the free space, unlike the conventional antenna, which is mostly excited by electric field

Patent Status:
The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.

• Published U.S. Patent (No. 2011-0181303)
New Age Spintronic Devices with Wide-Range Turnability
(UD14-02)

**Technology Description:**

This invention presents a novel method to tune the ferromagnetic resonance (FMR) through controlling of the interlayer exchange coupling. We have developed a microwave detector based on Spintronic devices with high resonant frequency and frequency tunability without using an external magnet. The invention will significantly improve the frequency band of Spintronic devices without the need of applied magnetic field, which would dramatically reduce the size and energy consumption. Furthermore, the deploying of interlayer exchange coupling would benefit other microwave devices based on FMR such as microwave absorber.

**Benefits:**

- Utilization of a microwave detector without the use of an external magnet
- Significantly improves the frequency band of Spintronic devices without the need of an applied magnetic field
- Reductions in size and energy consumption
- Achieved frequency controlled range of more than 10 GHz and the working frequency can go up to 40 GHz and higher
- Easy to implement and the cost to manufacture is low

![Fig. Illustration of spin valve. The resistance of the device is determined by the magnetization of the effective layer that is several nm thick. (a) high resistance state when the two moments are antiparallel. (b) low resistance state when the two moments are parallel. (c) The moment of reference layer is fixed. The moment of free layer is precessing due to microwave. The resistance is oscillating as $R[\theta(t)]$.](image)

**Patent Status:**

The technology is patent pending with fully preserved U.S and worldwide patent rights available for licensing opportunities.
Technology Description:

As mobile electronics continue to evolve, the need for high-output, long-lasting rechargeable batteries has grown tremendously. Rechargeable lithium ion (Li-ion) batteries have high energy/weight ratios and high charge/discharge efficiencies relative to other rechargeable batteries which make them ideal for modern portable electronics, medical devices, satellites and electric vehicles. The development of high-energy storage devices has been a research area of top-most importance in recent years and rechargeable batteries are anticipated to be the primary sources of power for modern-day mobile energy requirements. Charge capacity has become the main limitation of today’s Li-ion batteries and the proposed method will overcome this by introducing silicon (Si) to the anode (negative electrode). This formation releases the stress induced by Li ion movement during charge-discharge cycles. The proposed method is expected to realize theoretically determined maximum charge capacity of Si-anode Li-ion batteries with long cycle stability. Silicon anode (Si-anode) Li-ion batteries can have a theoretical charge capacity of ten times greater than currently used graphite anodes.

Benefits:

- High charge capacity (close to theoretical maximum of 4,200 mAh/g)
- Increased reliability and durability

Patent Status:

The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.
Cost Effective, High Power Supercapacitor Electrodes  
(UD12-26)

Technology Description:
This technology is a novel technique for the simple, cost-effective, and scalable manufacture of support and additive free metal/metal oxide nanocomposite for use in supercapacitor electrodes. Super (or ultra) capacitors are a globally growing market, projected to increase at a compound annual growth rate of over 20% during the next 5 years. However, current supercapacitor technologies are limited in several aspects: 1) inability to provide both high power and high energy density; 2) delicate manufacturing procedure precludes large-scale production of nanostructured electrodes; and 3) necessary inclusion of additives and electrode material itself inhibits the performance of the electrode and limits electrode size. This new technique for fabricating metal/metal oxide electrodes is able to produce a nanostructured conductive metal core with controlled metal oxide crystallinity; coupled with a slow charge/fast discharge process, high power and high energy density can be simultaneously achieved. The technique is simple and low-cost, suitable for large-scale commercialization. The manufactured electrodes are robust, monolithic, and free from additives and binders, resulting in one of the best performances reported to date. This technology is featured as journal cover of Angewandte Chemie, International Edition Vol. 50, Issue 30.

Benefits:
• Electrodes achieve one of the best performances reported to date
• Electrodes manufactured are robust, monolithic, and free from additives or binders
• Technique is simple and feasible for large scale production

Fig. A schematic of NiO/Ni nanocomposite electrodes.

Patent Status:
The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.

• Published W.O Patent (No. WO 2013/163259)
**Technology Description:**
This invention introduces two new classes of spectral imaging sensors. Both classes of devices use spectrally and spatially patterned coded arrays, referred to as colored-coded arrays, to sense spatio-spectral information from a scene. The spectral range captured by the imaging systems can be within any region of the optical electromagnetic spectrum, from the UV to the long wave IR. This is determined by the range sensitivity of the Focal Plane Array (FPA) detector, CMOS imaging camera, or photodetector array. In both types of imaging devices, the underlying spectral cubes are reconstructed via computational algorithms.

The first class of sensors utilizes the colored-coded apertures to first code the 3D underlying signal, the coded signal is then spectrally dispersed using a prism or optical dispersive element. The coding is done at the image plane either by transmissive coated lithographic masks, by coated reflective micromirror devices, or by crystal based spatial light modulators. The coded and dispersed field is then collected and integrated by the 2D focal plane array (FPA) detector, or photodetector array, over their spectral sensitive response.

The second type of spectral imaging sensors do not apply the colored coding in the optical path, but at the detector. This approach first modifies the incoming field by a dispersive element, such as a prism, optical dispersive element, or by a convolution-type coded aperture such as a MURA (Uniform Array). The dispersed field is then projected onto a FPA detector whose pixel elements are coded individually by spatio-spectral sensitive film coatings. The colored coding at the pixel level in the CMOS imager or FPA can also be realized by integrating microscopic wedge filters that implement pixel level Fabry-Perot interferometers (FPI). In this case, the colored codes are determined by the length of the cavity on the FPI filter on each pixel.

**Benefits:**
- Maximum spatial and spectral resolution from optimized colored-patterns
- High spatial and spectral selectivity

**Patent Status:**
The technologies are patent pending with fully preserved U.S patent rights available for licensing opportunities.
Carbon Nanotube Fiber Based Stretchable Wire-Shaped Supercapacitors
(UD14-34)

Technology Description:

Wire-shaped supercapacitors (WSS) have attracted considerable attention due to the interest in development of wearable energy devices. This invention involves a novel method to fabricate the stretchable WSS using continuous carbon nanotube (CNT) fibers as the electrodes, a spandex fiber as the substrate and H2SO4-poly (vinyl alcohol) (PVA) gel as the solid electrolyte. A thin layer of poly (dimethylsiloxane) (PDMS) was coated on the spandex fiber, thus forming a core-skin structure, in which the inner spandex fiber provides elasticity and the outer PDMS layer protects the spandex fiber from the H2SO4-PVA gel electrolyte. The PDMS coated spandex fiber was then prestrained to 100% (Step 1) in figure B, and a thin layer of H2SO4-PVA gel electrolyte in liquid state was applied onto the PDMS/spandex fiber. In step 2, a straight WSS was “glued” onto the spandex fiber, taking advantage of the stickiness of the liquid gel electrolyte, as shown in figure C. The resulting assembly was left in the fume hood for the liquid electrolyte to solidify. In step 3, the prestrain on the spandex fiber was released, resulting in the sinusoidal buckling of the supercapacitor and hence its stretchability as shown in figure below.

Benefits:

• Excellent electrochemical properties even at a tensile strain of up to 100% or after 20 mechanical stretching-releasing cycles (MSRCs) with maximum strain of 100%.
• Capacitance retention reached 108% even after undergoing 20 MSRCs and 10,000 charge-discharge cycles, revealing its electrochemical stability.

Uses:

• WSS can be integrated with miniaturized and portable electronics (e.g. computing device, wearable displays, health monitoring devices and communication devices).
• Can be integrated with solar harvesting devices into industrial textiles covering large areas (e.g. permanent and temporary tents).

Patent Status:

The technology is patent pending with fully preserved U.S. and worldwide patent rights available for licensing opportunities.
**Technology Description:**

A novel modulator-based optical interconnect architecture is presented in this invention to replace the metal interconnections on integrated circuits which have become problematic as device integration densities scale. Especially for on-chip global communication, the growing requirements for bandwidth while staying within practical power consumption budgets exhibit an increasing challenge to microprocessor chip makers. Even with multi-core architectures, the continuous scaling of the required bandwidth density still exists and only increasing the number of cores per chip will slow data-intensive programs. Optical interconnect technologies can provide a viable solution to the growing bandwidth requirements in modern microprocessors. The innovative modulator-based optical interconnection approach provided can achieve high bandwidth, high coupling efficiency and high link density. The invention comprises one photonic layer in which prismatic coupling structures are embedded in optical waveguides and one layer of surface normal modulator and receiver array on the top of the silicon CMOS and metallization layers.

![Vertical prismatic coupling fabrics](image)

**Benefits:**

- High bandwidth, high coupling efficiency, high link density
- Easily manufactured (small footprint), CMOS compatibility

**Patent Status:**

The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.

- **Published US (No. 2012-0106890)**
Technology Description:
The current invention is targeting on-chip and off-chip optical interconnects. Future multi-core chips will demand aggregate on- and off-chip bandwidths in the TBytes/sec regime. However, metal on-chip global interconnections and off-chip communications do not scale commensurately with the CMOS device sizes, resulting in challenges to meet the growing bandwidth requirements within acceptable power budgets. Optics is a potential solution to replace the fundamentally limited electrical interconnects. In this invention, very compact optical interconnect fabrics are proposed to replace the metal global wires and obviate the need for opto-electronic and electro-optic conversions when signals propagate between the on-chip and off-chip domains. One key aspect is the multi-reflection prismatic structures embedded in waveguides, which enable the direct coupling from the integrated multiple quantum well devices to the intra-chip guided-wave fabrics and provide enhanced modulation. Tapered remote couplers provide free-space interconnections between chips or remote regions on-chip. Both coupling structures have small footprint areas and hence are projected to provide high bandwidth densities. The coupling fabric can also be used to optically interconnect two silicon die within a multichip module.

Benefits:
- It allows very short distance optical interconnects (such as on-chip and chip-to-chip) with low-power, high-density and reliable photonic sources and detectors compatible with Si CMOS processes.

Patent Status:
The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.

• Published US (No. 2012-0114281)
Dual-Channel Optical Multiplexer for Increased Bandwidth

(UD10-27)

Technology Description:
The progress of the multicore paradigm depends on the ability of communication architectures to deliver bandwidth to the processor cores and memory subsystems. Since traditional methods have nearly exhausted their physical limits, new alternative architectures to replace them may already be past due. The solution proposed in this invention utilizes light as a mode of communication. We consider the use of GaAs/GaAlAs multiple quantum well (MQW) devices in reflection mode along with polymeric waveguides to implement optical interconnects. MQW devices exhibit the quantum confined Stark effect due to which the optical absorption in the device is strongly dependent on the electric field applied perpendicular to the wells. The devices can be operated as highly efficient photodetectors when biased appropriately. This duality removes the need for a different type of devices and/or material systems for modulation and photodetection. A challenge in using MQW devices for optical interconnects is to deliver the bandwidth while being limited to operating a single wavelength. The method proposed here can double the bandwidth of the optical link.

Benefits:
This invention provides increased bandwidth and can enable system synchronization by precise clock distribution. Additionally, it alleviates design problems such as crosstalk and voltage isolation. Also, it negates the need for repeaters thereby saving silicon real estate and the power consumption associated with the repeaters.

Patent Status:
The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.

- Published U.S. (No. 2011-0249933)
Technology Description:
Optical modulators and switches are critical building blocks for optical communication networks. As optical links progressively evolve to replace electrical wirings at the board and chip levels, power consumption and speed are increasingly becoming the limiting factors to further scale down the length of optical interconnects. To compete with existing electrical interconnect technologies, the energy consumption of optical devices has to be on the order of 10 fJ/bit or lower. This low energy consumption poses a significant design challenge for optical modulators: traditional LiNbO$_3$ Mach-Zehnder (M-Z) interferometer modulators typically operate at about 1000 times this power value or more. State-of-the-art silicon-based electro-absorption and electro-optic modulators currently achieve a typical switching energy of 50 - 100 fJ/bit. Switching energy down to less than 10 fJ/bit was attained in plasmonic nanostructures with strong optical confinement but at the cost of increased insertion loss due to metal absorption.

This invention’s achievement of low power and high speed is based on the derivation of the energy-bandwidth limit in classical intra-cavity electro-optic modulators using a coupled mode theory formalism. The invention demonstrates that this classical limit can be overcome if a coupling modulation scheme is adopted because coupling modulation speed is not bound by the cavity photon lifetime. By exploiting a novel dual-cavity modulator design and strong sub-wavelength optical confinement in nano-slots, the proposed modulator device achieves an ultra-low modulation energy of 0.26 aJ per bit, which is more than 1000 times smaller than current state-of-the-art EO modulators, and a 3 dB optical bandwidth of 80 GHz, an outstanding energy-bandwidth performance well beyond the classical performance limits. The dual cavity modulator also features low insertion loss (< 0.02 dB) and a small footprint (~ 10 mm), thus making it an ideal device building block for next-generation integrated photonic circuits and optical switching fabrics.

Benefits:
- Low-power properties require less energy for operational use
- High-speed properties ensure efficiency
- Low insertion loss & small footprint create variety of opportunities for use in integrated optics & photon

Patent Status:
The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.
Technology Description:
An automatic method to embed QR codes into color images with bounded probability of detection error is presented. The embeddings are compatible with standard decoding applications and can be applied to any color image with full area coverage. QR information bits are encoded into the luminance values of the image, taking advantage of the immunity of QR readers against local luminance disturbances. To mitigate the visual distortion of the embedding, the algorithm utilizes blue noise masks for the selection of modified pixels and nonlinear programming techniques to optimize local luminance levels. A tractable model for the probability of binarization error is developed, and different image quality metrics are used in the optimization to yield best results in terms of robustness and quality. In order to minimize the processing time, the optimization techniques proposed take into account the mechanics of common binarization methods and are designed to be amenable for parallel implementations. Experimental results show that the probability of detection error of these embeddings are similar to their monochromatic counterparts while yielding considerable visual quality improvement with respect to existing methods.

Benefits:
- Improved visual quality of QR codes
- Bounded probability of error to maximize accuracy

Patent Status:
The technologies are patent pending with fully preserved U.S and worldwide patent rights available for licensing opportunities.
**Technology Description:**

An XSlit camera collects rays that simultaneously pass through two oblique (neither parallel nor coplanar) slits in 3D space. We observe that a cylindrical lens is a section of a cylinder that focuses rays passing through it onto a line parallel to the intersection of the surface of the lens and a plane tangent to it. The lens compresses the image in the direction perpendicular to this line, and leaves it unaltered in the direction parallel to it (in the tangent plane). This implies that we can concatenate two layers of cylindrical lenses to synthesize an XSlit lens. To further increase the XSlit camera’s depth-of-field, we couple the lens with slit-shaped apertures. Fig. 1 illustrates our prototype POXSlit camera where we mount the XSlit lens on a commodity interchangeable lens camera (e.g., Sony NEX-5N). We align the two cylindrical lenses orthogonally using a lens tube.

**Benefits:**

- Produces a coplanar common point that creates a 3-D image
- Useful in surgical scenarios
- Can be used to visualize organs in 3-D where there is not enough space for traditional translational stereo to function properly
- Demonstrations available upon request

**Patent Status:**

The technology is patent pending with fully preserved U.S. and worldwide patent rights available for licensing opportunities.

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**Fig. Using XSlit camera for scene understanding.** (a) Scene acquisition: the scene consists of two sets of parallel lines on different planes; (b) A perspective image; (c) An XSlit image; (d) We detect the two planes (highlighted in red and green) using the XSlit image.
3D Light Field Camera
(UD14-15)

Technology Description:

Conventional light field cameras maintain high spatial resolution however they suffer from poor angular resolution. The invention of this new 3D Light Field Camera solves this problem by combining a consumer DSLR camera, a cylindrical lens array attached to the sensor and a modified lens with a narrow-slit aperture. The 3D light field camera is capable of diverging rays in one direction while maintaining high spatial resolution in the other direction. Specifically, the cone of the rays that emit from the object will be converged and partially blocked by the narrow-slit on the main lens, becoming a fan of rays. Then these rays will be optically sorted by direction onto the pixels underneath the cylindrical lens array. The number of rays captured by our invention depends on the sensor’s resolution, which in our case is approximately $5,184 \times 3,456$. To use the 3D light fields, we have developed a tailored algorithm to generate images with parallax. Furthermore, we can print out the raw light field image on regular glossy photo papers and mount it on a cylindrical lens to produce 3D photographs. To our knowledge, this will be the first practical 3D photography technique that can allow users to directly perceive solid stereoscopic views from different perspectives without glasses. With the rapid growth of the 3D display technology, people are more likely to watch 3D content instead of 2D images. Our 3D light field camera goes much further than that: we can capture the 3D content directly from the scene and then display it. By attaching a cylindrical lens array to the sensor and a narrow-slit mask to the aperture, we can easily convert a consumer DSLR camera to a 3D light field camera. Consumers will be able to take pictures the same way with a conventional camera and produce a 3D image.

Benefits:

- Produces a 3D image without the use of glasses
- Unlike model based rendering, the image based rendering approach needs no geometry of the scene
- Consumers will be able to view the portrait from a different perspective on a computer screen and print out the raw light field image
- Product is inexpensive and portable, perfect for product advertising
- Product demos are available upon request

Patent Status:

The technology is patent pending with fully preserved U.S and worldwide patent rights available for licensing opportunities.
Micro-Scale Optical Sensing
(UD14-29)

Technology Description:

Micro-scale optical sensing could open up a door for innovations in optical sensing, photovoltaics, optical interconnections, and illuminations as well as many other areas of electrical and computer engineering. The present invention describes a novel method and apparatus for high efficiency optical sensing using micro-scale optical structures integrated with photodetectors and methods for making the same. Specifically, an example of implementing the present invention is described in the disclosure, which realizes high efficiency, low cost, and small form factor concentrating photovoltaics systems. This invention for the first time integrates wafer-level optical concentrating elements with solar cells in order to enhance conversion efficiency and reduce costs. Low cost manufacturing methods based on mature semiconductor processing technology and misalignment-tolerant integration are also disclosed.

Benefits:

- Provides novel high-efficiency low-cost photovoltaics using micro-scale optical concentrators at the wafer level
- Provide low cost, misalignment-tolerant fabrication and integration methods for high efficiency multijunction
- Significantly reduces the size of concentrating photovoltaic systems

Patent Status:

The technology is patent pending with fully preserved U.S and worldwide patent rights available for licensing opportunities.
Technology Description:

This application solves the problem of having to deploy expensive single-sensor-based networks to monitor vibrations of complex structures. The information captured in digital videos can be extracted and analyzed to quantify vibrations of structures and mechanical systems. This application is used to analyze the change of intensity of one pixel with a fixed (or Eulerian) coordinate. The information of several pixels can be combined as well with this application. The advantage here is that every pixel represents a candidate sensor and the sensor location can be changed after the data has been collected (i.e. the application is flexible). The method can be performed on a system with or without targets where targets consist of rectangular patches with gradient color patterns.

Benefits:

- Inexpensive
- Flexible in its application
- Performed contactless

Uses/Users:

- Analyze and quantify vibrations of structures and mechanical systems
- Applications exist in industries such as transportation infrastructure, automobile, and aerospace

Patent Status:

The technology is patent pending with fully preserved U.S. and worldwide patent rights available for licensing opportunities.
Technology Description:
This technology is related to optics and optical sensing. In particular, the present invention describes a novel method and apparatus for high-efficiency low-cost optical sensing using micro-scale optical structures integrated with photodetectors and methods for making the same. Specifically, an implementation of the present invention in photovoltaics is described, offering high efficiency, low cost, and small form factor micro-concentrating photovoltaics systems. The present invention integrates micro-solar cells with wafer-level self-aligned micro-optical concentrating/mechanical elements to enhance conversion efficiency and reduce costs. Low cost manufacturing methods based on mature semiconductor processing technology and misalignment-tolerant integration are also disclosed, which will benefit photodetection and illumination in various areas, such as optical sensing, photovoltaics, optical interconnects, illumination, etc.

Fig. An exemplary embodiment of the self-aligned optical concentrating photovoltaic system. (a) Perspective view. (b) An arrayed system consists of a plurality of such sub-modules: e.g., a layer of a lens array, a ball lens array, and a single substrate with an array of etched reflective cavities.

Benefits:
• High-efficiency low-cost optical sensing
• Single silicon wafer used for optical concentration, photovoltaic, and mechanical integration functionalities
• Simple molded front optic
• Can be employed on a flexible substrate/superstrate

Uses/Users:
• Optical sensing

Patent Status:
The technology is patent pending with fully preserved U.S. and worldwide patent rights available for licensing opportunities.
Examining Samples Under a Wide Range of Conditions
(UD07-21)

**Technology Description:**
This invention consists of a laser microscopy system built using a specially-designed microscope equipped with long working distance infinity-corrected objectives. This system allows one to perform high-resolution laser micro-spectroscopy analysis for samples mounted in hot, cold, high-pressure, vacuum, fluidic, or electrochemistry chambers. This system provides its users with an un-paralleled level of flexibility, allowing measurement of relevant properties in soft- or solid-state materials in temperatures ranging from 4 to 1750 K. This system provides complete laser-microscopy analysis at high spatial resolution of materials and devices inside an environmental chamber.

![Laser microscopy of cells.](image)

**Benefits:**
This system provides its users with increased resolution while being capable of imaging in a wide range of conditions. The optical ports can be changed to a straight or confocal configuration for increased flexibility.

**Patent Status:**
The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.

- U.S. Issued Patent (No. 7,817,275)
Technology Description:
This is a novel method to cost effectively integrate optical waveguides into a printed circuit board that can be used for interchip communication. Compared to photolithography, this method offers the advantage of using prefabricated waveguides, such as optical fiber, that has orders of magnitude less attenuation than photolithographically defined polymer waveguides.

Benefits:
• High speed data transmission for chips on the printed circuit board
• Less heat generation on the board
• Minimum cost compared to using photolithography, laser ablation, reactive ion etching and embossing techniques

Patent Status:
The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.

• Published U.S. (No. 2012-0128291)
Technology Description:

Distributed Bragg Reflectors have been the primary mirrors used to form laser cavities in silicon photonics platforms however this new invention has the potential to change that. This Sagnac Loop Mirror is an adjustable and easy to fabricate mirror for building lasers on silicon photonics platforms. Distributed Bragg Reflectors require ring resonator filters which require high lithography resolution and are extremely sensitive to fabrication variations. The novelty of this invention emerges in its ability to avoid the use of Distributed Bragg Reflectors, balance the cavity circulation power and output power, and decrease the loss of crucial sharp wavelength bends.

Benefits:

- Much easier to manufacture than Distributed Bragg Reflectors
- Can be implemented with little to no adjustment to ring or disk resonator format
- The filter could also be made tunable utilizing either thermal effect of free carrier plasma dispersion effect

![Schematic illustration of the Sagnac mirror based laser cavity](image)

Patent Status:

The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.
Technology Description:
The invention describes a simple and versatile method to fabricate high-index-contrast 3-D photonic devices on flexible substrates. The method leverages the amorphous nature and low deposition temperature of novel ChG alloys to pioneer a 3-D multilayer monolithic integration approach with dramatically improved device performance, processing throughput and yield. A mechanical theory was derived accounting for multiple neutral axes in one laminated structure to accurately predict its strain-optical coupling behavior. Through combining monolithic fabrication and local neutral axis designs, devices were fabricated that boast record optical performance ($Q=460,000$) and excellent mechanical flexibility enabling repeated bending down to sub-millimeter radius without performance degradation, both of which represent major improvements over state-of-the-art.

Benefits:
- Process readily adaptable to different glass composition with tailored optical properties to meet different applications
- Solves the problem of limited mechanical robustness on flexible electronic devices

Uses/Users:
- Structure is highly mechanically flexible, thus can be used in all flexible electronic devices where large deformation or bending cycles are required

Patent Status:
The technology is patent pending with fully preserved U.S. and worldwide patent rights available for licensing opportunities.
Machining Thin Film Lithium Niobate Using a Dicing Saw
(UD14-43)

Technology Description:
This invention involves a novel method for machining thin film Lithium Niobate from bulk wafers using an automated dicing saw. Unlike other dicing methods used to produce thin ridge waveguides, this method requires the release of thin fin like structures which are then bonded to a handle substrate for further processing. First, a cut more than halfway through the bulk Lithium Niobate is made which is then filled with a wax or epoxy, and the surface is polished flat. A second cut of the same depth but offset by the width of the blade and desired film thickness, is made which results in a tall and thin fin like structure supported by the filler material. The bulk material is then flipped over and a third wider cut is made all the way through the filler layer. The filler could either be removed using a solvent to produce thin film strips, or left fixed to the bulk material to create a thin film stack. The unique aspect of this method is the ability to produce fins fewer than 10 micrometers thick that can be released from the bulk material, bonded to a handle wafer and further processed. The method of producing strips is shown in the figure below.

Benefits:
• Allows the realization of a thin film using commercially available material and routine procedures
• Offers an alternate and efficient means of fabricating thin film lithium niobate
• Precise thickness of films can be attained

Uses:
• Fabrication of photonic devices, especially ultra-broadband electrooptic modulators

Patent Status:
The technology is patent pending with fully preserved U.S. and worldwide patent rights available for licensing opportunities.
**Technology Description:**

This invention relates to an innovative design of a safety electrical plug and receptacle that achieves two important features: 1) In a conventional AC environment, the receptacle is not energized until the plug is fully engaged, thus providing power only to the properly inserted male plug. 2) In a DC environment, the invention terminates the current before the plug is removed, thus preventing an arc from forming. The arc is a potential fire hazard and causes some of the metal at the tips of the prongs and the receptacle to vaporize, thus reducing the lifetime of the receptacle and causing pitting. Most efforts to devise a safer electrical receptacle have concentrated on quickly interrupting a live circuit when a trigger event occurs or on some sort of mechanical arrangement to prevent non-plugs from properly engaging the female contacts, which are often unreliable. This invention involves an optoelectronic circuit of easy implementation.

**Benefits:**

- Provides a safer electrical outlet
- Prevents an arc in a DC distribution system
- Reliable and easy to implement

**Patent Status:**

The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.

- U.S. Issued Patent (No. 8,770,998)
High-Speed Data Transfer for Underwater Communications
(UD10-30)

**Technology Description:**
This technology provides a method and an apparatus for high data rate communication between underwater platforms using acoustical signals. Sound waves have proved to be the most effective method of underwater data transmission due to a resistance to attenuation. Unlike electromagnetic and optical waves which suffer high attenuation in water due to the scattering physics of the environment, sound waves propagate very effectively. The method of the invention uses a multiple-element source and multiple-element receiver to transmit more data simultaneously, effectively increasing the data rate. Algorithms are provided for techniques to improve the accuracy of the transmission, and a prototype has been developed and tested in a coastal water environment.

![Source-receiver geometry](Fig. Source-receiver geometry)

**Benefits:**
- Higher data rates, range, and reliability than single element transmitter and receiver systems.
- Acoustic waves superior for underwater transmission than electromagnetic or optical methods due to attenuation and scattering of the latter in sea water.

**Patent Status:**
The technology is patent pending with fully preserved U.S. patent rights available for licensing opportunities.

- [Published U.S. (No. 2014-0098841)](#)
Technology Description:
Censoring, saturation, limit of detection, and quantization occur in all fields of science, engineering, economics, and data analysis. Traditional estimators become biased when variables are only measurable within a certain dynamic range. Use of this invention, The Tobit Kalman filter, allows for unbiased, real-time, recursive estimation of variables of interest beyond the dynamic range of the measurements. The Tobit Kalman filter produces accurate signal estimates and associated estimation uncertainty with low computational complexity.

Example Applications:

Benefits:
- Accurate signal estimation while using low cost, low power, and range limited sensors
- Real-time, recursive, not computationally intensive.
- Easily implemented on an embedded device.

Uses/Users:
- Reconstructing data from a low-cost sensors which suffer from drift, noise, and poor calibration.
- Tracking targets and their uncertainty when exiting the field of view of an imager.
- Tracking targets in an image frame behind occlusions (i.e. walls, tunnels, fences, clouds, etc.).
- Biological systems when measurement techniques lack sensitivity.
- Disease modeling and prediction.
- Economic modeling and prediction.
- Image reconstruction and depth estimation.
- Audio reconstruction.
- Poll analysis and model identification, allowing the possibility of real time intervention.
- Categorical and survey data analysis. Tracking trends and market statistics.

Patent Status:
The technology is patent pending with fully preserved U.S. and worldwide patent rights available for licensing opportunities.
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