



# INVENTIONS

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Technologies Available for Licensing

UNIVERSITY OF DELAWARE

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AGRICULTURE &  
FOOD SCIENCES

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### Live Attenuated Newcastle Disease Virus Vaccines and Preparation Thereof

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**Inventor:** Gelb, Jack Jr.  
**Patent Number:** 5,250,298  
**Issue Date:** October 5, 1993  
**Docket Number:** UD88-29 CON

Novel live, cold-adapted temperature-sensitive (CaTs), attenuated Newcastle disease virus vaccines are provided, which are effectively immunogenic and contain a mutant of a Hitchner B1 parent strain of Newcastle disease virus.

### Identification of Fat and Lean Phenotypes in Chickens Using Molecular Markers

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**Inventors:** Cogburn, Larry A.;  
 Carre, Wilfrid G.;  
 Wang, Xiaofei  
**Serial Number:** 11/013,546  
**Filing Date:** December 16, 2004  
**Docket Number:** UD04-11

The present invention relates to a method for identifying the phenotype of a chicken using a genetic polymorphism associated with a fat or lean phenotype. More particularly, the invention relates to a method of identifying a fat or lean chicken phenotype by determining the presence of an insertion/deletion associated with a fat or lean phenotype in one or both of the duplicated chicken Spot 14 genes, also referred to as thyroid hormone responsive Spot 14 protein paralogs.

### Endoparasitic Microorganism Infecting Plant Pathogenic Fungi Which Belong to the Deuteromycetes, Basidiomycetes, Ascomycetes, and Oomycetes

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**Inventors:** Evans, Thomas A.;  
 Esh, Ayman M.  
**Serial Number:** 60/799,602  
**Filing Date:** May 11, 2006  
**Docket Number:** UD06-14

This invention is a cytoplasmically inherited endoparasite that inhibits the growth of many plant pathogenic fungi including *Rhizoctonia solani*, *Fusarium* sp., *Pythium* sp., and *Phytophthora infestans*, organisms that are the cause of major diseases of vegetable and field crops. The organism is highly infectious towards the target organisms, affects the *in vitro* growth of the fungi by endoparasitism, and is capable of spreading rapidly through infected fungal hosts, severely infecting fungi within one to four weeks. Morphological characteristics of the infected fungus as well as the growth behavior are altered. All studies to date have been performed on *in vitro* cultures or greenhouse studies. Also, we have succeeded in infecting healthy fungi artificially in the laboratory and in curing them from the infection.





BIOMEDICAL SCIENCE

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### Miniaturized Immunosensor Assembled from Colloidal Particles Between Micropatterned Electrodes

**Inventors:** Kaler, Eric W.;  
Velev, Orlin D.

**Patent Number:** 6,333,200

**Issue Date:** December 25, 2001

**Docket Number:** UD98-19

Immunological tests for specific diseases, pathogens, or allergens are routinely used in hospitals, laboratories, food, drug, and environmental control, and others, and are typically carried out by latex agglutination. This method involves optical reading of the turbidity of a dispersion. These methods constitute a multi-billion dollar industry, which is rapidly growing now because of increased demand for better health care and environmental quality. Our invention provides a general means to replace the agglutination assays with sensors that can test simultaneously for the presence of different molecules in very small samples.

The invention is based on the use of standard micropatterned conductive electrodes connected to sensing elements. After the sensors are brought into contact with a solution containing the target molecules, a series of events leads to a signal that can be read directly by a computer.

We have tested our idea experimentally and shown that the device works as expected. The extreme miniaturization of the active area leads to very high sensitivity, which can be estimated as being at least 200 times higher than the agglutination assays available today. The device is disposable and relatively inexpensive. The invention can also be applied to test for DNA fragments and other genetic markers.

### Bioactive Peptides for Cell Adhesion

**Inventors:** Farach-Carson, Mary C.;  
Carson, Daniel D.;  
Safran, Jeffrey B.

**Serial Number:** 10/363,376

**Filing Date:** July 7, 2003

**Docket Number:** UD01-01

The invention is directed to a polypeptide derived from domain IV of the extracellular matrix protein perlecan that can selectively adhere cells, nucleic acids encoding the inventive polypeptide, vectors comprising the nucleic acids, devices comprising a scaffold coated with the inventive polypeptide, and methods of adhering cells to a scaffold using the inventive polypeptide.

### Uptake of the Sperm Adhesion Molecule 1 (SPAM1 or PH-20) by Mammalian Sperm Via Its Lipid Anchor in an *In Vitro* System

**Inventor:** DeLeon, Patricia A.;  
Chen, Hong;  
Zhang, Hong;  
Griffiths, Genevieve S.

**Serial Number:** 60/528,312

**Filing Date:** December 9, 2003

**Docket Number:** UD04-18

This invention deals with the transfer of biologically active SPAM1 to mammalian spermatozoa via secretory vesicles in an *in vitro* environment. SPAM1 is the most widely conserved mammalian sperm membrane protein and plays multiple roles in fertilization. The best of these functions is its hyaluronidase activity that is necessary for the dissolution of the cumulus cells that surround and form a barrier around the oocytes. SPAM1 is secreted *in vivo* in vesicles in the epididymal epithelium and *in vitro* in the medium of cultured cells in both a soluble and a membrane-bound form, the latter being in the form of epididymosomes. Sperm exposed to SPAM1 via epididymosomes, obtained after ultracentrifugation of the epididymal luminal fluid or culture medium, or in the form of a recombinant protein with its lipid anchor intact, acquire the protein after co-incubation. Transfer of SPAM1 to the surface of the sperm is vesicle-mediated and apparently similar to the epididymosome-spermatozoa interactions that occur *in vivo* during epididymal sperm maturation.

## Monoclonal Antibodies Recognizing Prox 1

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**Inventors:** Duncan, Melinda K.;  
Chen, Xiaoren;  
Cain, William

**Serial Number:** 60/710,921

**Filing Date:** August 24, 2005

**Docket Number:** UD05-08

Prox 1 is a protein that appears to regulate the transcription of genes important for the development of the ocular lens, the liver, the hair cells of the ear, and the lymphatic system. While polyclonal antibodies against Prox 1 have been created previously and used in numerous publications, stable, specific monoclonal antibodies against Prox 1 had not previously been reported. Prox 1 is one of the only known markers of the lymphatic system that has been proven consistently useful to tell lymphatic from blood vessels. Prox 1 is of interest to a number of research groups because of its role in the development of these systems. Further, Prox 1 monoclonal antibodies may have clinical applications since the presence of a lymphatic system in a tumor may be predictive of its metastatic potential since these vessels may allow the dissemination of tumor cells from a primary lesion to distant sites.

## Grow to Fit: Computational Method for Structure Prediction and Refinement of Protein and Protein-Ligand Complexes

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**Inventors:** Duan, Yong;  
Zhang, Hong

**Serial Number:** 60/752,776

**Filing Date:** December 21, 2005

**Docket Number:** UD06-15

The rough energy landscapes and tight packing of protein interiors are some of the critical factors that have prevented wide application of physics-based models in protein side-chain assignment and protein structure prediction in general. Complementing the Rota-meter based methods, this technology proposes an ab initio method that utilizes molecular mechanics simulations for protein side-chain assignment and refinement. By reducing the side chain, a smooth energy landscape was obtained due to the increased distances between the side chains. The side chains then gradually grow back during molecular dynamics simulation while

adjusting to their surroundings driven by the interaction energies. The method overcomes the barriers due to tight packing that limits conformational sampling of physics-based models. A key feature of this approach is that the resulting structures are free from steric collisions and allow application of all-atom models in the subsequent refinement. Tests on a small set of proteins showed nearly 100% accuracy on both  $X^1$  and  $X^2$  of buried residues, and 94% of them were within  $20^\circ$  from the native conformation, 79% were within  $10^\circ$ , and 42% were within  $5^\circ$ . However, the accuracy decreased when exposed side chains were involved.

## Method for Binding and Time Dependent Release of Heparin Binding Growth Factors Using Perlecan Domain 1 (PlnD1)

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**Inventors:** Farach-Carson, Mary C.;  
Carson, Daniel D.;  
Yang, Weidong

**Serial Number:** 60/813,537

**Filing Date:** June 14, 2006

**Docket Number:** UD06-22

This method relates to a recombinantly produced fragment of the extracellular matrix protein perlecan that consists of glycosylated domain 1 bearing heparin sulfate to which heparin binding growth factors can bind and then be released in a time dependent manner. In the absence of degrading enzymes that include heparanases or proteases, the growth factors remain bound to PlnD1 and are very slowly released. Release rates can be increased by the presence of these degrading enzymes either by exogenous addition or by natural action of these enzymes in tissues. This is a new use for PlnD1 that has previously been disclosed to act in concert with heparin binding growth factors to promote cartilage tissue differentiation.



### Protein Kinase – Inducible Domains

**Inventors:** Zondlo, Neal;  
Balakrishnan, Shalini

**Serial Number:** 60/787,589

**Filing Date:** March 30, 2006

**Docket Number:** UD06-27

Protein kinases and phosphatases are two classes of enzyme that modify proteins in cells by reversible addition or removal of a phosphate group on the protein, leading to changes in regulation and cellular control. Humans have over 500 kinases and 100 phosphatases, and changes in the activities of these enzymes have been implicated in most human diseases, particularly cancer, Alzheimer's disease and heart disease. Therefore a major class of emerging pharmaceuticals is kinase inhibitor, small molecules that block the actions of these enzymes. Small molecules that inhibit kinases have proven useful clinically, e.g., Gleevec to fight cancer. Approaches are necessary to understand the activities of the different protein kinases and phosphatases, to understand which kinases are most important for particular diseases. We have developed an approach to detect the activities of kinases by developing proteins whose structures depend on action by a particular protein kinase. The approach involves peptide ligands whose structures depend on action by a particular protein kinase. The approach involves peptide ligands whose structures, fluorescence, and magnetic properties depend on phosphorylation by protein kinases. The approach involves a new principle using phosphoserine and/or phosphothreonine to mimic glutamic acid residues, with the concomitant structure and properties of the proteins depending on whether the phosphorylated residue is present, indicating whether the particular kinase is active. The approach is designed to be applicable to the specific imaging of the activities of each of the individual protein kinases and phosphatases.

### Single-Wall Carbon Nanotube Device for Detecting Cancer Cells

**Inventor:** Panchapakesan, Balaji

**Serial Number:** 60/856,452

**Issue Date:** November 3, 2006

**Docket Number:** UD06-33

Monoclonal antibodies (mAb) specific to cell surface antigens over-expressed on cancer cells adsorbed to single-wall carbon nanotube (SWCNT) devices can bind to their antigens in a drop of buffer, resulting in a slight drop in conductance. However, detection of molecular signatures directly in live cancer cells using an electronic device has been elusive until now. This technology is the first application of nanotube-based electronic devices for targeting molecular signatures directly in cancer cells. Receptor-specific antibodies act as specific nano-switches that complete a circuit between the nanotubes and the cell-surface receptors, resulting in an increase in conductance of the device. Such devices might be able to detect circulating breast cancer cells in blood samples.

### Pan-Antagonists for the Androgen Receptor and Androgen Receptor Mutants Associated with Anti-Androgen Withdrawal

**Inventors:** Koh, JohnTze-Trun;  
McGinley, Paula L.

**Serial Number:** 60/832,897

**Filing Date:** July 24, 2006

**Docket Number:** UD06-35

This technology is based on the development of PLM1 (N-(4-cyano-3-(trifluoromethyl)phenyl)-2-hydroxy-2-methyl-3-(naphthalene-1-ylsulfonyl)propanamide), PLM2 (3-(2-benzylphenylsulfonyl)-N-(4-cyano-3-(trifluoromethyl)phenyl)-2-hydroxy-2-methylpropanamide) and related derivatives that are antagonists of the human androgen receptor and androgen receptor mutations associated with clinical failure of currently prescribed anti-androgens. PLM1 and its derivatives were uniquely designed to target AR mutations that are known to impart resistance to known anti-androgens used in cancer chemotherapy. As such, these analogs are believed to have the potential to delay the occurrence of anti-androgen withdrawal syndrome and to serve as a second line of defense in anti-androgen therapy when mutations to the androgen receptor give rise to anti-androgen withdrawal.

## Clusterin/ApoJ Facilitating the Delivery of GPI-Linked Membrane-Free Proteins to Mammalian Sperm Surface *In Vitro*

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**Inventors:** DeLeon, Patricia A.;  
Griffiths, Genevieve S.

**Serial Number:** 60/855,500

**Filing Date:** October 31, 2006

**Docket Number:** UD07-13

The invention relates to a method for effectively delivering membrane-free bioactive proteins with a lipid anchor (GPI-linked proteins) to the surface of epididymal or ejaculated sperm. The process is facilitated or promoted in the presence of Clusterin/ApoJ, a well-known lipid carrier, and the acquisition of these molecules, such as Sperm Adhesion Molecule 1 (SPAM1), can significantly impact sperm maturation and function. The invention is further directed to the previously unreported interaction between clusterin/ApoJ and SPAM1 in both the epididymal luminal fluid (ELF) and the uterine luminal fluid (ULF).

## Tag and Target Drug Delivery System

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**Inventors:** Naik, Ulhas P.;  
Millili, Peter G.

**Serial Number:** 60/921,119

**Filing Date:** March 29, 2007

**Docket Number:** UD07-17

The following invention is a novel drug delivery system containing an innovative approach to cancer cell targeting. Effective elimination of cancer cells can be achieved through a multi-staged process delivering cytotoxic agents with enhanced specificity. Combining the advantages of nanoparticle gene therapy with unique molecular biology approaches, this delivery system has the potential to significantly improve cancer treatment. Furthermore, the flexibility of this delivery system allows for individualized therapy, providing health-care professionals with multiple treatment options.

## Oligonucleotide-Directed Base Modification in *C. Elegans*

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**Inventors:** Kmiec, Eric B.;  
Parekh-Olmedo, Hetal

**Serial Number:** Provisional Filed

**Filing Date:** January 29, 2007

**Docket Number:** UD07-22

Single-strand DNA oligonucleotides can be used to alter the genomic sequence of DNA in the nematode *C. elegans*. The oligonucleotides are introduced using a bacterial carrier system and have been found to direct the repair of a single base mutation — the mutation site analog of the human mutation responsible for muscular dystrophy. The evidence shows clear indications of phenotypic changes in the movement of the worm.



CHEMICAL SCIENCE

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### Method of Cooling with an Endothermic Fuel

**Inventors:** Stiles, Alvin B.;  
Spadaccini, Louis J.;  
Marteny, Pierre J.;  
Colket, Meredith B., III

**Patent Number:** 5,176,814

**Issue Date:** January 5, 1993

**Docket Number:** UD91-14

A heat source, perhaps on a high-speed vehicle, may be cooled by transferring thermal energy from the heat source to an endothermic fuel decomposition catalyst in order to heat the catalyst to a temperature sufficient to crack or dissociate at least a portion of an endothermic fuel stream. The endothermic fuel is selected from the group consisting of normal paraffinic hydrocarbons and methanol. The heated endothermic fuel decomposition catalyst is contacted with the endothermic fuel stream at a liquid hourly space velocity of at least about 10 hr<sup>-1</sup> to cause the endothermic fuel stream to crack or dissociate into a reaction product stream.

### Carbon Molecular Sieve for the Kinetic Separation of Acid Gases and Fluorocarbons

**Inventors:** Foley, Henry C.;  
Mariwala, Ravindra K.;  
Manzer, Leo

**Patent Number:** 5,261,948

**Issue Date:** November 16, 1993

**Docket Number:** UD92-03

This is a method for the preparation of a carbon molecular sieve capable of separating acid gases and fluorocarbons of the formula CaHbXcFd, wherein a is from 1 to about 6, b is from 0 to about 13, c is from 0 to about 13, d is from 1 to about 14, and X is a halogen; on the basis of shape selectivity and size exclusion. A precursor resin is heated at about 0.2°C per minute to about 500°C. Then the resin is soaked at about 500°C for about six hours in flowing inert gas.

### Products Having Multiple-Substituted Polysiloxane Monolayer

**Inventors:** Wirth, Mary J.;  
Fatunmbi, Hafeez O.

**Patent Number:** 5,716,705

**Issue Date:** February 10, 1998

**Docket Number:** UD92-04 DIV

A protective monolayer is formed on, e.g., silica gel and glass surfaces comprising a monolayer of silicon and oxygen atoms, which is substituted with first and second hydrocarbyl substituents.

### Microencapsulation Process Using Supercritical Fluids

**Inventors:** Gelb, Jack;  
Shine, Annette Dudok

**Patent Number:** 5,766,637

**Issue Date:** June 16, 1998

**Docket Number:** UD96-14

The invention comprises a method for microencapsulating a core material comprising the steps of (a) mixing a core material with an encapsulating polymer; (b) supplying a supercritical fluid capable of swelling the polymer to the mixture under a temperature and a pressure sufficient to maintain the fluid in a supercritical state; (c) allowing the supercritical fluid to penetrate and liquefy the polymer while maintaining temperature and pressure sufficient to maintain the fluid in a supercritical state; and (d) rapidly releasing the pressure to solidify the polymer around the core material to form a microcapsule. This method requires neither that the polymer nor core materials be soluble in the supercritical fluid and can be used to rapidly and efficiently microencapsulate a variety of materials for a variety of applications.

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### Reactive Distillation Process for Free Radical Halogenation

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**Inventors:** Barnum, Chris S.;  
Blaisdell, Charles T.

**Patent Number:** 5,449,801

**Issue Date:** September 12, 1995

**Docket Number:** UD00-03

The present invention relates to a process for the selective, high-yield halogenation of particular silyl, phenyl, or carbonyl compounds under reactive distillation conditions which doesn't require recycling of the starting material.

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### Use of Hydrostatic Pressure to Inhibit and Reverse Protein Aggregation and Facilitate Protein Refolding

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**Inventors:** Robinson, Anne S.;  
Robinson, Clifford R.;  
Foguel, Debora;  
Silva, Jerson L.

**Serial Number:** 10/673,000

**Filing Date:** September 26, 2003

**Docket Number:** UD00-01

A novel approach is described for reversing aggregation and increasing refolding by application of hydrostatic pressure. A protein of interest in an aggregated, or inclusion body, or other non-native or inactive state is subjected to high hydrostatic pressure. This treatment dissociates the aggregated protein to states (or conformations) competent for refolding and results in increased formation of native protein once pressure is released. The technique can facilitate conversion of non-native proteins, including inclusion bodies and aggregates, to native proteins without addition of chaotropic agents, changes in buffer, or large-scale dilution of reagents required for traditional refolding methods.

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### Support Mesoporous Carbon Ultrafiltration Membrane and Process for Making the Same

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**Inventors:** Strano, Michael;  
Foley, Henry C.;  
Agarwal, Hans

**Patent Number:** 6,719,147

**Issue Date:** April 13, 2004

**Docket Number:** UD00-04

A novel supported mesoporous carbon ultrafiltration membrane and process for producing the same. The membranes comprise a mesoporous carbon layer that exists both within and external to the porous support. A liquid polymer precursor composition comprising both carbonizing and non-carbonizing templating polymers is deposited on the porous metal support. The coated support is then heated in an inert-gas atmosphere to pyrolyze the polymeric precursor and form a mesoporous carbon layer on and within the support.

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### An Undergraduate Teaching Lab: Transient Heat Conduction Using Thermocouples, Thermochromic Liquid Crystals, and Numerical Simulation

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**Inventors:** Prasad, Ajay K.;  
Stahl, Roger

**Patent Number:** 6,783,368

**Issue Date:** August 31, 2004

**Docket Number:** UD00-10

This is a novel experiment to demonstrate transient heat conduction for undergraduate students. The experiment provides a visual appreciation of temperature contours, along with quantitative measurements. Students also perform a numerical simulation of the transient conduction problem and compare results with the experiment.



### Micro Polymerization Catalyzed by External Acid Source

**Inventors:** Prather, Dennis;  
Yao, Peng;  
Schneider, Garrett;  
Murakowski, Janusz

**Serial Number:** 60/642,988

**Filing Date:** January 12, 2005

**Docket Number:** UD04-19

The invention is an alternative to conventional lithography for generating images in polymers which are widely used in today's lithography industry. Unlike the traditional way, which uses photon-generated acid to catalyze crosslinking, our method directly introduces acid to the resist from external sources. As a result, the final image is determined by the location of introduced acid and its diffusion profile. Curing resist by exposure with particular light may or may not be needed for the formation of the final structure.

### Formation of Selenide, Sulfide, or Mixed Selenide-Sulfide Films on Metal or Metal Coated Substrates

**Inventors:** Eser, Erten;  
Fields, Shannon

**Serial Number:** 60/620,352

**Filing Date:** October 21, 2004

**Docket Number:** UD05-10

The present invention disclosure shows that the root cause of the cracking of Mo films is the chemical reaction with Se, which reduces the yield strength of the film. Consequently, the solution is to inhibit this chemical reaction by limiting of the exposure of the Mo film to Se and by incorporating oxygen into the Mo at concentrations high enough to passivate against reaction with Se.

### Cobalt Containing Catalyst for NOx Trap Applications

**Inventors:** Lauterbach, Jochen;  
Snively, Christopher M.;  
Vijay, Rohit;  
Hendershot, Reed;  
Feist, Ben;  
Rivera-Jimenez, Sindia M.

**Serial Number:** 11/459,042

**Filing Date:** July 21, 2006

**Docket Number:** UD05-22

The addition of cobalt to exhaust after treatment catalyst formulations was found to substantially increase their nitrogen oxide (NO<sub>x</sub>) storage for both lean burn and Diesel exhaust conditions. The addition of cobalt to NO<sub>x</sub> storage and reduction (NSR) catalysts containing 1% w/w platinum and 15% w/w barium (1Pt/15Ba) on Al<sub>2</sub>O<sub>3</sub> has been studied. Under fuel lean conditions, the addition of Co more than doubled the NO<sub>x</sub> storage, as compared to conventional catalyst formulations. In addition, a noble metal free 5Co/15Ba catalyst was found to store NO<sub>x</sub> at least as efficiently as a conventional benchmark 1Pt/15Ba catalyst.

### Catalytic Microcombustors for Compact Power or Heat Generation

**Inventors:** Norton, Daniel G.;  
Wetzel, Eric D.;  
Vlachos, Dionisios G.

**Serial Number:** 11/451,113

**Filing Date:** June 12, 2006

**Docket Number:** UD05-29

A number of consumers, commercial and military applications require improved power sources for portable electronic equipment. Traditional batteries suffer from a number of limitations. In most applications, batteries are either too heavy or do not last long enough. Recharging times for reusable batteries are very slow (typically hours), and in fact the highest energy density batteries are single-use. Most battery chemistries also use heavy metals and other toxic materials, which present safety and health risk, as well as environmental disposal complications. This invention describes means of producing electricity from hydrocarbons by coupling a thermoelectric element with a catalytic microcombustor. These systems currently exhibit efficiencies comparable to conventional batteries, but with virtually instant

recharging (by simply adding more fuel) and negligible environmental impact. Due to the high energy density of hydrocarbons, these systems are also expected to eventually exhibit efficiencies significantly higher than traditional batteries. These micro reactors could also be useful for synthesis of chemicals with improved yield and catalyst lifetime, inherent safety, and increased effective rates (process intensification).

### Co-B Alloy: Preparation from Cobalt Oxides and Catalytic Performance for Hydrogen Production From $\text{NaBH}_4$

**Inventors:** Palanichamy, K.;  
Prasad, A. K.;  
Advani, S. G.

**Serial Number:** Provisional Filed

**Filing Date:** December 21, 2007

**Docket Number:** UD08-12

This invention involves the use of cobalt oxides as precursors for the preparation of inexpensive Co-B alloy catalysts which could replace the expensive Pt- and Ru-based catalysts for  $\text{H}_2$  generation from  $\text{NaBH}_4$ . The cobalt oxides will undergo chemical reduction in the presence of  $\text{NaBH}_4$  to generate catalytically active Co-B compounds. The Co-B compounds can either be prepared *in-situ* in the  $\text{H}_2$  generation reactor or they can be prepared *ex-situ* and added to the  $\text{H}_2$  generation reactor. The *in-situ* catalyst preparation will involve substantial time delays for  $\text{H}_2$  generation depending on the reactivity of the oxide material for the Co-B alloy formation. We propose to prepare the active Co-B compound outside of the  $\text{H}_2$  generator so that  $\text{H}_2$  generation could occur immediately on adding the catalyst to the  $\text{H}_2$  generator.

### Thin-Film Catalyst Templates for Hydrogen Generation from Chemical Hydrides

**Inventors:** Palanichamy, K.;  
Prasad, A. K.;  
Advani, S. G.

**Serial Number:** Provisional Filed

**Filing Date:** February 6, 2008

**Docket Number:** UD08-13

Chemical hydrides are an attractive source of  $\text{H}_2$  for the operation of  $\text{H}_2/\text{O}_2$  Polymer Electrolyte Membrane Fuel Cells (PEMFCs). Chemical hydrides have good volumetric, as well as gravimetric  $\text{H}_2$  storage capacity. Among the chemical hydrides, sodium borohydride ( $\text{NaBH}_4$ ) is desirable due to its high  $\text{H}_2$  content of 10.57 wt. % and the excellent stability of its alkaline solutions. Alkaline solutions of  $\text{NaBH}_4$  undergo hydrolysis in the presence of suitable catalysts to produce  $\text{H}_2$  that is free from any impurities. The rate of  $\text{H}_2$  generation could be regulated as per the demand. The catalysts currently employed for the hydrolysis of  $\text{NaBH}_4$  are based on precious metals such as Pt, Ru which are expensive. Recently, cobalt and nickel borides are being developed as inexpensive replacements for the Pt-, Ru-based catalysts. The unsupported boride catalysts, as well as those supported on common carrier materials are mainly prepared in powder form. The use of homogeneous powdered catalysts for  $\text{H}_2$  generation has inherent disadvantages such as:

1. Post-reaction separation and recycling of the catalyst from the viscous suspension is difficult;
2. The suspended particles tend to aggregate, especially at high concentration; and
3. Particulate suspensions are not easily applicable to continuous flow systems.

This invention proposes to prepare CoB, NiB, and CoNiB alloy catalysts in the form of thin films. Electroless and electroplating techniques will be employed for the preparation of thin film catalysts on substrates such as Ni, Cu or stainless steel (SS).



LIFE & MARINE SCIENCE

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### Delivery System for Heparin-Binding Growth Factors

**Inventors:** Carson, Daniel;  
Farach-Carson, Mary C.;  
Timpl, Rupert

**Serial Number:** 10/363,368

**Filing Date:** August 4, 2003

**Docket Number:** UD01-02

This process involves the novel use of a recombinant fragment of the heparan sulfate proteoglycan, perlecan, to bind and deliver growth factors. This fragment can be used either in soluble or insoluble forms or as a coating for various surfaces.

### Down-Regulation of Osteopontin

**Inventors:** Taber, Douglass;  
Malcolm, Scott C.;  
Farach-Carson, Mary C.;  
Xu, Yihuan

**Serial Number:** 10/446,218

**Filing Date:** May 28, 2003

**Docket Number:** UD01-03

(-)-Astrogorgiadiol, prepared by total synthesis, has been shown to downregulate the production of Osteopontin (OPN) messenger RNA.

### Methods and Compounds to Prevent Wood Deterioration in Marine Environments

**Inventors:** Sipe, Alison R.;  
Cary, Stephen C.;  
Wilbur, Ami E.

**Serial Number:** 10/474,621

**Filing Date:** June 24, 2004

**Docket Number:** UD01-29

Shipworms are important destroyers of wood in the marine environment. Wood users have long sought methods for preventing or limiting their attack. While heavy-duty wood preservatives are highly effective against these organisms, there is increasing concern about risks to non-target organisms. This has resulted in a gradual shift away from broadly toxic materials to either alternative materials or to woods with naturally durable heartwood. Naturally durable woods contain an array of chemicals that have the potential to target specific marine borer life stages. Shipworms are most

sensitive to toxins in the larval stage. One possible target for control is to inhibit the growth of a shipworm symbiont required for wood degradation. This symbiont, a cellulolytic nitrogen-fixing bacterium acquired vertically, might be sensitive to specific compounds present in naturally durable woods. In this study, the potential inhibition of the symbiont by extracts from the heartwood of various wood species was compared with that of *Aspergillus niger*. Only a few of the materials inhibited the organism, suggesting that the woods resist attack through more direct action against the marine borer.

### Rapid High-Throughput Screen for Detecting Biological Species in Ballast Water

**Inventors:** Cary, Steven Craig;  
Coyne, Kathryn J.

**Serial Number:** 60/331,335

**Filing Date:** October 30, 2001

**Docket Number:** UD01-31

This invention is a process that may be used to identify and enumerate invasive species in ship ballast water. It is a rapid, high-throughput process that is both accurate and sensitive. Biological species are size-fractionated by filtration and the DNA is extracted. Invasive species are detected by quantitative real-time polymerase chain reaction (PCR) using primers and probes specific to targeted organisms. Each species will be identified using a "tiered" approach through the use of general group-specific primer sets followed by genus- and species-specific primers. All of this may be done simultaneously on a single 96-well plate or on sequential plates that are scored for presence or absence of target organisms. Presence or absence of a given organism is determined by successful PCR amplification and detection on an instrument using a DNA intercalating fluorescent dye (i.e., Syber Green). Additionally, the concentration of each species of interest in the ballast water can be determined by the use of a series of spiked standards. Ninety-six well plates can be designed with an array of primers and probes including appropriate control wells to meet the needs of any given geographical region. These plates may be custom designed on the basis of potential or recognized threats and pre-packaged for use by laboratories that are equipped with real-time PCR machines. This process is particularly suitable for rapid identification of harmful algal bloom (HAB) species and invasive invertebrates (crab larvae, zebra mussels), as well as human pathogens (i.e., *Vibrio cholera*).

## Novel Potent Reversible Fatty Acid Oxidation Inhibitors

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**Inventors:** Thorpe, Colin;  
Wang, Wenzhong

**Patent Number:** 7,045,547

**Issue Date:** May 16, 2006

**Docket Number:** UD02-22

The invention describes a new strategy for a class of potent fatty acid oxidation inhibitors that are potential effective agents for treatment of diabetes and heart disease (e.g., anti-anginal therapies) with improved safety profiles. Excessive fatty oxidation has been implicated in these diseases, and inhibition of fatty oxidation has been shown to drastically alleviate symptoms of these conditions.

The new proposed inhibitors are both reversible and mechanism-based inactivators of the acyl-CoA dehydrogenases. Previously, these enzymes have not been successfully used as a target for modulating fatty acid oxidation activity. The new class of compounds reversibly, rapidly, and stoichiometrically modify the FAD cofactor of acyl-CoA dehydrogenases. Particular acyl-CoA dehydrogenase targets can be selected by manipulation of acyl chain length. However, the new development makes it feasible to design reagents that are sufficiently membrane permeable, resistant to hydrolysis, and, importantly, avoid the sequestration of cellular CoA. While the nature of the inhibitors is such that rapid degradation by competing isomerases is diminished, excess reagent can be eliminated by isomerization. Once inhibited, the acyl-CoA dehydrogenases regain activity with half-lives ranging from a few minutes to several days depending on the length of the acyl side chain and on the size of the pantetheine analog fragment. The precedents offer an unusually versatile way to modulate hydrolytic stability, lipophilicity, selectivity, reversibility, and enzymatic potency.

## Apparatus for Attracting Mosquitoes and Not Attracting Beneficial Insects To Electronic Bug Killers

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**Inventors:** Nosee, John G.;  
Kocsis, Terrill G.

**Patent Number:** 6,860,061

**Issue Date:** March 1, 2005

**Docket Number:** UD03-25

An apparatus for attracting mosquitoes to an electronic insect-killing machine (i.e., bug zapper) is provided. The apparatus includes a converter device that fits over a fluorescent or ultraviolet light bulb of the bug zapper. The converter device controls radiant light and heat emitted by the light bulb to produce a desired level of heat to create a warm mass, or host simulator, that simulates a blood host meal for biting insects. Mosquitoes and other biting insects, which have infrared vision, are attracted to the host simulator. When used with a scented lure that lures the mosquitoes and biting insects near the insect killer, the host simulator lures the mosquitoes and other insects to the killing device of the insect killer. The mosquitoes and biting insects are destroyed once lured to the killing device. The converter device also blocks most of the visible light emitted by the light bulb, and therefore does not lure beneficial insects, which are attracted to visible light, into the insect killer.

## A Process for Identifying Cellular RNAs that are Targeted for Cleavage by MicroRNAs (miRNAs)

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**Inventors:** Green, Pamela J.;  
Souret, Frederic;  
Kastenmayer, James

**Serial Number:** 60/557,276

**Filing Date:** March 29, 2004

**Docket Number:** UD04-02

This invention is a process for identifying RNAs that are targeted for cleavage by miRNAs. Briefly, we discovered that inactivation of the gene for a cytoplasmic 5' to 3' exonuclease, results in the accumulation of diagnostic RNA cleavage products (intermediates) corresponding to transcripts that are targeted for cleavage by complementary miRNA. Treatment of the mutant with a chemical that inhibits RNA synthesis can enhance the accumulation of the intermediate relative to that of controls.



### Removal of Waterborne Microorganisms And Disinfection Byproduct Precursors Using Elemental Iron

**Inventors:** Jin, Yan;  
Chui, Pei C.

**Serial Number:** 60/503,266

**Filing Date:** September 15, 2003

**Docket Number:** UD04-07

We have demonstrated that elemental iron can adsorb and inactivate water-borne viruses and remove disinfection byproduct (DBP) precursors such as natural organic matter (NOM). Results of our studies demonstrate that, within 15 minutes of effective contact time, elemental iron consistently achieved between 4-log and 5-log removal of two viruses and that most of the viruses removed by iron were inactivated. Our results also indicate that elemental iron can simultaneously remove natural organic matter such as humic acid from water. When water containing microorganisms and NOM comes into contact with elemental iron (e.g., as an active component in a filtration column), pathogens and NOM can be removed from water in a continuous fashion. These results suggest that elemental iron may potentially help disinfect water and wastewater, minimize use of chemical disinfectants such as chlorine, and prevent formation of toxic DBPs.

### Chemical Attractants in Horseshoe Crab, *Limulus Polyphemus*, Eggs: The Potential for an Artificial Bait

**Inventors:** Targett, Nancy M.;  
Ferrari, Kirstin M.

**Serial Number:** 60/537,538

**Filing Date:** January 20, 2004

**Docket Number:** UD04-25

This invention provides an artificial bait that serves as an alternative to the use of horseshoe crabs as bait for commercial eel and conch fisheries. In particular, the invention is directed to an artificial bait impregnated with metabolites from horseshoe crab eggs.

### An Artificial Bait Based on a Peptide Attractant Found in Horseshoe Crab, *Limulus Polyphemus*, Eggs

**Inventors:** Targett, Nancy;  
Costanza, Jennifer

**Serial Number:** 60/546,630

**Filing Date:** February 20, 2004

**Docket Number:** UD04-34

This invention relates to the isolation and characterization of the peptide attractant found in the eggs of *Limulus polyphemus* horseshoe crabs. More particularly, the invention relates to the identification of the characteristics of such attractant and the development of an independent source of the attractant based on the characterization.

### Process for Humane Euthanasia of Livestock in Confinement Facilities

**Inventors:** Benson, Eric R.;  
Malone, George W.;  
Alphin, Robert L.;  
Estevez, Inmaculada;  
Van Wicklen, Garrett L.

**Serial Number:** 60/759,666

**Filing Date:** January 18, 2006

**Docket Number:** UD05-01

The invention is a new process for existing equipment. Existing fire-fighting equipment (portable high expansion foam generator) was modified to promote maximum entrainment of a selected gassing agent. High expansion foam requires mixing of gas, water, and foam concentrate. In typical high expansion foam applications, ambient air and/or compressed air will be used as the gas for inclusion in the foam. For other applications, alternative gases, such as CO<sub>2</sub> and/or nitrogen, can be used.

For concept and procedural verification, an Ansul Mini-Fomax generator was used. A high pressure expansion nozzle was used to disperse the gas within the shroud to the generator. The shroud restricted gas entry from the front side of the generator, but did not limit gas entry from the rear of the generator. A 0 – 500 psig adjustable regulator was used to control the supply of gas to the foam generator. For this application, the gas could include ambient air, CO<sub>2</sub>, nitrogen, argon, and other gases. Mixed gas levels can range from 0% to 100% depending on application. Portable high expansion foam generators have been modified to promote inclusion of a single gas within the air-foam-water mixture. Foam generators have not been used to euthanize poultry or other animals.

The CO<sub>2</sub> and water supplies were manually controlled to adjust the gas level in the foam. Ansul Jet-X high expansion foam was used for the test. Foam samples were drawn at each test for analysis.

The invention is directed to a method for humanely euthanizing animals comprising:

1. Placing one or more animals into a substantially enclosed container;
2. Filling said container with a foam mixture comprising foam, a euthanizing gas, and water, whereby said foam mixture completely envelops the one or more animals in said container;
3. Allowing said foam container mixture to remain in said container until said one or more animals are euthanized; and
4. Removing the said foam and gas mixture from said euthanized animals.

### Use of *Kosteletzkya* for Production of Seaside Biodiesel Fuel

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**Inventors:** Gallagher, John L.;  
Seliskar, Denise M.

**Serial Number:** 60/670,139

**Filing Date:** April 11, 2005

**Docket Number:** UD05-14

The present invention relates to the use of *Kosteletzkya* in producing oil for use as biodiesel fuel. More specifically, the present invention relates to the use of salinized land or irrigation of non-saline land with saltwater for production of *Kosteletzkya* without using valuable freshwater resources.

### Geometric Registration of Image by Similar Transform Using 2-Ground Control Points

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**Inventors:** Kang, Q. Yong;  
Jo, Young-Heon;  
Yan, Xiao-Hai

**Serial Number:** 60/858,254

**Filing Date:** November 5, 2007

**Docket Number:** UD07-03

It is a new technique to obtain the geometric registration of an image using only 2-Ground Control Points. It will enhance present geometric registration processes, which require more than 3-Ground Control Points. Thus, this technique will provide wide ranges of applications to image analysis, especially for high spatial resolution of remote sensing images measured by multi-satellite sensors near coastal regions.

### Cloud-Free Vegetation Index

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**Inventors:** Kang, Q. Yong;  
Jo, Young-Heon;  
Yan, Xiao-Hai

**Serial Number:** 60/961,132

**Filing Date:** July 19, 2007

**Docket Number:** UD07-29

This is a new process to obtain cloud-free vegetation index from satellite measurements. Since vegetation index is simply estimated using the ratio of two satellite bands, unwanted signals are embedded, such as cloudiness, smoke or haze, and poor viewing angles. Accordingly, those properties can reduce the quality of the estimated vegetation index. In order to compensate for these, several days' vegetation index observations are composited for each pixel, with only the highest vegetation index value observed during the composite period being saved. Several days' composite may remove those signals, but there are still shallow cloud contaminations in vegetation index products. In order to remove cloud from vegetation index, we identify the coverage of cloud using land-surface temperature information. Because the cloud temperature is much lower than land surface temperature, we can identify cloud areas and thus can mask them out before computing vegetation index. Cloud-free vegetation information can be used to monitor environmental changes in agriculture and forest, etc.



### Estimation of Subsurface Thermal Structure Using Sea Surface Height and Sea Surface Temperature

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**Inventors:** Kang, Q. Yong;  
Jo, Young-Heon;  
Yan, Xiao-Hai

**Serial Number:** Provisional Filed

**Filing Date:** January 23, 2008

**Docket Number:** UD08-16

This patent is a new process to obtain subsurface thermal structure using sea surface temperature (SST) and height (SSH) measurements. Because of ocean dynamics, spatial features of subsurface temperature anomalies from sea surface to mixed layer depth (MLD) are strongly related with SST anomaly and those from MLD to upper thermocline depth are strongly related to SSH anomaly. Although a few studies showed that SST related to temperature in MLD, it has never been reported that subsurface temperature anomaly at a certain depth reflects SSH anomaly. Thus, we combined SST and SSH anomaly information using bilinear regression method to simulate and estimate continuous vertical subsurface thermal structure. Subsurface thermal information is useful in determining the trajectories of fish in open-ocean fisheries and in detecting ocean acoustic signals.





MATERIALS SCIENCE

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### High Modulus Polymers and Composites from Plant Oils

**Inventors:** Wool, Richard P.;  
Kusefoglu, Selim;  
Palmese, Guideppe;  
Khot, Shirikant;  
Zhao, Ralph

**Patent Number:** 6,121,398

**Issue Date:** September 19, 2000

**Docket Number:** UD98-01

The synthesis of liquid molding resins derived from plant oils that are capable of curing to high modulus thermosetting polymers and composites is described in this invention. The resins described resemble the unsaturated polyester, vinyl ester and epoxy resins presently used as the polymer matrix material in high performance glass, carbon, aramid and natural fiber reinforced composite materials. The resins disclosed herein are suitable for polymer and composite manufacture by Resin Transfer Molding (RTM), Reaction Injection Molding (RIM), Vacuum Assisted Resin Transfer Molding (VARTM), Seeman's Composite Resin Infusion Manufacturing Process (SCRIMP), Atmospheric Pressure Molding (APM), open mold casting, spray-up, Sheet Molding Compound (SMC) Bulk Molding Compound (BMC), filament winding, pultrusion, prepregs, lamination and compression molding. The resins in this invention are synthesized predominantly from plant — in particular, from the abundant and cheap, soybean — triglycerides with suitable comonomers and reactants that functionalize and render the plant triglyceride polymerizable. The polymerization reactions involve free radical initiated addition, condensation or ring opening polymerization. The functionalized triglycerides is used in conjunction with reactive diluents, accelerators, viscosity modifiers, cross-linking, toughening and coupling agents. The liquid resins are then mixed with initiators, catalysts and the reinforcing fibers and chain extended or cross-linked to give the final cured composite.

### Pressure-Sensitive Adhesives from Plant Oil

**Inventors:** Wool, Richard;  
Bunker, Shana

**Patent Number:** 6,646,033

**Issue Date:** November 11, 2003

**Docket Number:** UD01-24

This invention describes the synthesis of monomers and the subsequent polymers that are capable of being used in the pressure-sensitive adhesive (PSA) industry. The starting material is derived from plant oils such as high oleic soybean oil, olive oil, and other oils which are capable of being chemically functionalized. Specifically, the material is a fatty acid methyl ester that is esterified from a triglyceride molecule. This long aliphatic molecule resembles petroleum-based polymers such as 2-ethylhexyl acrylate and n-butyl acrylate, which are currently being used in the PSA market. The monomer and polymer disclosed comprise a new composition of matter and a new use for known and future genetically modified plant oils.

### Sheet Molding Compound Resins from Plant Oils

**Inventor:** Wool, Richard P.;  
Lu, Jue;  
Khot, Shrikant N.

**Patent Number:** 6,900,261

**Issue Date:** May 31, 2005

**Docket Number:** UD01-28

This present invention concerns the preparation of novel thermosetting resins derived from plant and animal oil triglycerides for use in sheet molding compounds. The starting materials are derived from sources such as, but not limited to, soybean oil, linseed oil, rapeseed oil, cottonseed oil, corn oil, palm oil, fish oil, canola oil, and peanut oil. These resins are produced by suitably functionalizing the triglyceride with chemical groups necessary for the SMC thickening process and polymerization reaction. Specifically, this liquid polymer composition contains a modified polyester oligomer having a carboxylic acid group and ethylenic unsaturation.

### Low Dielectric Constant Materials from Plant Oils and Chicken Feathers

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**Inventors:** Wool, Richard P.;  
Hong, Chang Kook

**Serial Number:** 10/621,727

**Filing Date:** July 17, 2003

**Docket Number:** UD02-46

This invention relates to the development of low dielectric constant materials from soybean oils and chicken feathers. Soybean resin such as acrylated epoxidized soybean oil (AESO) and soybean oil pentaerythritol glyceride maleates (SOPERMA) is mixed with a reactive diluent such as styrene monomer. After that, various concentrations of chicken feather fibers or the mats are mixed with the resin physically or using a vacuum assisted resin transfer molding (VARTM) process. The mixtures are then free-radically copolymerized to produce rigid composites. Surprisingly, the dielectric constants of the chicken feather composites are sufficiently low for electronic applications. Also, the mechanical properties of the composites are enhanced significantly with adding chicken feather fibers. The incorporation of chicken feather fibers gives rise to a considerable increase of stiffness of the soy oil-based composites. The density of the composites decreases with an increase of chicken feather fiber content. Soybean resin is based on triglycerides from soybean oil. Triglyceride oils can be derived from any plant oil such as linseed oil, rapeseed oil, cottonseed oil, corn oil, palm oil, and canola oil. This invention is not limited to chicken feathers and can be applied to any kinds of feathers. These new composites derived from renewable resources such as plant oils and chicken feathers are natural, bio-based, and environmentally friendly materials.

### Injection Gate and Vent System for Thermoset Resin in Liquid Composite Molding Processes Such as Resin Transfer Molding (RTM) or Vacuum Assisted RTM

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**Inventors:** Advani, Suresh G.;  
Devillard, Mathieu;  
Lawrence, Jeffrey

**Serial Number:** 60/444,944

**Filing Date:** February 5, 2003

**Docket Number:** UD03-21

This invention is a new system invented for delivering any curing fluid such as a thermoset resin to various injection locations distributed over the molding surface and also venting the mold cavity. To deliver the fluid to all of the injection locations needed, a channel-based resin delivery system was designed. This will distribute the fluid provided by a single fluid source to various locations. The same way, an independent and similar vent channel will let the air escape out of the mold at various vent locations when resin is injected or infused into the mold cavity.

### Aligned Carbon Nanotube Composite Ribbons and Their Production

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**Inventors:** Chou, Tsu-Wei;  
Thostenson, Erik T.

**Serial Number:** 60/492,904

**Filing Date:** August 6, 2003

**Docket Number:** UD03-35

This invention describes a technique by which carbon nanotubes can be uniformly dispersed in a polymer and subsequently fabricated in macroscopic nanotube/polymer ribbons having nanotubes aligned in a primary direction. The technique is readily scalable and could be applied to the fabrication of larger-scale structural/functional materials and devices.



### A Monolithic Hurricane-Resistant Roof Made from Low-Density Composites

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**Inventors:** Wool, Richard P.;  
Dweib, Mahmoud A.;  
Shenton, Harry W.;  
Chapas, Richard

**Serial Number:** 60/512,546

**Filing Date:** October 17, 2003

**Docket Number:** UD04-17

This invention describes novel composites and processing to make large-scale monolithic housing structural components. A monolithic roof structure was designed, and scale-model prototypes were manufactured and tested. Plant oil-based resins and natural fibers such as, but not limited to, flax, hemp, pulp, and cellulose fibers from recycled paper and wood pulp in the form of mats were used; a vacuum-assisted resin transfer molding process (VARTM) was used to manufacture composite materials of up to 50% fiber weight fraction.

### A Method for Producing Thin Films

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**Inventors:** Birkmire, Robert W.;  
Eser, Erten;  
Hanket, Gregory;  
McCandless, Brian E.

**Patent Number:** 6,676,994

**Issue Date:** January 13, 2004

**Docket Number:** UD00-09

Thin films are produced by a method wherein a material is heated in a furnace placed inside a vacuum system. An inert gas is flown over/through the heated material. The vapors of the material are entrained in the carrier gas which is then directed onto a substrate heated to a temperature below that of the furnace temperature and placed in close proximity to the exit of the furnace.

### Active and Adaptive Photochromic Fibers, Textiles, and Membranes

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**Inventors:** Rabolt, John A.;  
Bianco, Andrea

**Serial Number:** 60/553,513

**Filing Date:** March 16, 2004

**Docket Number:** UD04-36

This invention encompasses the incorporation of reversible photochromic molecules (e.g., dyes) into micro- and nanofibers through the electrospinning process. In this process, a solution of a polymer (such as polymethylmethacrylate (PMMA) and the photochromic molecule is shaped into a small-diameter fiber by the application of electrostatic forces using electric fields that vary, for example, from 300–2,000 volts per centimeter. The resulting fibers are collected on a target that can be electrically grounded or held at a voltage lower (or oppositely charged) than that of the “nozzle” where the droplet of polymer/photochromic molecule first emerges from the reservoir of solution. The fibers have diameters that range from 1–2 microns to hundreds of nanometers and have been shown to contain a uniform distribution of photochromic molecules throughout. Mats, membranes, and non-woven textiles formed from these fibers have been shown to reversibly change color depending on the wavelength of light they are exposed to. Uses range from nonwoven textiles and membranes that change color depending on the amount of wavelength of light impinging on them from optical switches and sensors.

## Multifunctional and Biologically Active Matrices from Multi-Component Polymeric Solutions

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**Inventors:** Kiick, Kristi L.; Yamaguchi, Nori; Rabolt, John F.; Casper, Cheryl L.

**Serial Number:** 60/666,787

**Filing Date:** March 31, 2005

**Docket Number:** UD05-17

The invention is a novel strategy for the incorporation of low molecular weight, biologically active molecules (or molecules with other activities, e.g. sugars, peptides, polysaccharides, polypeptides, dyes, electroactive groups, etc.) into a fibrous or other matrix. The biological (or other) molecules are conjugated to an intermediate molecular weight polymer (e.g., but not limited to: linear, star, hyperbranched) to allow retention of the biomolecule in its bioactive form in fibers and other forms of polymeric materials (e.g., films, gels, solids, particles, etc.). The invention is currently demonstrated with a heparin-modified star copolymer incorporated into electrospun fibers. Attachment of active molecules to intermediate molecular weight polymers is necessary to permit retention of the molecules in the material over time scales relevant for biological and other potential applications. The choice of intermediate molecular weight polymer will permit control over retention and release rate of the molecule or other active species.

## Comfortable Ballistic Resistant and Protective Composite Materials Composed of Shear Thickening Fluids Reinforced by Fillers Such as Fibers

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**Inventors:** Wagner, Norman J.; Wetzel, Eric D.

**Serial Number:** 60/651,417

**Filing Date:** February 09, 2005

**Docket Number:** UD05-21

The protective properties of STF's can be greatly enhanced, while maintaining their comfortability and flowability, by reinforcing STF's with short, discontinuous, high strength fibers. These novel blends consisting of STF's with various types of short fibers selected to impart specific properties to the resulting fluids provides a number of significant benefits to the composite material. For example, we believe that adding these fibers provides tensile strength to the STF, and allows more efficient load transfer throughout the

material. However, because the fibers are short, the deformability and flowability of the STF can be greatly maintained. Additional benefits include increased stress transfer upon impact transmitted to the STF by the addition of high modulus, stiff short fibers. Such materials are anticipated to have significant benefits as compliant, processable, and flowable ballistic, puncture, stab, and shock resistant materials.

## An Automated Process for Embedding Optical Fibers in Woven Composites

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**Inventors:** Goossen, Keith; Wetzel, Eric D.; Caruso, Richard P.

**Serial Number:** 1/557,617

**Filing Date:** November 8, 2006

**Docket Number:** UD05-31

This invention relates to a completely automated process for embedding optical fibers in fiberglass yarn, which could be used as a yarn in textile processing, allowing automated embedding of optical fibers in textiles and woven composites.

## Wireless Optical Communication to Optical and Electrical Networks Embedded in Composites

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**Inventors:** Goossen, Keith; Yarlagadda, Shridhar; Wetzel, Eric D.; O'Brien, Daniel

**Serial Number:** 60/726,116

**Filing Date:** October 10, 2005

**Docket Number:** UD06-03

Composite structures with embedded sensing and communication busses are being widely explored. However, coupling external devices to the embedded optical and electrical cables in composites using physical connectors is cumbersome and prone to mechanical failure. A novel approach of wireless optical coupling to optical fibers and cables embedded in composites is presented. An assembly consisting of optical transceivers connected to a coaxial cable or optical fiber is embedded inside the composite. These embedded transceivers can be remotely sensed by external optical transceivers, so that signal coupling to the composite can be achieved without a physical connection. A micro-coaxial cable link with the optical transceivers embedded in the resin



has been demonstrated. Systems that do not require electrical power have also been designed to simplify operation. One of the possible design implementations for this approach is to include an embedded transceiver which draws its power from the outside optical transmitter. Another approach is to use embedded optical fibers with impregnated fluorescent dye. The dye fibers convert an external visible (light-emitting diode) signal into wave guided light which is transmitted in the fiber. The response of embedded optical fibers with impregnated fluorescent dye has been measured to be microseconds or less, thus supporting data rates of at least a few megabits per second. With the wireless optical implementation, sensing and communication to embedded optical and electrical networks is enabled with minimum physical invasiveness.

#### Vacuum Assisted Resin Transfer Molding Techniques with Flow Flooding Chamber

**Inventors:** Advani, Suresh G.;  
Vernin, Nicholas;  
Chohra, Mourad

**Serial Number:** 11/458,122

**Filing Date:** July 18, 2006

**Docket Number:** UD06-04

This invention is a new improvement for the resin delivery in a composite manufacturing process called Vacuum Assisted Resin Transfer Molding (VARTM). The object of the invention is to provide a solution to circumvent the need for distribution media to achieve low injection times. Thus, the desired composite part can be created with injection times that are comparable to when one uses a distribution media, but as our process does not use the distribution media there is no wasted material in terms of distribution media and peel-ply. In addition, there is a savings in time and labor since one does not have to manually place the peel ply and distribution media on top of the preform and remove it after the part has cured. Also, there is a savings in the resin quantity used, as most of the resin that goes into the distribution media and the peel ply is wasted.

In accordance with this invention a flow channel is placed on the top face of the fabric preform creating a Flow Flooding Chamber (FFC) to accelerate the resin flow and reduce the injection time. To accomplish this, we locally lift the bag using a rigid, external vacuum chamber, which is placed on top of the bag during injection.

#### Preparation of Polyolefin Class of Polymers from Electrospinning Process

**Inventors:** Rabolt, John F.;  
Lee, Keun-Hyung;  
Givens, Steve R.

**Serial Number:** 11/562,797

**Filing Date:** November 22, 2006

**Docket Number:** UD06-16

The invention relates to a process for producing a porous membrane with polyolefin classes of polymers using the electrospinning process. These polyolefin membranes and/or membranes made from poly-olefin, their copolymers, and/or their polymer blends have a high surface area, small pore size, soft feel, flexibility, and possess the possibility of producing three-dimensional structures for use in filtration, protective textiles, and gas separation, etc.

Polyolefin, poly- $\alpha$ -olefin, their copolymers, and/or their polymer blends are completely dissolved in a multi-component solvent system to form a clear solution when heated from room temperature to 120°C depending on the polymer type, molecular weight, and solvent system used. Upon cooling slowly from 120°C to 25°C – 50°C under ambient conditions, a clear solution is obtained and is then used to electro-spin polymer micro- and nanofibers.

The polymer component is a single polyolefin or a mixture of polyolefins, where the polyolefins also include polyolefin copolymers and/or modified polyolefins. Mixtures of different polyolefins are interesting due to varying physical properties such as mechanical, physical, and thermal characteristics. For example, by adding a certain amount of poly(4-methyl-1-pentene) in poly(1-butene), thermal characteristics can be influenced, while adding certain amounts of a polyolefin with a high molecular weight can increase mechanical properties. In this case, high molecular weight polyolefins must be soluble in the solvent used.

## An Automated Process for Embedding Optical Fibers in Fiberglass Yarns

**Inventors:** Goossen, Keith;  
Wetzel, Eric D.;  
Caruso, Richard P.

**Serial Number:** 60/734,849

**Filing Date:** November 9, 2005

**Docket Number:** UD06-17

The invention relates to a completely automated process for embedding optical fibers in woven fabrics in both warp and weft directions. These fabrics were embedded in resin using a vacuum infusion process, resulting in a structural composite with integrated optical conduit with less than 1dB optical loss. Conventional connectorization techniques for optical fibers require polishing steps which increase the labor, cost, and complexity associated with integrating waveguides into composite structures. A novel technique for connectorization of optical fibers is demonstrated which requires no polishing, short times, and simple tooling. The combination of automated optical fiber introduction and non-polishing connectorization should enable low-cost incorporation of optical buses into structural composites.

In one embodiment of the invention, the actuator device contains a material with first optical absorption coefficient greater than the material with second optical absorption. In another embodiment, the actuator device contains a first optical absorption coefficient lower than the second optical absorption coefficient. In yet another embodiment, the actuator device is capable of achieving strains of 0.3% to 3.75% per watt of optical energy. This is significantly better than most piezoelectric materials that are used today for actuation. Further, the optical energy necessary for actuation is significantly smaller compared to hundreds of volts necessary for piezoelectric mechanical actuation technologies. In general, the present invention relates to techniques for integrating optical fiber into composite structural materials for embedded sensors and communication links. Such structures where optical fibers exist embedded in structures have existed previously. The present invention, however, relates to the method of introduction. In accordance with the invention, the fiber can be introduced in an automated fashion into composite structural materials which have as one of their components a woven fabric. Such fabrics are akin to textiles and, in fact, the invention could be used where the fabrics are textiles. The invention could also be practiced where the fabrics are armor-related fabrics such as woven fiberglass. In such practice of the invention, a spool of optical fiber can replace a spool of fiberglass in the weaving machinery. One aspect of the invention is the method of integrating optical fiber into woven materials in an automated fashion by replacing the spool of yarn by a spool of optical fiber in the weaving machine.

## Thermal Detection of Air Leakage in Vacuum Infusion Processes

**Inventors:** Zhou, Fuping;  
Alms, Justin B.;  
Corlay, Chalotte;  
Advani, Suresh

**Serial Number:** 60/746,156

**Filing Date:** May 01, 2006

**Docket Number:** UD06-25

The Vacuum Assisted Resin Transfer Molding (VARTM) process is an increasingly popular type of Liquid Composite Molding. In VARTM, resin is drawn into a mold by vacuum and distributed evenly along a line in order to impregnate the fibers which are placed in a mold. There are four steps in the process: First, the fabric preform is cut to the desired size; then it is placed on a one-sided mold. Second, a bagging film is positioned around the fabric and adhered with tacky tape to the mold surface. Third, the resin is drawn into the mold until the fabric is saturated. In the final step, the injection is closed but the vacuum is maintained until the resin cures, and then the solid composite is extracted from the mold.

During the VARTM process, checking the vacuum level is standard procedure especially when a huge part is being made. Any air leakage into the mold will introduce voids in the composite and will result in the part being discarded. The inventive method is to detect air leakage in any Vacuum Infusion process with a heat gun. A heat gun is used to produce hot air around 300°F. Hot air is distributed along the interface of the bagging film, tacky tape, and mold surface or is pumped into the mold itself. If there is any air leakage, hot air will be infused into or expelled out of the bagging from that region. This higher temperature of the hot air near the leaking region can be detected by an infrared camera very effectively, allowing one to seal the leak before introducing the resin into the mold.



### Multifunctional and Biologically Active Matrices

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**Inventors:** Kiick, Kristi L.;  
Yamaguchi, Nori;  
Rabolt, John F.;  
Casper, Cheryl

**Serial Number:** 60/833,994

**Filing Date:** July 28, 2006

**Docket Number:** UD06-29

This technology relates to a biologically active functionalized electrospun matrix to permit immobilization and long-term delivery of biologically active agents. In particular the invention relates to a functionalized polymer matrix comprising a matrix polymer, a compatibilizing polymer and a biomolecule or other small functioning molecule. In certain aspects the electrospun polymer fibers comprise at least one biologically active molecule functionalized with low molecular weight heparin. Examples of active molecules that may be used with the multi-component polymer of the invention include, for example, a drug, a biopolymer, a growth factor, a protein, a nucleotide, a polysaccharide, a biological macromolecule or the like. The invention is further directed to the formation of functionalized crosslinked matrices, such as hydrogels, that include as least one functionalized compatibilizing polymer capable of assembly.

### Emulsification of Concentrated Dispersions of Colloidal and Nanoparticles

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**Inventors:** Wagner, Norman J.;  
Nam, Caroline H.

**Serial Number:** 60/811,339

**Filing Date:** June 6, 2006

**Docket Number:** UD06-32

A novel method to emulsify dispersions into an immiscible or partially miscible carrier fluid is a new process that was inspired by the need to improve coating conditions of shear thickening fluids to ballistic grade fabrics such as Kevlar®. The methods entail the use of a co-solvent such as heptane to lower the viscosity of the particle dispersion and a surfactant dissolved in an immiscible carrier fluid, such as water. Different techniques can be used to achieve an emulsion: sonication and/or mechanical mixing.

### Novel Hydrogels and Uses Thereof

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**Inventors:** Schneider, Joel;  
Pochan, Darrin J.;  
Rajagopal, Karthikan;  
Haines-Butterick, Lisa

**Serial Number:** Provisional Filed

**Filing Date:** November 14, 2006

**Docket Number:** UD07-05

The present invention provides novel hydrogels and methods of making and using such hydrogels. The present invention provides hydrogels that may be formed by the self-assembly of peptides in solution; such self-assembly may be brought about by a change in one or more characteristics of the solution. Characteristics of the solution that may be changed include pH, ionic strength, temperature, and concentration of one or more specific ions. In addition, hydrogels of the invention may be disassembled by changing one or more characteristics of the hydrogel such as pH, ionic strength, temperature, and concentration of one or more specific ions.





MEDICAL DEVICES

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## Mouth Mouse

**Inventor:** Manal, Kurt  
**Serial Number:** 10/864,491  
**Filing Date:** June 10, 2004  
**Docket Number:** UD03-26

The mouth mouse is a novel method for controlling a computer mouse by sliding your tongue on the roof of your mouth. The mouth mouse has a number of force sensitive sensors embedded in a dental retainer. The sensors detect the magnitude and location of the force applied by the user's tongue, and based on these forces, custom software moves the mouse pointer on the computer screen.

## A Gravity Balancing Leg Orthosis for Robotic Rehabilitation

**Inventors:** Agrawal, Sunil K.;  
 Fattah, Abbas;  
 Banala, Sai  
**Serial Number:** 11/113,729  
**Filing Date:** April 25, 2005  
**Docket Number:** UD04-21

Gravity balancing is often used in industrial machines to decrease the required actuator efforts during motion. In the literature, a number of methods have been proposed for gravity balancing that include counterweights, springs, and auxiliary parallelograms that determine the center of mass. However, these concepts have not yet been seriously applied to rehabilitation machines. This invention presents the underlying design and fabrication of a gravity-balance orthosis (GBO) for the human leg that can fully or partially balance the human leg over the range of its motion. This design combines the use of auxiliary parallelograms to determine the center of mass along with springs to achieve a full or partial gravity balanced orthosis design.

## Activating a Non-Isometric Functional Movement Through Electrical Stimulation

**Inventors:** Binder-Macleod, Stuart A.;  
 Perumal, Ramu;  
 Wexler, Anthony S.;  
 Ding, Jun  
**Patent Number:** PCT/US2006/004969  
**Issue Date:** February 10, 2006  
**Docket Number:** UD05-20

One embodiment of the present invention provides a system that determined the activation patterns needed to excite a muscle to produce a desired functional movement using transcutaneous electrical stimulation. During operation, the system first obtains the subject specific parameter values to be used by a non-isometric force motion model. Next, the model is used to define the subject specific activation pattern that will produce a predefined functional movement in response to electrical stimulation of the muscle. The system then applies the computed electrical stimulation to the muscle to produce the desired functional movement in the subject and makes appropriate adjustments in the stimulation pattern to compensate for any errors in the original computation or changes in subject's responsiveness to stimulation.

## Two Degree-of-Freedom Ankle-Foot Orthosis

**Inventors:** Agrawal, Sunil K.;  
 Agrawal, Abhishekl;  
 Banala, Sai K.;  
 Binder-Macleod Stuart A.  
**Serial Number:** 11/453,386  
**Filing Date:** June 15, 2006  
**Docket Number:** UD05-26

An ankle-foot orthosis (AFO) is commonly used to help subjects with weakness of ankle dorsiflexor muscles due to peripheral or central nervous system disorders. Both these disorders are due to the weakness of the tibialis anterior muscle which results in lack of dorsiflexion assist moment. The deformity and muscle weakness of one joint in the lower extremity influences the stability of the adjacent joints, thereby requiring compensatory adaptations. We have designed an innovative ankle-foot orthosis (AFO) that allows two degree-of-freedom motion to the ankle, while serving to maintain proper foot positions for subjects during walking. The prototype AFO would introduce greater functionality over currently marketed devices by means of its inversion-eversion degree-of-freedom in addition to flexion-extension. This invention is a new device. It is a significant improvement to existing AFOs by providing an additional inversion-eversion degree-of-freedom.

## Passive Gravity-Balanced Assistive Device for Sit-to-Stand Tasks

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**Inventors:** Agrawal, Sunil K.;  
Fattah, Abbas;  
Catlin, Glenn;  
Hamnett, John

**Serial Number:** 60/748,429

**Filing Date:** December 8, 2005

**Docket Number:** UD06-12

Sit-to-stand (STS) is one of the most common daily activities, which is also a pre-requisite for other functional movements that require ambulation. STS activity is mechanically demanding, and it is estimated that, in the United States, more than two million people over age 64 have difficulty in rising from a chair.

A machine is said to be gravity balanced if joint actuator torques are not needed to keep the system in equilibrium in any configuration. Gravity balancing is often used in industrial machines to decrease the required actuator efforts during motion. A number of methods have been proposed for gravity balancing that include counterweights, springs, and auxiliary parallelograms that determine the center of mass. However, these concepts have rarely been applied to rehabilitation machines, which generally require externally supplied power to function and thereby pose increased risk to the user.

STS motion is primarily a planar activity, and gravity balancing is a useful principle that can assist a user in this activity. A gravity-balancing apparatus does not require power and keeps the human body in neutral equilibrium during the entire range of motion, enabling a person to stand up from a chair without significant effort.

According to one exemplary embodiment, the present invention provides a passive gravity-balancing assist device for sit-to-stand motion. The design combines the use of auxiliary parallelograms to determine the center of mass along with springs connecting the center of mass to an inertially fixed frame so that the total potential energy of the system is constant during sit-to-stand motion. The passive gravity-balancing assistive device minimizes risk to the user and may be employed as a rehabilitative aid, a training device, an evaluation tool for the study of sit-to-stand motion, or other related uses.

## Passive Swing-Assist Exoskeletons for Motor-Incomplete Spinal-Cord Injury Patients

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**Inventor:** Agrawal, Sunil K.

**Serial Number:** Provisional Filed

**Filing Date:** April 6, 2007

**Docket Number:** UD07-20

This patent application describes the design of a passive swing-assist orthosis for gait training of spinal-cord injury patients. Through simulation of a swinging leg, spring parameters on the exoskeleton are optimized so that it provides the propulsion force required by a subject during walking. Experiments have been performed with healthy subjects walking on a treadmill. In the coming months, this passive orthosis will be used for gait learning of spinal cord injury patents.

## Intelligent Powered Mobility for Special Needs Children

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**Inventors:** Agrawal, S. K.;  
Galloway, J.;  
Ryu, J.-C.

**Serial Number:** Provisional Filed

**Filing Date:** October 3, 2007

**Docket Number:** UD08-15

Our current mobile robot prototype, the “UDI” uses a commercial robot, adapted to seat an infant with a joystick. The UDI is equipped with an on-board computer, odometry to record its movements, an array of sensors on its periphery to determine the obstacle-free area around it, and a wireless communication link to a host computer to continuously transfer position data. Using joysticks, UDI can be either manually driven by the infant or a caregiver. In addition, using in-house developed intelligent software, it can be autonomously or semi-autonomously driven safely while avoiding obstacles. Our current data collection with UDI only utilizes the manual drive capability of the robot. Our next generation prototypes will have additional capabilities to enhance training and assessment of infant learning, such as:

1. Semi-autonomous navigation of the robot to respond to infant joystick commands and obstacles in the environment;
2. Development of a force-field joystick to train an infant to navigate within a cluttered environment;
3. “Virtual leash” to allow the robot to autonomously follow a parent within a selected leash radius while navigating in an indoor or outdoor environment.



PHYSICS/ELECTRONICS/  
COMMUNICATION

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### **Metal-Insulator-Semiconductor Field Effect Transistor Having an Oxidized Aluminum Nitride Gate Insulator Formed on a Gallium Nitride or Silicon Substrate, and Method of Making the Same**

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**Inventors:** Kolodzey, James;  
Olowolafe, Johnson

**Patent Number:** 6,593,194

**Issue Date:** July 15, 2003

**Docket Number:** UD96-15 DIV

This invention comprises a novel composition of electronic insulating material and methods for preparing same. This new insulator is suitable for use in the implementation of field effect transistors and other electronic devices for integrated circuit applications, especially for group III nitride-based semiconductors. One implementation would involve fabricating field-effect transistors directly on Gallium-Nitride substrates and integrating the transistors with GaN blue lasers to achieve desired opto-electronic logic circuitry. This novel composition is especially desirable because it is stable at normal integrated circuit processing temperatures and because its insulating qualities are very good (e.g., its relative dielectric constant is near 12). In other words, the insulator has device-grade characteristics.

### **New Watermarking Methods for Digital Images and Videos Based on Wavelet Transforms**

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**Inventors:** Xia, Xiang-Gen;  
Boncelet, Charles G.;  
Arce, Gonzalo R.

**Serial Number:** 6,556,689

**Filing Date:** April 29, 2003

**Docket Number:** UD97-16

This invention comprises a new method for secretly imbedding a source identification into a digitized image without adversely affecting the perceived image.

### **Method and Apparatus for Spread Spectrum Image Steganography**

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**Inventors:** Boncelet, Charles G.;  
Marvel, Lisa M.;  
Retter, Charles T.

**Patent Number:** 6,557,103

**Issue Date:** April 29, 2003

**Docket Number:** UD98-16

The Spread Spectrum Image Steganography (SSIS) of the present invention is a data hiding/secret communication steganographic system which uses digital imagery as a cover signal. SSIS provides the ability to hide a significant quantity of information bits within digital images while avoiding detection by an observer. The message is recovered with low error probability due the use of error control coding. SSIS payload is, at a minimum, an order of magnitude greater than of existing watermarking methods. Furthermore, the original image is not needed to extract the hidden information. The proposed recipient need only possess a key in order to reveal the secret message. The very existence of the hidden information is virtually undetectable by human or computer analysis. Finally, SSIS provides resiliency to transmission noise, like that found in a wireless environment and low levels of compression.

## Precoded and Vector Onal/ Frequency Division Multiplexing

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**Inventor:** Xia, Xiang-Gen  
**Patent Number:** 6,928,047  
**Issue Date:** August 9, 2005  
**Docket Number:** UD99-17

This invention provides significant improvements over conventional orthogonal frequency division multiplexing techniques. By means of a relatively simple precoding technique, the inventor has demonstrated that removal of unwanted spectral nulls can be achieved in a digital communication channel without prior knowledge of the channel's intersymbol interference characteristics. With the vector OFDM systems, the data rate overhead in the OFDM systems is reduced in comparison to the conventional OFDM systems.

## Spherical Robot

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**Inventors:** Agrawal, Sunil K.;  
Bhattacharya, Shourov  
**Patent Number:** 6,414,457  
**Issue Date:** July 2, 2002  
**Docket Number:** UD99-21

By employing a novel simple-but-elegant internal drive mechanism, the inventors have developed a spherical robot capable of omni-directional movements controlled remotely via a radio link. The relatively simple design minimizes the number of moving parts needed while concurrently improving reliability. The device has been tested in the laboratory. Potential uses include military applications and movable remote surveillance.

## Multi-Channel Wavelength Division Multiplexing Using Photonic Crystals

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**Inventors:** Prather, Dennis W.;  
Sharkawy, Ahmed Samir;  
Shi, Shouyuan  
**Patent Number:** 6,891,993  
**Issue Date:** May 10, 2005  
**Docket Number:** UD01-18

The current invention provides a Multi-Channel Division Multiplexing (MWDM) system synthesized on a two-dimensional (2-D) Photonic Crystal (PC). The system consists of two parts: a waveguiding element, realized by a line defect in a photonic crystal, and frequency selective elements, realized by photonic crystal microcavities. The present invention is a new technique for achieving high-density wavelength division multiplexing in photonic crystals over a small area which will facilitate its future integration into optical integrated circuits.

## Hetero-Structure Photonic Band Gap Materials

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**Inventors:** Prather, Dennis W.;  
Sharkawy, Ahmed S.;  
Shi, Shouyuan  
**Patent No.:** 6,832,033  
**Issue Date:** December 14, 2004  
**Docket Number:** UD01-19

The current invention provides a new structure consisting of a hybrid combination of a rectangular and a triangular photonic crystal. The new structure (hetero-structure) gives the advantages of both structures for an application such as an optical beam splitter (Y coupler) and combiner. A hetero-structure splitter/combiner achieved a transmission efficiency as high as 90% in comparison to a uni-structure splitter/combiner with an overall transmission efficiency of 50%.



### Multiple-Nozzle Thermal Evaporation Source

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**Inventors:** Eser, Erten;  
Hanket, Gregory M.

**Patent Number:** 6,562,405

**Issue Date:** May 13, 2003

**Docket Number:** UD02-02

The invention (evaporation source) is an apparatus for evaporating bulk materials — elemental or compound — to form a thin film on a moving substrate. The evaporation source consists of: (1) an evaporation chamber; (2) two or more effusion nozzles which direct the evaporating material from the evaporation chamber towards the substrate, and optionally; (3) an expansion chamber interposed between the evaporation chamber and effusion nozzles.

The high temperature of the surface of the evaporation material within the evaporation chamber generates a vapor pressure above the surface that drives the vapor through the nozzles toward the substrate where it condenses to form the desired film. To achieve both deposition uniformity and high utilization of the evaporating material, it is necessary to properly position multiple effusion nozzles across the substrate width. To avoid an excessive number of sensors and heating elements, it is desirable to feed these nozzles from a single evaporation chamber.

This type of source is currently in use in both research and commercial environments. The present disclosure improves multiple-nozzle evaporation sources currently in use by: (1) the incorporation of tapered nozzles for the purpose of reducing the thermal gradients along them and thus improving their performance; and (2) design of the evaporation chamber and/or expansion chamber to ensure uniform vapor pressure in the evaporation chamber.

### Multiple-Nozzle Thermal Evaporation Source

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**Inventors:** Eser, Erten;  
Hanket, Gregory M.

**Patent Number:** 6,982,005

**Issue Date:** January 3, 2006

**Docket Number:** UD02-02 DIV

A multiple nozzle thermal evaporation source includes a plurality of nozzles having a tapered shape. The nozzles may comprise a thermally conductive material having a low emissivity material.

### Method and Apparatus for Real-Time Multi-Threading

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**Inventors:** Gao, Guang R.;  
Theobald, Kevin B.

**Serial Number:** 10/515,207

**Filing Date:** November 18, 2004

**Docket Number:** UD02-03

A computer architecture, hardware modules, and a software method, collectively called “EVISA,” are described that allow low-overhead multithreading program execution to be performed in such a way as to keep all processors usefully busy and satisfy real-time timing constraints. The architecture can be incorporated into the design of a multithreading instruction processor or can be used as a separate architectural module in conjunction with pre-existing non-multithreading processors as well as specialized Intellectual Property (IP) core modules for embedded applications.

## Micro-Ring Cavity Gyroscope with Magnetic Field Lock-In Minimization

**Inventors:** Prather, Dennis;  
Murakowski, Janusz A.

**Patent Number:** 6,603,558

**Issue Date:** August 5, 2003

**Docket Number:** UD02-04

The invention embodies a micro-ring cavity gyroscope with a sensitivity axis for sensing rotational motion comprising: at least one micro-ring cavity laser comprising a light amplifying medium and magneto-optical material capable of generating an electromagnetic standing wave; at least one standing wave detection means; and means for generating a magnetic field that at least partially immerses said micro-ring cavity laser in a magnetic field, wherein said standing wave detection means senses the position of the electromagnetic standing wave with respect to said micro-ring cavity laser, and the magnetic field perturbs the electromagnetic standing wave to minimize lock-in phenomenon enabling detection of rotational motion.

## Etchless Fabrication of Planar Photonic Bandgap Structures in High Index Material

**Inventors:** Murakowski, Janusz;  
Pustai, David;  
Prather, Dennis

**Patent Number:** 7,157,296

**Issue Date:** January 2, 2007

**Docket Number:** UD02-17/18

The invention is a new process for making planar photonic bandgap (PBG) structures consisting of regularly distributed holes in high index dielectric material. It also allows for controlled placement defects within the PBG lattice so as to pattern waveguides, cavities, etc., for creating photonic devices. The PMMA perforated membrane is obtained in a way described therein. It is accomplished by sputtering silicon. Silicon has a high refractive index of  $\sim 3.4$  for near infrared wavelengths, thereby allowing for opening a wide photonic bandgap and thus improved operational characteristics of the PBG structure as compared to the pure PMMA membrane.

It should be noted that obvious modifications to the described procedure could be applied without departing from the spirit of the invention. For example, material other than silicon can be deposited as the high index guiding medium. Also, sputtering can be replaced by other methods suitable for depositing thin films, such as evaporation or chemical vapor deposition (CVD).

## Electro-Optical Two-by-Two Switching in a Photonic Bandgap Waveguided Coupler

**Inventors:** Prather, Dennis W.;  
Sharkawy, Ahmed;  
Shi, Shouyuan;  
Soref, Richard A.

**Serial Number:** 10/502,071

**Filing Date:** July 19, 2004

**Docket Number:** UD02-26

The invention provides a new technique for switching an electromagnetic wave propagating through photonic crystal waveguides. Electromagnetic waves can be either microwave or optical regime based on the constituent materials of a photonic crystal. The invention makes use of coupled photonic crystal waveguides, where the coupling coefficient between nearby waveguides can be modulated via an external electrical or optical means. We propose that the “loss tangent” of dielectric material in the coupling region can be modified by external “commands” to spoil the coupling, thereby re-routing the light. We have found that the induced loss does not significantly attenuate the waves traveling in the straight-through channels. To attain switching in 2D PBG guides made from silicon/air, the free-carrier absorption loss of Si can be controlled by (1) carrier injection from forward-biased PN junctions on the posts; (2) depletion of doped posts with MOS gates; (3) generation of electrons and holes by above-gap light shining upon the designated pillars, a contact less process. If the PBG coupler is implemented in III-V semiconductor heterolayers, then the electro-absorption effect could be used.



### E-beam and Ultraviolet Lithography Combination for Large Area Photonic Crystal Circuits

**Inventors:** Prather, Dennis W.;  
Murakowski, Janusz

**Serial Number:** 60/357,184

**Filing Date:** February 15, 2002

**Docket Number:** UD02-29

The invention is a new process for making large area planar photonic bandgap (PBG) structures consisting of regularly distributed holes in high index dielectric material and controllably placed defects within this lattice, so as to realize waveguides, cavities, etc., for creating photonic devices. The process is based on the observation that some positive ultraviolet (UV) resists, like for example AZ5214, are electron beam sensitive and behave like negative e-beam resists. This allows for creating desired structures using a combination of electron and UV exposures. As a result, we combine the best features of the two exposure methods: the high speed of UV exposure and the high resolution of the electron beam exposure. The process of making the structure proceeds as follows:

- a. UV positive, e-beam negative resist is deposited on a silicon on insulator substrate by spinning its liquid solution and then evaporating the solvent.
- b. Regular PBG lattice is exposed by interference pattern from coherent sources of radiation; for example, three sources can create a triangular lattice of bright spots (antinodes of the interference pattern) on a surface.
- c. Defects (waveguides, cavities, and the like) are patterned using electron beam.
- d. The sample is chemically developed. The developer dissolves areas exposed to light (antinodes of the interference pattern) and unexposed to electron beam. This produces a pattern of a regular grid of holes corresponding to antinodes of the interference patterns, and defects placed with the electron beam.
- e. The pattern is transferred to the underlying silicon slab using standard etching techniques.

### Method for Fabricating 3-Dimensional Photonic Crystals with Engineered Defects

**Inventors:** Prather, Dennis;  
Murakowski, Janusz

**Serial Number:** 60/405,709

**Filing Date:** August 26, 2002

**Docket Number:** UD03-02

The invention is a new process for making large area three-dimensional photonic crystal structures consisting of regularly distributed 3-D structures in high index dielectric material and controllably placed defects within this lattice, so as to realize waveguides, cavities, etc., for creating photonic devices. The process is based on the observation that some positive ultraviolet (UV) resists, for example AZ5214, are electron-beam sensitive and behave like negative e-beam resist. By controlling the accelerating voltage of the electrons, one can control their penetration depth in the resist and thus the depth of e-beam exposure whereby defects so created have the desired three-dimensional geometry. The regular 3-D lattice of the photonic crystal is created by interferometric volume exposure of the photoresist. As a result, we combine the best features of the two exposure methods: the high speed of large area UV exposure and the high resolution and controlled depth of the electron beam exposure. The process of making the structure proceeds as follows:

- a. UV positive, e-beam negative resist is deposited on a substrate by spinning its liquid solution and then evaporating the solvent.
- b. Defects (waveguides, cavities, and the like) are patterned using electron beam. The vertical dimension of the defects is controlled by properly adjusting the voltage accelerating electrons impinging upon the surface.
- c. Another coat of the UV positive, e-beam negative resist is deposited.
- d. Regular 3-D photonic crystal lattice is exposed by volume interference pattern using coherent sources of radiation.
- e. The sample is chemically developed. The developer dissolves areas exposed to light (antinodes of the interference pattern) and unexposed to electron beam. This produces a pattern of a regular grid of holes corresponding to antinodes of the interference patterns, and defects placed with the electron beam.

f. The voids are back-filled with high index material using standard techniques known in the art; for example, chemical vapor deposition can be used here.

g. Resist is chemically dissolved to leave 3-D structure in the high index material.

The process described above can be modified and/or extended in a number of ways without departing from the spirit of the invention. For example, after step c, step b can be repeated so as to achieve a multilayered structure of defects; UV exposure can be applied after step b and then again after step c. Any number of techniques can be used for step f. The dissolution of resist in step g can be accomplished using a wet process by using a specific solvent, e.g., acetone, or by oxygen plasma (dry etch, ashing), or it may be burnt off in high temperature, or the removal process might be skipped altogether if the contrast between the material used in step f and the resist is sufficient for a specific application.

#### Fast System for Color Prediction in Halftones

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**Inventors:** Arce, Gonzalo R.;  
Nino, Cesar L.

**Patent Number:** 7,173,733

**Issue Date:** February 6, 2007

**Docket Number:** UD03-08

The invention is a system that characterizes an inkjet color printer, reducing drastically both the number of measurements and the computational complexity. This system is based on a new mathematical model developed entirely by the inventors. The need for color accuracy and the ability to predict accurately the output of a given printer are the core technology of colorproofing, a business where the main customer is basically every graphic magazine (such as *American Photo*, *Newsweek*, *Time*, etc.) as well as companies that produce graphic designs for advertising purposes, or companies that produce color product catalogs. The goal in colorproofing is to reproduce as closely as possible the behavior, in terms of color, of the magazine press in order to minimize the risk of a mismatch in color between the original graphic design (in the computer monitor, for example) and the final impression.

#### Method for Creating High-Aspect Ratio, Flip-Chip Conductive-Polymer Bumps Using Photolithography and Polishing

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**Inventors:** Prather, Dennis;  
Lohokare, Saurabh

**Serial Number:** 10/710,870

**Filing Date:** August 9, 2004

**Docket Number:** UD03-16

Commercially used polymer flip-chip wafer-bumping processes use stencil-printing techniques that offer a crude alignment resolution (~10 microns). The invented process uses a low-viscosity, spin-on conductive polymer bump material that offers improved bumping resolution (~2–3 microns) using photolithography and also eliminates the requirement for a sophisticated head system (for scraping and dispensing the polymer material) by use of a polishing technique.

#### Method for Generating Software Pipelined Code for Loop Nests

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**Inventors:** Gao, Guang R.;  
Rong, Hongbo

**Serial Number:** 10/944,986

**Filing Date:** September 20, 2004

**Docket Number:** UD03-36

This invention presents a new method for generating software pipelined code for loop nests. The code is characterized by the parallel execution of several iterations from the outermost loop. The iterations are partitioned into groups. Iterations within the same group are executed in parallel. For a perfect loop nest, iteration points in the iteration space are issued at a fixed rate.



### Method and Apparatus for Iterative Emulation of Large Logic Circuits Containing Multiple Identical Logic Modules

**Inventors:** Gao, Guang R.; Sakane, Hirofumi; Yakay, Levent; Karna, Vishal; Leung, Clement

**Serial Number:** 10/967,814

**Filing Date:** November 18, 2004

**Docket Number:** UD04-16

This invention presents (1) a new method for emulating a large logic circuit design containing a plurality of identical coarse-grain logic modules; and (2) an emulator system utilizing the method. Under the invented method, which is called iterative emulation scheme, the amount of required emulation resources is significantly reduced, compared with conventional emulation methods, by folding the identical modules into a single module copy in the hardware description language (HDL) level. The principle of the method can be applied to any type of emulation platform such as configurable logic circuit or even logic simulation environment. The method is demonstrated on an FPGA (Field Programmable Gate Array) with a large multiprocessor design as a case study.

### TIR-Evanescent Coupler for Fiber-to-Waveguide Integration of Planar Optoelectronics Devices

**Inventors:** Prather, Dennis W.; Lu, Zhaolin

**Serial Number:** 60/536,631

**Filing Date:** January 15, 2004

**Docket Number:** UD04-24

A method for parallel coupling from a single mode fiber, or fiber ribbon, into an SOI waveguide for integration with silicon optoelectronic circuits is described. The coupler incorporates the advantages of the vertically tapered waveguides and prism couplers, yet offers the flexibility of planar integration. The coupler can be fabricated using wafer polishing technology or grayscale photolithography. When optimal coupling is achieved on our experimental setup, the coupler can be packaged using epoxy bonding to form a fiber-waveguide parallel coupler or connector. Two-dimensional electromagnetic calculation predicts a coupling efficiency of 77% (-1.14dB insertion loss) for a silicon-to-silicon coupler with a uniform tunnel layer. The coupling efficiency is experimentally shown to be 46% (-3.4dB insertion loss) excluding the loss in silicon and the reflections from the input surface and output facet.

### 10GHz, AlGaAsSb/A1GaSb Photodetectors for 1550nm Operating Wavelength

**Inventors:** Prather, Dennis; Lohokare, Saurabh

**Serial Number:** 11/040,430

**Filing Date:** January 21, 2005

**Docket Number:** UD04-26

The invention is a detector device designed in the AlGa(As)Sb material system on GaSb substrate. The lattice-matched device structure is grown using molecular beam epitaxy. The use of AlGa(As)Sb as the active material in this device structure has the ability to achieve high-speed and low-noise avalanche photodetectors. This is due to the essentially unipolar multiplication regime that can be established in these materials, due to a very high hole-to-electron ionization coefficient ratio. Also a bandgap resonance effect observed for a certain composition of this material can result in very high multiplication factors.

### The "RTD-A Controller" – a Next-Generation Regulatory Controller

**Inventors:** Ogunnaike, Babatunde A.; Mukati, Kapil

**Serial Number:** 10/845,840

**Filing Date:** May 14, 2004

**Docket Number:** UD04-31

This invention is a novel basic regulatory controller algorithm that takes proper advantage of 21st-century digital technology to overcome the chronic weaknesses of the current controller technology. It is intended as an alternative to the classical PID controller.

Over 80% of control loops in industry are under basic regulatory control implemented using the popular PID algorithm. Surprisingly, this implementation of regulatory controllers (including the modern day digital version) is still based on century-old concepts that were dictated by the limitations imposed by the technology of the time, namely mechanical addition and multiplication of signals; electronic amplification. Even though versatile, these controllers possess many weaknesses that limit their achievable performance.

### High-Frequency Soft Magnetic Materials with Laminated Submicron Magnetic Layers and the Method to Make Them

**Inventors:** Xiao, John Q.;  
Zhao, Yuwen;  
Zhang, Xiaokai

**Serial Number:** 60/582,578

**Filing Date:** June 24, 2004

**Docket Number:** UD04-50

This invention is a new process to make high frequency soft magnetic materials. The structure consists of laminated Fe sheets with lateral dimension of a few to a few hundreds microns and thickness of less than one micron. The metallic Fe core materials are coated with a thin layer of insulator that will electrically isolate the Fe core materials from each other.

### Three-Dimensional Lithographical Fabrication with Mismatched Resist and Exposure Source

**Inventors:** Prather, Dennis;  
Yao, Peng

**Serial Number:** 60/575,074

**Filing Date:** May 27, 2004

**Docket Number:** UD04-55

The invention is a new method of three-dimensional fabrication, which can be applied for making arbitrary three-dimensional structures made of photosensitive material. A latent 3-D structure is firstly built up on a substrate by repeated coating, exposure, and post exposure baking; it is then revealed by development using corresponding developer. Virtually any arbitrary 3-D structure can be fabricated using this method using the following steps:

1. Mesh the 3-D structure into a series of 3-D patterns or slices.
2. Make photo mask or masks that contains those 2-D patterns and proper alignment marks.
3. Use the proposed method to reconstruct the original 3-D structure layer-by-layer with corresponding 2-D pattern for each layer. The processing steps for each layer include:
  - a. coat photoresist (spin or spray);
  - b. softbake with a hotplate;
  - c. expose with a mask designed for this layer;
  - d. post exposure bake with a hotplate to form the latent image. This step is not necessary if the latent image is formed immediately after the exposure.

### A Method and Apparatus for Optical Sources Based on Reflection Spatial Light Modulators for Intrachip Global Communications

**Inventors:** McFadden, Michael J.;  
Haney, Michael W.;  
Iqbal, Muzammil

**Serial Number:** PCT/US2005/021466

**Filing Date:** June 17, 2005

**Docket Number:** UD04-56

This invention is an optical interconnection architecture for linking arbitrary points in a field (e.g., a microchip). The invention enables high-density arbitrary point-to-point links, while the micro-prism and microlens at the receiving end of the link provides misalignment tolerance.

### A Method and Apparatus for Free-Space Optical Interconnects Between Arbitrary Locations in a Field Using Lenses, Steering Elements, and a Curved Reflecting Surface

**Inventors:** Haney, Michael W.;  
McFadden, Michael J.  
Iqbal, Muzammil

**Serial Number:** 11/611,414

**Filing Date:** December 15, 2006

**Docket Number:** UD 04-57

The invention is a structure to integrate optical waveguides with reflection-mode spatial light modulators (such as Multiple Quantum Well Modulators) to create effective photonic sources and sinks that can be readily integrated in free-space or guided-wave optical interconnect fabrics to provide high-density interconnect bandwidth on integrated circuits. Each transmitter or receiver in a link comprises a waveguide with an etched 45° end-facet on one side of a substrate, and a microlens on the other side. The end-facet reflects the light from the waveguide perpendicularly through the substrate, and the lens collects it onto a modulator. When the modulator is “on,” the reflected beam propagates back through the microlens, and emulates the behavior of a surface-normal photonic emitter (like a laser or LED). The microlens may be designed so that the beam emits into free-space, or it can be focused onto another 45° end facet of an output waveguide adjacent to the input guide. The same optical arrangement may be used if the modulator is operated as a photo-detector, wherein it serves as a receiver for the link. The invention lends itself to easy integration with both free-space and guided-wave optical interconnect fabrics.



### Hollow Cathode Plasma Source for Bio and Chemical Decontamination of Air and Surfaces

**Inventors:** Shah, S. Ismat;  
Pradhan, Anshu

**Serial Number:** 60/703,417

**Filing Date:** July 29, 2005

**Docket Number:** UD04-58

This invention describes a method of using a low-pressure plasma generated by a Hollow Cathode Source (HCS) for abatement of airborne chemical or biological pollutants by cleaving the pollutant and then trapping the gaseous pollutant and its associated by-products into a solid deposit. A two-step process is involved in the abatement of polluting species. In the first step, the reactive ions and energetic ions present in the plasma lead to chemical cleaving of complex molecules into simpler molecules. In the second step, the chemical pollutant and the by-products created in the first step get deposited onto the target surface in the form of an easily removable solid waste layer.

### Low-Temperature Synthesis of Hexagonal ZnS Nanocrystals and Their Derivatives with Different Transition Metal Dopants

**Inventor:** Xiao, John Q.;  
Zhao, Yuwen

**Serial Number:** 60/605,944

**Filing Date:** August 31, 2006

**Docket Number:** UD04-61

This invention concerns a new low-temperature wet-chemistry synthetic technique to fabricate high-temperature polymorph of zinc-blend ZnS, hexagonal (wurtzite) ZnS, in the form of nanocrystals. This is a completely new method which will impact significantly on the fabrication of ZnS class of wide band gap semiconductor nanocrystals (CdS, PbS, HgS).

### A Ferro Magnetic Metal-Insulator Multilayer Radio Frequency Circulator

**Inventor:** Chui, Siu-Tat

**Serial Number:** 60/670,247

**Filing Date:** April 12, 2005

**Docket Number:** UD05-09

This technology is a directional R.F. circulator for directing radio frequency signals, which does not require an external magnetic field. This circulator will work for frequencies much higher than currently possible, between 1 and 10 GHz. Instead of hard ferrites, a carefully designed composite of ferromagnetic metal and an insulating material is used. A plurality of connectors are located around the periphery of the material to provide input and output ports for the device.

### Apparatus and Method for Transmitting and Receiving High-Speed Differential Current Data Between Circuit Devices

**Inventors:** Kiamilev, Fouad;  
Kramer, Joshua;  
Zuo, Youngrong

**Serial Number:** 11/324,233

**Filing Date:** October 12, 2006

**Docket Number:** UD05-12

Over time, portable handheld devices such as mobile phones, portable entertainment consoles, personal digital assistants (PDA), global positioning systems (GPS), and mobile gaming devices are expected to become more powerful and thus require higher speed signaling interfaces between their internal components. These future handheld devices will require interfaces that operate at 10X to 100X faster data rates (e.g., one to ten gigabits per second). Unfortunately, existing electrical multi-gigabit signaling interfaces (such as CML or LVDS) consume too much power to be efficiently used in mobile platforms. This invention describes a physical interface, including driver and receiver circuits that reduce power consumption by 10X over present state-of-the-art. In addition, the invented interface reduces electromagnetic emissions leading to reduced EMI — an important consideration in mobile platforms. Together, reduced power consumption and lower electromagnetic emissions make the invention better suited for future portable devices than existing methods.

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### **Mechanically-Active Anti-Reflection Switch (MARS) Modulator with Wide-Angle Tolerance**

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**Inventor:** Goossen, Keith  
**Serial Number:** 60/659,750  
**Filing Date:** March 8, 2005  
**Docket Number:** UD05-15

The present invention relates to optical modulators, and more particularly to micromechanical optical modulators, that provide effective modulation over a wide angle-of-incidence.

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### **Zero-Alignment Method for Tunable Fabrication of Three-Dimensional Photonic Crystals by Multiple-Exposure Laser Interference Using Diffraction Gratings Patterned on a Single Mask**

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**Inventors:** Prather, Dennis;  
Schneider, Garrett J.;  
Wetzel, Eric  
**Serial Number:** 60/646,796  
**Filing Date:** January 25, 2005  
**Docket Number:** UD05-19

The invention is a new process for the fabrication of three-dimensional photonic crystals. It is based on the combination of several laser beams within a layer of photosensitive material (such as photoresist). Several beams are introduced into the material, generating an interference pattern that is recorded in the material as a latent image. This process is repeated for several such exposures in a way such that the combined result of all exposures is a three-dimensionally periodic pattern that can be revealed by chemical development. The novelty of the invention lies in the method used to generate the interfering laser beams from a single parent beam. We use a single mask plate patterned with several sets of diffraction gratings, illuminating each set of gratings separately to prevent the recording of undesired spatial frequencies arising from interference between different sets. The sets are isolated by a movable beam blocker.

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### **Improving the Reliability of the "Write" Process of MRAMs by Controlling the Grain Sizes of Magnetic Material**

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**Inventor:** Chui, Siu-Tat  
**Serial Number:** 60/600,811  
**Filing Date:** May 15, 2006  
**Docket Number:** UD05-27

A method for storing data in a magnetic memory element of an array of elements which avoids inadvertent switching of other elements is disclosed. First and second magnetic fields are applied to a selected magnetic element for a first-time interval to switch the element into an intermediate state where minor domains are created. A second value of magnetic fields are then applied large enough to switch the magnetization of the minor domains, but not large enough to switch the magnetization of an adjacent memory cell. Once the minor domain is switched, the magnetization of the magnetic element assumes the state where the major domain has a magnetization direction representing the value of the stored data bit. Reducing the grain size of crystallites combined in a bit, reduces the intrinsic anisotropy of the magnetic memory element thus improving bit selectivity.

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### **Fabrication of Quantum Dots Embedded In Three-Dimensional Photonic Crystal Lattice**

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**Inventors:** Murakowski, Janusz;  
Schneider, Garrett;  
Prather, Dennis W.  
**Serial Number:** 11/427,832  
**Filing Date:** June 30, 2006  
**Docket Number:** UD05-32

The invention is a new process for fabricating nanostructures, in the form of quantum dots (QD-s), in bulk epitaxially grown silicon. The quantum dots that form are naturally connected to the remaining silicon. Such geometry allows envisioning electrical current passing through the dots to excite optical emission, light amplification, and lasing.

This new process allows the use of CMOS-compatible (complementary metal-oxide-semiconductor) processes to produce quantum dots embedded in 3D photonic crystal, and where the QD-s are lithographically defined and, therefore, deterministically placed in the desired locations. The QD-s produced by the method are electrically connected (e.g., through the silicon veins) to a bulk silicon substrate and to the top surface



of patterned silicon. In the case of a laser, for example, the top electrode (e.g., metal) is optically isolated from the structure producing light by the intervening photonic crystal allowing for optical isolation of the optical mode from the metal, and thereby minimizing optical losses. By having the electrical connections going only through the QD-s without the ability to bypass them, pumping efficiency is improved by using all the current as an injection current. The QD-s are optically isolated from the substrate by the photonic crystal ("PhC"). Therefore, if light is produced in the QD-s by means of electrical pumping, this light does not leak to the substrate, thus improving the efficiency of light generation in the structure. Further, the QD-s are passivated as part of fabrication process, thus making quantum dots more stable, and with uniform size since the QD-s are defined by epitaxial growth and lithography, both of which are capable of high precision and high density fabrication of isolated QD-s.

#### **TDR/TDT (Time Domain Reflectometry/Time Domain Transmission) CT (Computerized Tomography) and Guided TDR/TDT CT in Two-Dimensional and Three-Dimensional Forms**

**Inventor:** Li, Jian  
**Patent Number:** 7,276,914  
**Issue Date:** October 2, 2007  
**Docket Number:** UD06-05/UD06-07

This invention comprises a novel technique of defect or discontinuity detection and positioning in media or at the interface of multi-media. Instead of open beam (ultrasound beams, x-ray beams, etc.) projection in traditional CT, this method utilizes electromagnetic fields (including light) that are bounded with wires, wave guides, optical fibers, etc., or other boundaries which can guide the electromagnetic fields or light through media along the projection path. This projection path is not one that open beam naturally forms in traditional CT when traveling according to radiation, propagation, reflection or other rules. The projection path in the present invention is composed of man-made materials that guide the electromagnetic fields (or light) to propagate through media. The traditional technique of TDR/TDT (Time Domain Reflectometry/Time Domain Transmission) is utilized to implement the electromagnetic field (or light) travel time analysis. The present invention brings a cheap, large-scale, and flexible (plane or curvy interface) 2-D and 3-D discontinuity detection and positioning method.

#### **Use of Porous Metallic Membranes as Gas Diffusion Layers in Fuel Cells**

**Inventors:** Zhang, Feng-Yuan;  
 Prasad, Ajay K.;  
 Advani, Suresh G.  
**Serial Number:** 60/813,537  
**Filing Date:** July 14, 2006  
**Docket Number:** UD06-24

The use of porous metallic membranes as gas diffusion layers in fuel cells provides several solutions to the current problems facing gas diffusion layers in fuel cells including the long-term requirements for fuel cell performance, durability, and cost. The recent developments of self-assembled monolayer (or SAM) on metal surfaces provides the promise of surface treatment to meet the needs in fuel cells. These self-assembled monolayers are very resilient and can be easily formed. SAM can strongly bond with metal atoms of the solid surfaces, permitting good adherence of the molecule to the surface. Therefore, they are very stable with long lifetimes. In addition, they prevent metal from corrosion/erosion. Because the self-assembled monolayers have thickness of the order of 10 angstroms, they present negligible resistance to thermal and electronic conductions and do not alter other characteristics of the substrate. The hydrophilicity and hydrophobicity of the substrate surface can be precisely controlled by carefully selecting SAM group to improve water transport in the fuel cell.

The novel methods of the present invention provide for controlling size and distribution of GDL pores over the design, which allow for a straight or independent (i.e., non-overlapping) pore configuration in the nanoporous gas diffusion media of the invention. This overcomes one other notable problem of the currently available carbon fiber GDLs and their production, which is variability in efficiency due to their random and unpredictable pore size and distribution. Thus, the methods of the invention provide, for the first time, for the production of GDLs that are highly consistent in their gas diffusion characteristics. In addition to the advantages listed above, the uniformity by which nanoporous GDLs can be constructed according to the present invention now allows for more accurate simulation modeling, and testing, which can greatly reduce development costs of new electrochemical and gas diffusion technologies, such as, for example, fuel cells, and biomedical devices.

## Electromagnetic/Optical Tweezers Using a Full 3-D Negative-Refractive Flat Lens

**Inventor:** Prather, Dennis W.;  
Lu, Zhaolin;  
Murakowski, Janusz;  
Shi, Shouyun;  
Schneider, Garrett

**Serial Number:** 60/791,537

**Filing Date:** March 30, 2006

**Docket Number:** UD06-26

The invention combines two recently developed techniques, 3D negative refraction flat lenses (or 3DNRFLs) and optical tweezers, and employs the very unique advantages of using 3DNRFLs for electromagnetic traps. First, the super-resolution and short focal distance of the flat lens result in a highly focused and strongly convergent beam, which is a key requirement for a stable and accurate electromagnetic trap. Secondly, the translation symmetry of 3DNRFL provides translation-invariance for imaging, which allows an electromagnetic trap to be translated without moving the lens, and permits a trap array by using multiple sources with a single lens. The 3DNRFL provides such a strong electromagnetic gradient force that electromagnetic trapping at microwave frequencies (i.e., microwave tweezers) is realized for the first time. This technique involves stably trapping and accurately manipulating a variety of neutral dielectric particles by simple movement of an imaged microwave source over a field-of-view not limited by imaging aberrations. In addition, a microwave tweezers array through a single negative refraction lens can be constructed to manipulate particles along a specific route by simply switching on and off a sequence of sources whereas requiring neither physical movement on the sources nor on the lens.

## Method for Scheduling Transmissions in an Ad Hoc Network

**Inventors:** Yackoski, Justin M.;  
Shen, Chien-Chung

**Serial Number:** 60/816,899

**Filing Date:** June 27, 2006

**Docket Number:** UD06-31

The invention relates to a method for scheduling and synchronizing all transmissions of data in an ad hoc network. Data is transmitted on a given path from a given source of the data to a given destination. Time is divided into cycles and each cycle node in the path transmits data belonging to the path during the same time slot reserved for that node and path. Time slots have arbitrary sizes, that are reserved via trial and error, and the time slot schedule is iteratively optimized to reduce end-to-end delay using local coordination rules between nodes. The scheduling method can be used for wireless, wired, or optical networks.

## Optically Driven Carbon Nanotube Actuators

**Inventor:** Panchapakesan, Balaji;  
Lu, Shoaxin

**Serial Number:** 60/843,727

**Filing Date:** September 11, 2006

**Docket Number:** UD07-07

This invention relates to an actuator device capable of converting optical energy directly into mechanical energy comprising single or multi-wall carbon nanotube(s). The performance of the device is better than most micro-electro-mechanical (MEMS) electrostatic actuators. The nanotube patterning technique to create the actuator devices is completely compatible with most complementary metal oxide semiconductor (CMOS) and micro-electro-mechanical systems (MEMS) processes. The device can be scaled very well in macro-, micro- and nanotechnologies.

In one embodiment of the invention, the actuator device contains a material with a first optical absorption coefficient greater than the material with second optical absorption. In another embodiment, the actuator device contains a first optical absorption coefficient lower than the second optical absorption coefficient. In yet another embodiment, the actuator device is capable of achieving strains of 0.3% to 3.75% per watt of optical energy. This is significantly better than most piezoelectric materials that are used today for actuation. Further, the optical energy necessary for actuation is significantly smaller compared to hundreds of volts necessary for piezoelectric mechanical actuation technologies.



Another aspect of invention also relates to a method of actuation comprising exposing an actuator device to a light source. The light source is “turned on” to initiate actuation and can be removed or “turned off” to stop actuation, thereby enabling wireless remote controlled actuation technology. In another embodiment, the method of actuation may further comprise the step of increasing or decreasing the intensity of the light source to increase or lower the strain response of the actuator device.

Yet another aspect of the invention provides a method of preparing a carbon nanotube actuator device comprising the steps of (a) forming of a carbon nanotube film on a substrate; (b) adding a photo resist layer on said nanotube film to form an actuator device; (c) etching said actuator device; and (d) optionally releasing said actuator device from said substrate. This patterning process is compatible with most MEMS and CMOS processes that are used today.

#### **Laser Microscope with Infinity-Corrected Long Working-Distance Objectives**

**Inventor:** Cloutier, Sylvain G.  
**Serial Number:** 60/905,408  
**Filing Date:** March 7, 2007  
**Docket Number:** UD07-21

The invention consists of a laser microscopy system built using a specially-designed microscope equipped with long working distance infinity-corrected objectives. The system allows to perform high-resolution laser micro-spectroscopy analysis for samples mounted in hot, cold, high-pressure, vacuum, fluidic, or electro-chemistry chambers.

#### **The Synthesis of Tellurium Containing Solid Materials by Aerobic Bacteria**

**Inventor:** Hanson, T. E.  
**Serial Number:** Provisional Filed  
**Filing Date:** March 27, 2008  
**Docket Number:** UD08-01

This invention describes the use of aerobic, tellurite resistant bacteria and yeast strains to convert soluble tellurium compounds (tellurite and tellurate) into solid tellurium nanoparticles.

#### **Non-Vertical Thermal Evaporation Sources for Wide-Area Deposition**

**Inventors:** Hanket, G.;  
 Birkmire, R. W.  
**Serial Number:** Provisional Filed  
**Filing Date:** October 12, 2007  
**Docket Number:** UD08-04

Non-vertical wide-area thermal evaporation source configurations offer advantages such as higher achievable substrate temperatures for substrates such as glass, as well as the potential of doubling areal throughput with minimal additional infrastructure. A variety of configurations are disclosed which offer these advantages, as well as insensitivity to contamination by falling debris, improved deposition uniformity, and inhibited spitting of condensed evaporant droplets.

#### **I-III-VI<sub>2</sub> Photovoltaic Absorber Layers with Improved Manufacturability and/or Device Performance**

**Inventors:** Hanket, G.  
**Serial Number:** Provisional Filed  
**Filing Date:** October 2, 2007  
**Docket Number:** UD08-05

The incorporation of various additional constituents into I-III-VI<sub>2</sub>-based chalcopyrite absorber layers may be used as a means of reducing processing temperature and/or improving device performance without otherwise modifying the absorber layer or device fabrication processes.

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## Cell Voltage Monitoring System

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**Inventors:** Brunner, D.;  
Peticolas, B.

**Serial Number:** Provisional Filed

**Filing Date:** December 10, 2007

**Docket Number:** UD08-08

A compact system for monitoring individual cell voltages in long chains of cells, such as fuel cell stacks or batteries, while maintaining high voltage isolation and safety. This system is more accurate than systems using solid-state switches.

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## Anti-Whiplash Vehicle Seat System with Active Head Restraints

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**Inventor:** Nilakantan, G.

**Serial Number:** Provisional Filed

**Filing Date:** October 29, 2007

**Docket Number:** UD08-09

The present invention relates, generally, to a vehicle seat assembly, broadly, to a safety arrangement, and more specifically to a vehicle seat assembly having an active head restraint system that minimizes the distance between the occupants head and headrest through the forward pivotal motion of the headrest during a rear collision event.

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## Electromagnetic Wave Detector and Methods of Making Them

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**Inventors:** Xiao, J. Q.;  
Moriyama, T.

**Serial Number:** Provisional Filed

**Filing Date:** February 13, 2008

**Docket Number:** UD08-24

The current invention involves a solid state device to detect a broadband electromagnetic wave. The invention miniaturizes present electromagnetic wave receivers. It can be used as an on-chip electromagnetic wave receiver or detector for the future telecommunication on the chip level. Furthermore, it can be used to generate a pure spin current which is desired in the future spintronics.



