

Purdue Featured Technologies

Definition of Technology Readiness Levels (source: NASA)	4
High-end Equipment and Manufacturing.....	5
PRF No. 64631 Vessels with Integral Life-Sensing Capability.....	5
PRF No. 65006 Modular Heat Exchanger for Metal Hydride Hydrogen Storage.....	6
PRF No. 65366 Fabricating Absorber Films with Nanoparticle Inks.....	7
PRF No. 65762 Thermoelectric Materials for High Temperature Applications	8
PRF No. 65763 Nanostructure-Based Thermoelectric Energy Conversion	9
PRF No. 65806 Flexible Polymer-Based Thermoelectric Materialson Fabrics for Use as Personal Cooling/Heating Clothes and Portable Power Source	10
PRF No. 65257 Selenization of CIS Nanoparticles.....	11
PRF No. 65352 Hydraulic System with Integrated Common Rail Energy Recovery System.....	12
PRF No.65644 Organic Rankine Cycle with Flooded Expansion and Internal Regeneration	13
Agribusiness and Food	14
PRF No. 65190 Greatwoods - Genetically Superior Hardwoods	14
PRF No. 65530 PCR Assay to Identify dw3 Stable Alleles	15
Biotechnology and Medicine	16
PRF No. 66061 Wireless Magnetic Tracking for Radiation Cancer Therapy.....	16
PRF No. 63076 Forehead Vital Signs Monitor.....	17
PRF No. 65127 Aerosolized Sol-gel Tissue Encapsulation.....	18
PRF No. 65660 Touch Actuated Micropump for Transdermal Drug Delivery	19
PRF No. 65683 Vaccine Linkers to Attach Proteins to Aluminum Hydroxide Adjuvants.....	20
PRF No. 65250 Oxygen Generator to Aid Cancer Treatment.....	21
PRF No. 65287 Radiofrequency Probe for Magnetic Resonance Imaging and Spectroscopy	22
PRF No.65476 Device for Continuous Measurement of IOP	23
PRF No. 66011 Implantable Wireless Glucose Sensor	24
PRF No. 65667 Detection and Treatment of Aurora A Kinase Related Diseases.....	25
PRF No. 64407 Quantification of Affinity-Selected Glycopeptides.....	26

PRF No. 65604 PHLDA 1 Antagonizes Aurora A Kinase-Mediated Breast Malignancy	27
Energy	28
PRF No. 64920 Method for Generating Hydrogen from Ammonia Borane.....	28
PRF No. 64923 Multiuse Coke Plant for Synthetic Fuel Production.....	29
PRF No. 64940 Fast Hydrolysis for Hydrogen Bio-Oil.....	30
PRF No. 65621 Low Lignin Second Generation BioEnergy Crops	31
PRF No. 66109 A Shade Tolerant Panel Design for Thin Film Photovoltaics.....	32
Information Technology.....	33
PRF No. 64948 Technology Assisted Dietary Assessment Technology.....	33
PRF No. 65245 ReadingMate for Active Treadmill Enthusiasts.....	34
PRF No. 65361 Privacy-Preserving Verification Software Framework.....	35
PRF No. 66540 Fingerprint Reader with Haptic Feedback.....	36
PRF No. 64669 3D Object Construction from 2D Images	37
PRF No. 64976 Optimized AES for Devices and Wireless Networks.....	38
PRF No. 62028 Fault-Tolerant Time-out Communication Protocol.....	39
PRF No. 65241 Constraint-Network Prognostics and Diagnostics.....	40
PRF No. 65981 Mixable - Social Learning Application.....	41
New Materials.....	42
PRF No. 64025 Cross-Linkable Polymeric Materials for Adhesion.....	42
PRF No. 64677 Generalized Intelligent Grinding Advisory System.....	43
PRF No. 64699 Self-Cleaning Materials.....	44
PRF No. 65476 A Nanofluidic Channel with Embedded Transverse Nanoelectrodes.....	45
PRF No. 2012-MART-66293 Acoustic Metamaterials with Embedded Microresonators.....	46
PRF No. 2013-ZIAI-66463 Adhesive Tape as a Smart Material.....	47
Civil Engineering.....	48
PRF No. 63081 Water/Cement Contents and Compressive Strength of Concrete from TDR.....	48
Electrical Engineering	49
PRF No. 63049 Anisotropic Etching of Polyethylene Terephthalate.....	49
PRF No. 65732 Vibratory Analysis of Batteries.....	50

PRF No. 2013-NOF-66347 Failure Prevention and Repair for Energy Distributions51

PRF No.66439 Wireless Antenna for Mobile Phone52

PRF No. 66539 Integrated Scalar Power Meter and Reflectometer53

PRF No. 66590 Metasurfaces for the Advanced Control of Waveguiding Properties54

PRF No. 66591 Metasurfaces to Enhance the Efficiency of Semiconductor Light Sources55

PRF No. 66592 Metasurfaces to Enhance the Efficiency of Solar Cells.....56

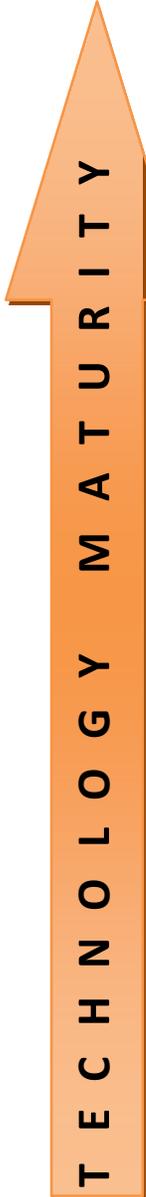
PRF No. 66596 Flexible Printed Coil for Stringed Instruments.....57

PRF No. 66606 Advanced Structure for Power DMOSFETs and IGBTs.....58

Purdue Featured Technologies

The following Purdue technologies are available for potential development, licensing or commercialization. Many of the technologies include a Technology Readiness Level (TRL) number (from 1-9) which indicates how close each technology is to the market. The higher the TRL number, the closer to marketplace ready functionality. For example, TRL 9 means the technology is fully proven in an operational environment; TRL 5 means full testing of prototype completed, and TRL 3 means proof of concept validated and active R&D has begun. See details in the diagram below:

Definition of Technology Readiness Levels (source: NASA)



Applied	TRL 9	Actual system "mission proven" through successful mission operations Fully integrated with operational hardware/software systems. Actual system has been thoroughly demonstrated and tested in its operational environment. All documentation completed. Successful operational experience. Sustaining engineering support in place.
	TRL 8	Actual system completed and "mission qualified" through test and demonstration in an operational environment: End of system development. Fully integrated with operational hardware and software systems. Most user documentation, training documentation, and maintenance documentation completed. All functionality tested in simulated and operational scenarios.
	TRL 7	System prototyping demonstration in an operational environment System prototyping demonstration in operational environment. System is at or near scale of the operational system, with most functions available for demonstration and test. Well integrated with collateral and ancillary systems. Limited documentation available.
	TRL 6	System/subsystem model or prototyping demonstration in a relevant end-to-end environment (ground or space): Prototyping implementations on full-scale realistic problems. Partially integrated with existing systems. Limited documentation available. Engineering feasibility fully demonstrated in actual system application.
Advanced	TRL 5	System/subsystem/component validation in relevant environment: Thorough testing of prototyping in representative environment. Basic technology elements integrated with reasonably realistic supporting elements. Prototyping implementations conform to target environment and interfaces.
	TRL 4	Component/subsystem validation in laboratory environment: Standalone prototyping implementation and test. Integration of technology elements. Experiments with full-scale problems or data sets.
Basic	TRL 3	Analytical and experimental critical function and/or characteristic proof-of concept: Proof of concept validation. Active Research and Development (R&D) is initiated with analytical and laboratory studies.
	TRL 2	Technology concept and/or application formulated: Applied research. Theory and scientific principles are focused on specific application area to define the concept. Characteristics of the application are described. Analytical tools are developed for simulation or analysis of the application.
	TRL 1	Basic principles observed and reported: Transition from scientific research to applied research. Essential characteristics and behaviors of systems and architectures. Descriptive tools are mathematical formulations or algorithms.

High-end Equipment and Manufacturing

PRF No. 64631 Vessels with Integral Life-Sensing Capability

Technology Readiness Level: 5

Many devices are consistently subjected to harsh and unpredictable conditions. Because of this, they become particularly susceptible to external injury. Some damages are not easily detected or prevented, even with proper maintenance and inspection. Damages to laminated structures can be especially harmful. Damages to some products such as tires occur because of gap damage within the tread, over-deflection, cuts, punctures, imbalance, impact, rubber hardening/degradation, or improper mounting/repair.

Purdue University researchers have developed a sensing method that can alert operators when a device's structural integrity has degraded. This can save time and effort in repairing or deciding to change the tire, and in some situations, prolong the operable life of a tire. This new sensor method can not only detect unsafe operating conditions, but also alert operators to damage that occurs in situ.

Advantages:

- Sensors detect both internal and external changing structural conditions
- Ability to sense multiple types of structural damage and pinpoint location of failure
- Low cost solution
- Readily incorporated into traditional manufacturing process
- Real time life evaluation
- Advanced detection allows safer operation and use of devices, eases repair efforts, and prolongs device life by allowing condition based maintenance

PRF No. 65006 Modular Heat Exchanger for Metal Hydride Hydrogen Storage

The ever increasing dependence on limited fossil fuel resources and resulting pollution have created an urgent need for cleaner fuel sources in pursuit of a more secure energy future. One alternate fuel source is hydrogen. Unlike fossil fuels, which produce energy by combustion and yield polluting byproducts, hydrogen is consumed by chemical reaction with oxygen forming only water as byproduct. Thus, hydrogen has enormous potential as a clean power source for future generation of automobiles.

There is great interest in developing hydrogen power devices, especially hydrogen powered automobiles. One prerequisite for this application is that there is enough hydrogen to give comparable driving ranges as conventionally fueled automobiles. However, hydrogen poses the problem of very low density. To overcome this obstacle, cryogenic storage containers filled with metal hydrides have been developed to store enough hydrogen in its liquid form to match its convention rival. However, with this technology, there is a requirement to heat the liquid hydrogen to make it available for use. Inventors at Purdue University have developed a unique modular heat exchanger for use in hydrogen fuel cells. The patent pending internal design optimizes both pellet contact area for increased heat transfer and hydride pellet capacity. Additionally, the modular design allows for easy replacement of defective or malfunctioning modules. These highly efficient heat exchangers can provide the necessary heat to evaporate the liquid hydrogen while remaining compact and durable enough for use over the broad range of temperatures and under the high environmental pressure of a hydrogen storage tank.

Domain:

- Mechanical Engineering

Advantages:

- Modular design makes repairs/replacements easy
- Durable design

PRF No. 65366 Fabricating Absorber Films with Nanoparticle Inks

Technology Readiness Level: 4

Semiconductor alloys based on copper, indium, gallium, sulfur, and selenium (CIGSSe) are some of the most promising candidates for photovoltaic applications due to their unique structural and electrical properties. The highest quality CIGSSe films have been traditionally fabricated using vacuum co-evaporation; however, production cost is high, which has limited its applicability for large scale fabrication. Recently, solar cells with CIGSSe absorber layers, fabricated by deposition of various alloys, have been developed using alternative approaches.

Among the various alternatives, coating technologies utilizing nanoparticle inks are a promising alternative for low cost and high throughput production of solar cells as compared to traditional vacuum-based deposition methods.

The optical and electrical properties of the CIGSSe absorber depend strongly on the composition. Thus, one of the major challenges to all deposition techniques is the ability to control and maintain the composition at the molecular level. To overcome this challenge, researchers at Purdue University have developed a method related to the fabrication and control of the composition profile along the depth $\text{Cu}(\text{In}_{1-x}\text{Ga}_x(\text{S}_{1-y}\text{Se}_y))_2$ absorber films where x and y are between 0 and 1, through the utilization of ink solutions containing $\text{Cu}(\text{In}_{1-x}\text{Ga}_x(\text{S}_{1-y}\text{Se}_y))_2$ nanoparticles where x and y are between 0 and 1. This method utilizes a precursor layer containing CIGSSe nanoparticles followed by selenization, which converts the nanoparticles into a densely packed absorber film that is fixed at the molecular level.

Advantages:

- Densely packed film where the composition is fixed
- More stable optoelectronic and electronic properties
- Cost-effective

PRF No. 65762 Thermoelectric Materials for High Temperature Applications

Technology Readiness Level: 3

Thermoelectric devices turn heat into electricity or vice versa. To work efficiently the particles that are used to construct the device need to be as one-dimensional as possible.

The best possible shape for these particles is a long, thin wire, which maximizes the electrical conductivity and minimizes the thermal conductivity of the device. Thermoelectric devices will allow waste heat to be captured and reused, greatly increasing efficiency. Purdue University researchers have developed several novel titanates for use in advanced thermoelectric devices. These new titanates could be used for harvesting electricity from the waste heat at high temperatures where a traditional Tellurium or Antimony-based compound will either oxidize or decompose. Alternative applications of this technology include use as energy storage devices such as in super capacitors.

Advantages:

- Can produce ultra-thin wires
- Thermal conductivity can be reduced

PRF No. 65763 Nanostructure-Based Thermoelectric Energy Conversion

Technology Readiness Level: 3

Thermoelectric materials directly convert temperature difference into electric voltage or vice versa. Therefore, thermoelectric materials can be used as an electric generator to recover waste heat into electricity or as a refrigerator.

Researchers at Purdue University have developed a new type of highly efficient, environmentally friendly thermoelectric material. These thermoelectric materials are based on a nanostructured Copper Zinc Tin Sulfide (CZTS), all of which are inexpensive, abundant, and non-toxic elements. In addition to being less costly and safer to produce, this technology works over a wider range of temperatures than most conventional thermoelectric materials.

Advantages:

- High efficiency
- Work over wide range of temperatures
- Non-toxic

PRF No. 65806 Flexible Polymer-Based Thermoelectric Material on Fabrics for Use as Personal Cooling/Heating Clothes and Portable Power Source

Thermoelectric cooling uses a device that transfers heat through a cooling plate and releases the heat on the opposite, hot side of the device. Current thermoelectric devices use materials that limit the pliability so applications are limited.

This device is thinner and more flexible than current thermoelectric devices so it can be coated onto fabric used to make clothing. Having clothing that keeps the body cool will protect those in hot climates, such as battlefields in Iraq and Afghanistan, from heat related illnesses and can also reduce detection by infrared body heat detectors. This device can also be used to convert body heat into electricity and serve as a portable power source.

Domain:

- Electrical Engineering

Advantages:

- Thin and flexible
- Portable power sources
- Can use body heat for electricity

PRF No. 65257 Selenization of CIS Nanoparticles

Technology Readiness Level: 5

There are currently various challenges in the selenization of CuInS₂ (CIS) films. There tends to be delamination of the film after selenization, where the film peels off from the substrates. Another method requires a high-temperature hydrogen reduction step to reduce the oxides, where substantial amounts of energy and time are necessary. This step is also potentially explosive and may require the use of highly toxic H₂Se gas. Further, expensive, high-end equipment is needed for safety concerns when the gas is at high temperatures. The most challenging problem in previous art is the lack of control of the film composition. Because the electric properties of CIS depend strongly on its composition, there is a need where composition of the film can be controlled at the nanometer scale.

Researchers at Purdue University have developed a photovoltaic printing technology utilizing CuInS₂ nanocrystal inks, allowing for the creation of CIGS at the molecular level. This is beneficial because smaller particles will lead to a more densely packed nanoparticle film, and it allows for the fabrication of the film with solely the CuInS₂ nanoparticle or a mixture of the CuInS₂ nanoparticle with other CIGS materials, such as CuIn(S_y,Se_{1-y})₂, CuGaS₂, CuGa(S_y,Se_{1-y})₂, Cu(InGa_{1-x})S₂, and Cu(In_xGa_{1-x})(S_y,Se_{1-y})₂. This process is also safe, less expensive, and has a high production yield.

Advantages:

- Safe
- Allows for creation of CIGS with the desired composition
- Inexpensive
- High production yields

PRF No. 65352 Hydraulic System with Integrated Common Rail Energy Recovery System

A new hydraulic system topology, developed by researchers at Purdue, offers improved efficiency, reliability, and performance. The fluid power system allows energy recovery from assistive actuator loads to be immediately used by other resistive loads in the system or stored in a common rail accumulator for later use.

In this hydraulic system, any port on any actuator can be connected to any other actuator via a common rail system. Because of this, the system controller can intelligently control each valve to recover the maximum possible energy from an actuator. The network of valves is configured in such a way that allows the hydraulic system to operate with characteristics of multi-level load-sensing, displacement control, independent metering, energy recovery, and energy storage (if an accumulator is added). These operating modes can co-exist depending on which combination provides the best overall efficiency and effectiveness for a given application and load cycle. The system includes the capability to re-route power in the event of component failure, leading to increased reliability and the ability to bypass the failed components in order to safely complete the desired task.

Domain:

- Mechanical Engineering

Advantages:

- More efficient use of hydraulic energy
- Captures energy that would have previously been lost
- Ability to bypass failed components and still function

PRF No.65644 Organic Rankine Cycle with Flooded Expansion and Internal Regeneration

An organic Rankine cycle (ORC) is often used in waste heat recovery applications. These are typically small-scale applications where thermal efficiency is low, and the benefits of traditional cycle enhancements (such as reheat stages or feed-water heaters) do not typically outweigh the costs required to implement them. An ORC with flooded expansion and internal heat regeneration is an alternative method of enhancement.

Researchers at Purdue University have developed an enhanced Rankine cycle type heat engine that provides comparable benefits to traditional cycle enhancements at a reduced cost and complexity. These enhancements reduce the heat input to the system, and increase its efficiency. It is an economical way to extract more work from a waste heat stream or geothermal temperature source.

Domain: Mechanic Engineering

Advantages:

- Increased efficiency
- Increased flexibility in refrigerant choice

Agribusiness and Food

PRF No. 65190 Greatwoods - Genetically Superior Hardwoods

Black walnut trees are highly desirable for use in veneers and as decorative hardwood, but the natural tendency of the walnut tree is to grow crooked and with variable growth rates. Both of these traits reduce the timber value of the tree and cause it to yield fewer pieces of lumber. Researchers have been trying to develop a better walnut tree since the early 1960s but with little success; the long growth time of the tree and a lack of genetic research in the past put making a better walnut tree out of reach until now.

Using various techniques researchers at Purdue University were able to develop several new walnut varieties that reduce variation in growth rate and tree form. These Greatwoods have higher growth rates, better timber quality, and a stronger resistance to disease than any clones currently available.

Black walnuts are not the only improved species being developed. The goal of the Hardwood Tree Improvement and Regeneration Center (HTIRC) at Purdue is to improve the genetic quality and regeneration of fine hardwoods, including black walnut, black cherry, butternut, northern red oak, white oak, and American chestnut through application of classical breeding, genomics, molecular markers, genetic modification, advanced propagation and seed production technologies, and silviculture. Greatwoods are the product of decades of research and testing that have created trees that are more profitable and resilient than ever.

Domain:

- Agriculture

Advantages:

- Higher timber quality
- Higher growth rate
- Better disease resistance

PRF No. 65530 PCR Assay to Identify dw3 Stable Alleles

Technology Readiness Level: 9

Sorghum plant height is a quantitative trait controlled by four major genes. Nearly all of the grain sorghum grown in the developed world is produced using semi-dwarf cultivars. These cultivars commonly are called "3-dwarf" sorghums since they utilize the recessive dwarfing alleles at three of the major dwarfing genes. Dw3 is the only height gene that has been cloned in sorghum. The recessive dw3 allele used in nearly all commercial cultivars does not produce a functional protein, and, although it can produce a useful dwarf phenotype, the allele is unstable and reverts to dw3 or tall plants. Commercial seed producers do not like height mutants because considerable effort is required to rogue these plants from hybrid seed production fields, which raise costs and seed loss.

Purdue researchers have developed a PCR assay to screen for stable dw3 alleles. Using this assay, four natural variants of dw3 were identified. These new alleles represent a solution to the problem of height mutants in sorghum and have been termed "dw3 stable." Plants with the new alleles cannot be differentiated from plants with the unstable allele by visual inspection. PCR markers have also been developed for the gene to facilitate marker assisted introgression of these alleles into elite parent lines.

Advantages:

- Eliminates height mutants
- PCR markers developed to allow identification of four stable dw3 alleles

Biotechnology and Medicine

PRF No. 66061 Wireless Magnetic Tracking for Radiation Cancer Therapy

Technology Readiness Level: 5

A serious side effect of radiation therapy for cancer treatment is that it kills healthy cells as well as cancerous cells. To limit the damage to healthy tissue the radiation is directed only to the area around the tumor. This is not an easy task because of the movements of organs within the body, the motion of which must be tracked to minimize collateral damage. Wired and wireless tracking systems currently exist but both have drawbacks. Wired systems require wires to extend through the skin which increases the risk of infection and can be mentally distressing to a patient. Existing wireless systems use passive transponders and can only track one of them at a time. Researchers at Purdue University have developed a novel wireless tracking system using active transponders, allowing multiple transponders to be tracked quickly and accurately. The transponders can also function as dosimeters to measure the radiation intensities at various sites.

PRF No. 63076 Forehead Vital Signs Monitor

Technology Readiness Level: 4

When performing medical operations, patients are usually connected to monitors that are away from the patient's body. If an anesthesiologist is monitoring the patient, it is not convenient for him to look away from the patient and the gauges to check the patient's heart rate, blood pressure, or oxygen saturation levels of the blood.

Researchers at Purdue have developed a lightweight, noninvasive, optical sensor applied to the forehead that can acquire systolic, mean, and diastolic pressure, heart and respiratory rate and oxygen saturation. It is useful for monitoring during surgery and other procedures in conscious or anesthetized subjects. Placing the monitor on the patient allows the surgeon or anesthesiologist to concentrate on the patient without having to look away to obtain vital signs.

Advantages:

- Lightweight
- Non invasive
- Easy to use

PRF No. 65127 Aerosolized Sol-gel Tissue Encapsulation

Technology Readiness Level: 3

Researchers at Purdue University have devised a method to encapsulate living cells within a mistable matrix for use in sensors or as adaptive drug delivery devices. Prokaryotic or eukaryotic cells can be suspended in the silica sol gel material, and then loaded into a nebulizer to aerosolize it into a fine mist of liquid particles. The aerosol can be used to actively or passively coat surfaces. The cells are able to maintain their functionality, affixed under the sol gel layer. This method can allow for the implantation of foreign cellular material without global suppression of the immune system.

Advantages:

- Highly adaptable
- Can be utilized under normal laboratory conditions
- Possible to generate complex lamellar glasses with layers tailored to facilitate different processes
- Layer thickness can be easily controlled

PRF No. 65660 Touch Actuated Micropump for Transdermal Drug Delivery

Technology Readiness Level: 3

Transdermal delivery of medications and other compounds has been aggressively pursued for many decades. Although patches have been used to deliver small hydrophobic molecules such as nicotine and nitroglycerin, an external pressure source in conjunction with a direct subcutaneous access port are required to deliver the majority of therapeutically important drugs through the skin. Microfluidics has played an important role in this area by providing microneedle arrays and miniature pumps. Although microneedle arrays made of silicon, polymers, and metals have reached a high degree of maturity in the past decade' their application has been limited due to the lack of a suitable micropump with adequate flow rate and back pressure.

Purdue University researchers have developed a new type of pump for drug-delivery patches that would use arrays of "microneedles" to deliver a wider range of medications possible than with conventional patches. The pump contains a liquid that boils at body temperature so that the heat from a finger's touch causes it to rapidly turn into a vapor, exerting enough pressure to dispense the drug through the microneedles. This technology's low-cost and battery-less operation make it the ideal single-use/disposable transdermal drug dispenser.

Advantages:

- Battery-less operation
- Low-cost and disposable

PRF No. 65683 Vaccine Linkers to Attach Proteins to Aluminum Hydroxide Adjuvants

Technology Readiness Level: 3

Vaccines typically work by exposing the body to an antigen, which is either a weakened form of a microorganism or a toxin that it creates. This exposure stimulates an immune system response that lets the body recognize the pathogen so that it can more easily recognize and destroy it in the future. Sometimes the proteins used in the vaccine are bound to an adjuvant (commonly aluminum hydroxide) which acts as an irritant to enhance the immune response to the antigen while reducing the amount of foreign material that must be injected. To attach the aluminum hydroxide to the protein a phosphate group is first attached to the protein; phosphate groups have a high electrostatic affinity for aluminum hydroxide so they readily bond to each other. However, current techniques for attaching the phosphate group to a protein have the unintended effect of changing the structure of the protein.

Purdue Researchers have developed a simple chemical reagent that attaches a phosphate group to specific sites on the protein that do not change the overall structure. This method can work with a wide variety of antigens and could lead to more effective vaccines for many different pathogens.

Domain:

- Pharmaceuticals
- Veterinary

Advantages:

- Does not modify protein structure
- Works with many varieties of antigens
- Uses adjuvant with excellent safety record

PRF No. 65250 Oxygen Generator to Aid Cancer Treatment

Technology Readiness Level: 4

Radiation, surgery, and chemotherapy are the three major treatments for cancer. Radiation destroys cancer cells by using high-energy photons to damage the cell's DNA. The effectiveness of radiation is dependent upon the oxygen concentration in tumors; however, the abnormal structures of tumor vasculature are leaky, lending the tumor environment hypoxic. Hypoxia can impede the success of radiation therapy because oxygen is necessary for successful cancer treatment.

Researchers at Purdue University have developed an ultrasonically powered, implantable micro-oxygen generator that can increase oxygen levels in a tumor target during radiation treatment. The generator has overall dimensions of 1.2mm x 1.3mm x 8mm, so it is small enough to be implanted using a hypodermic needle. This technology performs electrolysis to generate oxygen, which may be able to restore intratumoral oxygen concentrations to a normal or hyperoxygenated level, increasing the effectiveness of cancer treatment outcomes.

Domain:

- Biomedical Engineering

Advantages:

- Increases effectiveness of cancer radiation treatments
- Small size allows easy implantation
- Ultrasonically powered using external source

PRF No. 65287 Radiofrequency Probe for Magnetic Resonance Imaging and Spectroscopy

Technology Readiness Level: 4

Currently, nanoscale imaging methods are limited due to the inability to investigate structural and chemical information at the single cell level. While there are imaging techniques that can be used for determining nanoscale structural information, these techniques are unsuitable for applications with living biological materials.

Researchers at Purdue University have developed a method for the investigation of structural and chemical information at the single cell level. This method uses a radiofrequency probe coupled with an atomic force microscopy cantilever for precise localization to areas of interest and magnetic resonance for determining nanoscale structural information. This technology couples the precision of atomic force microscopy with magnetic resonance imaging to allow for single cell imaging of living biological materials. This technology will allow researchers to gather nanoscale information on the surface and subsurface levels of individual cells.

Domain:

- Biomedical Engineering

Advantages:

- Offers precise localization to features/materials of interest
- Provides nanoscale structural information in addition to local spectroscopic information
- Suitable for investigation at the single cell level

PRF No.65476 Device for Continuous Measurement of IOP

Changes in intraocular pressure (IOP) are harmful to a patient's eyesight causing irreversible damage. IOP monitoring is essential in the study and cure of many eye diseases, especially glaucoma. Current monitoring systems are unable to provide continuous monitoring of the patient, and the results are affected by individual patient variances in the eye. These devices also only detect IOP indirectly, by measuring applied pressure and flattening of the eyeball.

Researchers at Purdue University have developed an IOP monitoring system, which provides a direct and continuous monitoring of the patient's IOP, while at the same time, being independent of patient differences. Continuous monitoring is especially important when studying and curing diseases, such as glaucoma. The OccuTack consists of three components: a wireless implantable sensor, a penetrating needle for insertion, and a surgical tool for implantation. An external, wireless reader monitors the output of the sensor. This device was designed to be minimally invasive to the patient.

Domain:

- Biomedical Engineering

Advantages:

- Direct and continuous measurement of IOP
- Minimally invasive

PRF No. 66011 Implantable Wireless Glucose Sensor

Technology Readiness Level: 4

Type 1 diabetes afflicts approximately one million people living in the United States and 10 to 20 million people worldwide. Caused by the body's inability to produce its own insulin to regulate blood glucose levels, type 1 diabetes can cause a wide variety of complications and requires careful monitoring of glucose levels and insulin injections. The most common way to monitor blood glucose levels is with a finger stick, which measures glucose at a point in time, potentially missing important fluctuations, such as sudden hypoglycemic episodes. The most effective way to measure glucose levels is to monitor it continuously in a way that it could be recorded and tracked. To accomplish this, various monitor designs have been proposed, including several designs for implantable sensors, but most require an internal power supply or make use of potentially dangerous enzymes.

Researchers at Purdue University have developed a new design for an implantable glucose monitor that requires no internal power and has a fast reaction time to changes in glucose levels. The device uses a glucose sensitive ferrogel, which grows and shrinks based on the level of glucose present. The device is expected to have an area no larger than one cubic centimeter and once implanted into the body's soft-tissue, the ferrogel's change in size can be detected wirelessly, providing a continuous measurement of glucose levels.

Domain:

- Biomedical Engineering

Advantages:

- Device requires no internal power supply
- Fast reaction time to changes in glucose levels
- Provides continuous measurement of glucose levels

PRF No. 65667 Detection and Treatment of Aurora A Kinase Related Diseases

Technology Readiness Level: 3

Aurora A (AA) kinase is overexpressed in several types of cancers including prostate, breast, ovarian, colorectal, gastric, pancreatic, hepatocellular, gliomas, nonendometrioid, and aggressive non-Hodgkins lymphoma. Despite the well documented role of AA in cancer, the mechanism leading to oncogenesis remains unclear, mostly because only a few cancer related pathological targets of AA have been identified. The limited knowledge of which proteins AA effects has prevented the creation of cancer therapies and detection methods targeted to the AA pathway.

Researchers at Purdue University have identified LIMK2 and PHLDA1 as targets of AA. This knowledge has allowed the researchers to develop a method for detecting, prognosing, and monitoring cancer presence and progression in patients. Novel compounds to aid in the treatment of diseases arising from unregulated AA signaling pathways by controlling the activity of PHLDA1 and LIMK2 have also been found.

Domain: Biotechnology

Advantages:

- Accurate detection of cancer presence and stage of progression
- Novel compounds directed to treat a specific pathway cause less devastating side effects than alternatives such as chemotherapy

PRF No. 64407 Quantification of Affinity-Selected Glycopeptides

Technology Readiness Level: 2

A novel application of glycoprotein technology that greatly increases the specificity and sensitivity of serum tests for many types of cancer and other diseases was developed. Combinations of glycopeptides and glycoproteins are used in the diagnosis, treatment, and monitoring of diseases and their causes in clinical, diagnostic, and discovery medicine. With some exceptions, current tests generally lack the necessary sensitivity and specificity for early and accurate diagnosis.

Researchers at Purdue University have proposed an application of glycoprotein technology that greatly increases the specificity and sensitivity of serum tests for many types of cancer and other diseases. This novel method is used for stable isotope-labeling and affinity-selection of glycopeptides to identify serum glycoprotein changes. In addition to diagnosing and monitoring diseases, this method may also uncover novel targets for the development of therapeutics.

Domain: Biotechnology

Advantages:

- Sensitive enough to detect cancers without biomarkers
- Less complex and more sensitive than other methods

PRF No. 65604 PHLDA 1 Antagonizes Aurora A Kinase-Mediated Breast Malignancy

Technology Readiness Level: 3

Aurora A (AA) kinase is a serine/threonine kinase that is essential to the cell cycle. AA is overexpressed in several types of cancers, including prostate, breast, ovarian, and many others. More than dozen AA substrates are known; however, very few have been identified as potential targets in cancer. BRCA1 is the only AA substrate currently identified in breast cancer.

Researchers at Purdue University have developed a chemical genetic approach to identify additional AA substrates in breast cancer for use as potential targets for treatment of breast cancer. This approach led to the identification of several new substrates of AA, including PHLDA1.

Domain:

- Chemical Engineering

Advantages:

- Potential for targeted therapy with fewer harmful side effects than chemotherapy
- Wide variety of carcinomas may be affected by treatment of AA overexpression

Energy

PRF No. 64920 Method for Generating Hydrogen from Ammonia Borane

Major challenges exist to the commercialization of hydrogen fuelcells for wide-spread commercial use. Current methods of generation and on board storage are not safe or efficient and when combined with the fact that hydrogen technology is still too costly to be widely implemented, it is obvious that there are many roadblocks in the path of hydrogen fuel cell development.

Researchers at Purdue University have developed an innovative, new process for releasing hydrogen from ammonia borane. Ammonia borane has a high percentage of hydrogen and is a promising hydrogen storage material for fuel cells. This technology does not require the use of a catalyst and enables an increase in the amount of hydrogen released at specific temperatures than with pure thermolysis. This technology has the promise of being a major breakthrough in the area of fuel cell storage and efficiency.

Domain:

- Chemical Engineering

Advantages:

- Releases more hydrogen than current methods
- Required pressure can be easily created
- Cost effective

PRF No. 64923 Multiuse Coke Plant for Synthetic Fuel Production

Technology Readiness Level: 6

Although coke is an absolute essential part of iron making from ore and foundry processes, recently there was a shortfall of 5.5 million tons of coke per year in the United States. This shortfall resulted in increased imports, drastic increases in coke prices, and market volatility.

Purdue University researchers have developed an optimization algorithm for coke that could reduce annual coal fuel costs by up to 10 percent all-the-while allowing consideration for overlooked by-products that now have revenue potential. This cost reduction is obtained through the use of cheaper, lower heat content, high-sulfur coal from sources such as the Illinois Basin. Previously, the high-sulfur content was a detriment for coal users and almost made this coal unusable due to its undesirable trait of forming hydrogen sulfide during the pyrolysis process. This technology can place a value on this sulfur content, too. With modern technology and the current economic drivers for alternative energy, pyrolysis gas has a multitude of uses including the production of electricity, liquid transportation fuels, fertilizer, and hydrogen. The value of lower-grade coal alternatives can now be identified, and better yet, maximized.

Advantages:

- Reduced cost of coal through utilization of Illinois Basin coal
- Enhanced revenue streams

PRF No. 64940 Fast Hydrolysis for Hydrogen Bio-Oil

The transportation sector currently relies almost exclusively on liquid hydrocarbons as its energy source for good reasons. One of many reasons is that the high energy density of gasoline far exceeds that of proposed replacements like hydrogen or batteries. Additionally, the liquid hydrocarbon fuel distribution infrastructure is efficient and already in place. Production of liquid fuels from biomass can solve the problem of CO₂ emission from the transportation sector because CO₂ released from vehicle exhaust is captured during biomass growth.

Researchers from Purdue University have invented a process of “fast” pyrolysis, which is to be used on biomass. The process feeds H₂ from a carbon-free source to a fluidized bed reactor. The H₂ is mixed with a biomass in the reactor. The resulting mixture produces a biomass containing less oxygen atoms than normal due to the addition of the hydrogen. The mixture is then sent to a separator to remove the char, which is burned to create heat for the system, from the “bio-oil.” The bio-oil is further processed to create the hydrocarbon, which is then cooled to create the liquid hydrocarbon. The H₂Bioil has all of the advantages of conventional Bio-Oil in addition to a greatly increased energy density all-the-while retaining compatibility with the conventional hydrocarbon fuel distribution, a truly carbon neutral solution to the Green transportation fuels concern.

Domain:

- Energy

Advantages:

- Dramatically lower fuel cost
- Increased bio-oil energy density

PRF No. 65621 Low Lignin Second Generation BioEnergy Crops

In the quest for energy independence, production of biofuels, such as corn ethanol, has exploded. There has been a rapid increase in biorefinery construction, and tax credits encourage further production efforts. The majority of ethanol produced for transportation purposes is from corn, but this form of biofuel production is unsustainable. Transition from corn ethanol to cellulosic ethanol (derived from wood, grasses, or the non-edible parts of plants) is necessary, and federal support for this transition is evidenced by the substantial tax credits allotted for cellulosic-ethanol producers. Maximization of available biomass is necessary, however, to ensure the long-term success of cellulosic biofuels.

Researchers at Purdue University have developed a transgenic variety of poplar tree for use as feedstock for cellulosic-ethanol production. The transformed plant accumulates biomass faster than its non-transgenic counterpart. The biomass produced is more easily degradable, and the plant is sterile. These desirable traits are owed to multiple stem growth and low lignin production.

Domain:

- Energy

Advantages:

- Rapid accumulation of biomass (multi-stemmed)
- Biomass is easily degradable (low lignin)
- Sterility confines the altered genome and further increases biomass production

PRF No. 66109 A Shade Tolerant Panel Design for Thin Film Photovoltaics

Technology Readiness Level: 6

Solar cells are becoming increasingly efficient at converting light into electricity but they still suffer from some reliability issues. One such issue is that if a cell of the solar panel is in the shade it will shut down and start absorbing excessive energy from the connected cells. The excess energy causes heating in the cell that can cause damage or even start a fire. This problem has usually been addressed by connecting diodes between segments of cells to prevent the current from flowing into a shaded panel section, but this does not work unless a large area is shaded. Researchers at Purdue University have developed a new solution to this problem by designing a radial layout for a solar panel. This design assures that a shadow will shade many cells at once, allowing those cells to distribute the reverse voltage across them. The design avoids reverse breakdown without need for external bypass diodes, simplifying the manufacturing process and alleviating shadow degradation.

Information Technology

PRF No. 64948 Technology Assisted Dietary Assessment Technology

Technology Readiness Level: 4

Purdue University researchers have developed a technology to help the health-conscious better gauge what's on their plates by using their cell phone cameras. This project expands on a technique already in use by adding a strong scientific grounding. Currently, dieters can subscribe to websites that monitor eating habits by critiquing photos they send on their meals. This offers busy people the chance to get nutritional feedback without spending time writing down all of their meals, drinks, and snacks. It is designed to help people better evaluate portion sizes and nutritional content.

This software integrates various image processing technologies to provide a reliable method for estimating the sizes of food in the photos, techniques to help identify the food in the pictures, and the nutritional knowledge base to enable food evaluations and help determine possible impacts on health.

Advantages:

- Increased convenience
- Health awareness

PRF No. 65245 ReadingMate for Active Treadmill Enthusiasts

Reading is an activity that many people cannot perform while they are moving, namely because they cannot keep focused on the words. However, many people desire to read as well as exercise and equipment manufacturers are pushing to do just that: place computer screens on treadmills to display text and video. Unfortunately the users are in motion challenging their eyes to remain focused on the content on screen.

Inventors at Purdue have developed a device they call “ReadingMate” to overcome this problem. It utilizes a head tracking device implemented with software that dynamically moves text and multimedia content on a screen. The text moves with the user’s head alleviating strain on the eyes to keep things in focus.

Domain:

- Computer Technology

Advantages:

- Technology alleviates strain on eyes allowing an enjoyable reading experience
- Applicable to other industries where turbulence is an issue, such as aviation or construction

PRF No. 65361 Privacy-Preserving Verification Software Framework

Purdue University researchers have developed a set of protocols and algorithms as part of software that allows users to prove their knowledge of attribute to a service provider. The main feature of the protocols and algorithms is that they assure privacy of user data and security and protect the user data from malicious parties which may try to steal financial information from users or determine information about the user. The software includes the actual core framework, efficiency testing, and specific applications implementations using the framework. The core framework includes zero knowledge proof of knowledge protocols, oblivious transfer protocols, aggregation of commitments and digital signatures, secret key splitting and sharing, and a database backend using oracle.

These protocols and algorithms make it possible to prove information from between devices by using Wi-Fi, Ethernet, and Bluetooth. The framework is modularized giving more flexibility to the developer working on an application. They have developed a health care demo that is specific application scenario that uses the core framework. It includes code for the Nokia 6131 phone using the zero knowledge proof of knowledge protocols to preserve a doctor's identity during an electronic prescription scenario.

Domain:

- Information Technology

Advantages:

- Can run on multiple platforms
- Medium independent
- More flexibility

PRF No. 66540 Fingerprint Reader with Haptic Feedback

Technology Readiness Level: 6

High security checkpoints, especially when crossing borders or travelling through airports, can have long wait times, leading to increased stress levels. Biometric technologies, such as fingerprint readers and iris or facial recognition programs, are often times the source of the wait times. These technologies can be especially stressful for those with a disability such as blindness.

Researchers at Purdue University have combined two commonly used technologies to make the process of scanning a fingerprint simpler and less stressful, especially for those with disabilities. A vibrating pad connected to a fingerprint sensor will vibrate at different frequencies indicating good finger placement and appropriate force. The optimal force metric is individualized for each person and is dependent on a set of preestablished criteria. This technology is especially useful for blind individuals who are unable to see if the scan is complete and often times requires assistance from an attendant or companion. This method could also be used for iris recognition and other biometric technologies where, for instance, the vibration would come from a mat on the floor that individuals stand on. Overall, this technology could reduce the need for checkpoint attendants and greatly reduce the amount of time-spent waiting in security lines, therefore, increasing throughput, decreasing costs, and reducing stress.

Domain: Computer Technology

Advantages:

- Increases ease of use for individuals with disabilities
- Decreases cost by eliminating need for attendants
- Makes process much faster and less stressful

PRF No. 64669 3D Object Construction from 2D Images

Technology Readiness Level: 6

Many emerging visual fields, such as medical imaging and vision-assisted robotics, use techniques to reconstruct 3D objects from 2D images. Accurate and efficient image processing is very important for producing a reliable image with image reconstruction. Many reconstruction methods require a transparent object with multiple symmetries, which limit accurate reconstruction.

Purdue University researchers have developed a computer algorithm that takes one 2D image of a 3D object and reconstructs the object. This algorithm uses a minimal amount of data (one 2D image) to produce accurate and reliable reconstructions. Unlike other reconstruction methods, this algorithm minimizes the use of depth cues like shading, texture, motion, and stereo. Instead, reconstruction is performed using symmetry, planarity, and compactness. It is also possible to use this method with either transparent or opaque objects, which have only one symmetry.

Domain: Computer Technology

Advantages:

- Uses only a single 2D image
- Reproduces image constructions with minimal errors
- Tolerates noise in the original image
- Requires less input information compared to previous models

PRF No. 64976 Optimized AES for Devices and Wireless Networks

Technology Readiness Level: 7

Advanced Encryption Standard (AES) is an encryption protocol adopted by the United States government. It is difficult to use the AES protocol in low-rate wireless personal area networks (LR-WPAN) because of the enormous memory requirement and a resulting reduction in speed. Therefore, a secure encryption/decryption coding method that uses small amounts of memory while performing at an acceptable speed is needed.

Purdue University researchers have developed a new method of coding the AES that maintains the necessary speed (data encryption rate) while reducing the amount of memory required. This software solution is much more flexible and cost effective compared to current hardware implementations seen today in LR-WPAN.

Domain: Computer Technology

Advantages:

- Completely software based (minimizes need for additional hardware)
- Uses less memory: Random Access Memory (RAM) & Read Only Memory (ROM)
- More flexible than current hardware solution
- Reduces cost and size of circuit board

PRF No. 62028 Fault-Tolerant Time-out Communication Protocol

Technology Readiness Level: 6

Current single sensor flow systems are large and cannot measure multiple variables nor guarantee the delivery of accurate information all the time. On the other hand, sensor arrays, particularly micro-flow sensors, have costs, such as scaling problems, lack of proper development, and faults that make them less desirable. A large part of this problem is also due to the lack of a proper communication system that allows for efficient use of system resources among the sensors.

Purdue University researchers have developed a technology that implements innovative software that controls micro-flow sensor networks to solve the reliability issues and improve placement flexibility. The sensors are grouped in a way to provide immediate response to flow problems in less time. The software that controls these sensors ensures that the flow network operator is notified accurately and promptly to provide an immediate response that will not delay production or testing decisions.

Domain: Computer Technology

Advantages:

- Set up is easily understood and simple to implement
- Faster response to flow problems
- More reliable monitoring and control

PRF No. 65241 Constraint-Network Prognostics and Diagnostics

Technology Readiness Level: 6

Airport surface operations must ensure safety while increasing efficiency and throughput. Conflict detection and resolution (CD&R) detects and resolves trajectory conflicts between aircraft and ground transportation vehicles; however, current CD&R systems face various challenges. For example, manual CD&R prevents conflicts through separation assurance but underutilizes available resources. Computer-integrated CD&R notifies controllers of impending conflicts, but ultimately provides limited predictability. An improved method of conflict and error prediction and detection (CEPD) is needed to maximize efficiency of airport ground activities.

Researchers at Purdue University have developed a system based on interactive, constraint-network prognostics and diagnostics to control errors and conflicts (IPDN). IPDN is designed for systems with multiple cooperative units each configured to collaborate with other cooperative units in an environment where resources are shared. This CEPD system enables automated detection of conflicts using the relationships among cooperative units. Furthermore, IPDN enables automated, global resolution of conflicts through network analysis.

Domain: Computer Technology

Advantages:

- Automated detection of conflicts
- Uses network analysis to resolve conflicts

PRF No. 65981 Mixable - Social Learning Application

Technology Readiness Level: 9

College students are already accustomed to using Facebook, Twitter, and other social networks to connect with each other and share information, but they are rarely used for academic purposes. Researchers at Purdue University have developed a web tool, called Mixable, to extend student connections beyond the classroom and better enable them to share information for courses or learning networks.

The foundation of Mixable is class-based sharing, allowing students to share audio, images, links, files, and more. Students can connect with their enrolled classes to share audio lectures, form custom study groups, and much more. A major benefit of Mixable is that it can be used inside of Facebook and integrates with Twitter and Dropbox. Students are already familiar with these programs, so they can begin networking with little introduction. Mixable is available as an iPhone and Android mobile app, allowing students to connect socially and share information.

Domain: Computer Technology

Advantages:

- Integrates into popular open tools that students already use
- Conveniently available on the web and mobile devices
- Collects shared resources for easy access
- Builds connections with other students as well as friends
- Lectures and class files available anywhere

New Materials

PRF No. 64025 Cross-Linkable Polymeric Materials for Adhesion

Polymers currently available have a rigid structure that is not amenable to modification. It is beneficial to have access to materials whose physical properties can be changed to fit a given application. Researchers at Purdue University have developed a new class of modifiable polymers which supersedes those currently available. Such polymers can be used in industrial to medical adhesives, rust-proof coatings, and many other applications.

Purdue Researchers have developed a family of polymers in which cross-linking groups are incorporated. The polymers have varied properties (e.g., hardness, crystallinity) and varied degrees of incorporated cross-linking groups. The polymers are prepared such that they can be cross-linked with various metals. By combining flexibility in polymer design along with flexibility in cross-linking reactions, we present a new and versatile family of materials which include water soluble, UV-cure and solvent applications.

Consequently, new materials can be designed with, for example, various hardness, adhesive, electronic, and optical properties. These materials have been tested for strength on a polished aluminum surface, a traditionally difficult surface for bonding, and showed strong adhesion up to 5 MPa (~750 lb/in²). Bonding strength on par with super glue all without having been optimized. The polymer plus crosslink material is also stable in boiling water for up to 2 hours.

Domain:

- Materials Engineering

Advantages:

- Uniquely strong waterproof adhesive
- As strong as super glue without having been optimized

PRF No. 64677 Generalized Intelligent Grinding Advisory System

Grinding processes in manufacturing are diverse and complex with many variables affecting the process. Optimizing these variables is no simple task. Traditional grinding techniques say a very fine grind in a slow fashion is the best way to obtain a smooth surface finish. Conventional optimization strategies, which aim to speed up this generally slow process, often involve the use of trial and error and are of limited effectiveness.

The Generalized Intelligent Grinding Advisory System (GIGAS) has been developed to optimize complex manufacturing processes using novel methodologies. The optimization allows grinding to be done as quickly as possible, while maintaining the desired surface finish. This software based technology incorporates mathematical models and experimental data to enable an automatic optimization of the grinding process. GIGAS consists of several software databases which contain information on grinding machines, processes, and optimizations. To optimize an installed grinding machine, a user inputs the type of machine, materials being ground, the desired outcome along with several other variables. The software then quickly performs an efficient optimization based on those specifications. The user can then set up the grinding machine appropriately and enjoy the reduced manufacturing times while maintaining or even improving upon the original finish quality. With this technology manufacturers could typically see a 10-15% reduction in grinding times, with reductions of up to 65% possible, along with a 10% reduction in cost. As this technology is software based it requires little to no capital investment and has a return on investment of under 1 year. The current market for this technology is \$10 Billion.

The software's capability to automatically and quickly understand a situation effectively removes the need for a large amount of training data and trial runs. The software currently supports surface, cylindrical plunge, and cylindrical traverse grinding processes, but can easily be expanded to other grinding processes such as center-less and internal grinding.

Domain:

- Materials Engineering

Advantages:

- Automated grinding optimization
- Supports multiple types of grinding optimizations

PRF No. 64699 Self-Cleaning Materials

It has been possible to separate small amounts of oil from water for quite some time. This was made possible through the use of nanoporous filters. Unfortunately the minute size of the holes in a nanoporous filter requires the filtering process to be highly pressurized in order to function. In some situations such as oil spill cleanup, this is not always practical.

Inventors at Purdue University have devised a method of separating the small amounts of oil from water through the use of an advanced membrane coated glass micro filter. Micro filters don't have the same pressure requirements as nanoporous filters; therefore, water can flow freely through them. The membrane is composed of a patented hydrophilic layer of polyethylene glycol and each molecule is tipped with fluorine. The water is attracted by the polyethylene glycol and flows through both layers freely. The oil is stopped at the fluorine barrier where it beads and can be easily removed through the use of cross flow filtration. Typical filters collect oil and must be changed out frequently when they have been rendered ineffective. This technology saves money though extending the life of the filter by making the oil easy to remove instead of exchanging the filter itself; all without the need for high pressure parts, lowering system costs.

Domain:

- Materials Engineering

Advantages:

- High Pressure system is not necessary
- Longer life so filters do not need to be replaced as often

PRF No. 65476 A Nanofluidic Channel with Embedded Transverse Nanoelectrodes

Fabrication of nanochannels is attracting considerable interest due to its broad applications in nanobiotechnology and distinct advantages compared to more commonly used nanopores. Nanochannels allow for slower translocation and multiple sensing spots along the channel, which improves readout resolution; however, they require optical and electrical accessibility, which has proven difficult to provide.

Purdue University researchers have developed a novel fabrication technology for a nanofluidic channel that is simple and compatible with complementary metal-oxide semiconductor (CMOS) fabrication. Nanoscale electrical contacts are implemented on the channel, and a glass cover allows real-time microscopic examination.

Technology Domain: Biochemical engineering

Advantages:

- Compatible with CMOS fabrication
- Allows for electrical accessibility
- Real-time microscopic examination

PRF No. 2012-MART-66293 Acoustic Metamaterials with Embedded Microresonators

Technology Readiness Level: 4

Metamaterials are materials made to have special properties not found in nature, such as the ability to direct and manipulate sound waves. To accomplish this, resonator units are built into the material to control the way sound passes through. These acoustic metamaterials could reduce the noise and vibrations of vehicles, focus sound for communication systems, or even generate electricity from acoustic vibrations.

Purdue University researchers have developed a novel metamaterial and manufacturing process with micron-sized resonators suspended in matrix material. The resonators are composed of a hard ceramic or metal oxide core surrounded by an elastic solution, which allows the core to vibrate independently of the matrix. The material can be adjusted to select an effect or resonant frequency.

Domain: Materials and Manufacturing

Advantages:

- Adjustable resonator characteristics

PRF No. 2013-ZIAI-66463 Adhesive Tape as a Smart Material

Technology Readiness Level: 5

Environmentally-responsive materials are the basis for many emerging and novel applications in microsystem technologies. Polymers with enhanced humidity response can be used as humidity sensors or moisture-triggered actuators. Current efforts in this area have been geared towards engineered hygroscopic polymers with enhanced sensitivity, but these can be difficult to fabricate and handle.

Researchers at Purdue University have developed a humidity-sensitive smart material using laser-machined adhesive tape. The researchers discovered that the cellulose-acetate in the tape absorbs water, but the adhesive film repels it causing the tape to curl when in contact with moisture. The tape is brittle when dry, becomes flexible when immersed in water, and restores to its original shape upon drying, which is a crucial characteristic for an actuator material. A laser was used to machine the tape to one-tenth of its original thickness to magnify the curling effect. Cutting the tape at different angles also affects the direction and magnitude of bending.

The innovation could be used to collect water samples for environmental testing, to enhance heat dissipation from skin or other moist, hot surfaces, or as low-cost humidity sensors for agricultural and industrial applications. With added magnetic material, the tape could also be functionalized for remote manipulation.

Domain: Materials & Manufacturing

Advantages

- Inexpensive and simple to fabricate
- Uses a commercially available product

Civil Engineering

PRF No. 63081 Water/Cement Contents and Compressive Strength of Concrete from TDR

Technology Readiness Level: 9

A non-destructive, quick method of measuring the water content, cement content, water-cement ratio, and compressive strength of concrete was developed using time domain reflectometry. Current techniques for measuring the properties of concrete such as water-cement ratios and compressive strengths are often destructive and time consuming. New technologies are needed to increase the efficiency of concrete property testing.

Researchers at Purdue University have developed a means of measuring the water content, cement content, water-cement ratio, and compressive strength of concrete from time domain reflectometry in a non-destructive, quick manner. The method uses a step electrical pulse that is applied to a simple, rugged, and disposable probe embedded in concrete and the principle of Time Domain Reflectometry to estimate the free water content and the cement content from which the water-cement ratio is calculated. Monitoring the signal and temperature with time allows for the long-term strength calculations from data gathered at short times to be estimated, typically within one day.

Domain: Civil Engineering

Advantages:

- Non-destructive testing
- Fast test times

Electrical Engineering

PRF No. 63049 Anisotropic Etching of Polyethylene Terephthalate

Technology Readiness Level: 3

Polyethylene terephthalate (PET) is often used as a substrate for flexible electronic devices. However, PET cannot be easily etched to form membranes for device applications. In the past, etching was done using laser ablation, which is expensive and can only etch very small areas.

Purdue University researchers have developed a new method for etching PET, which is cost effective and useful for etching large areas. This technology allows for the etching and precise shaping of PET. It combines the use of several technologies to create an effective procedure for creating PET devices.

Domains: Electrical Engineering, Materials and Manufacturing

Advantages:

- Improves accuracy
- Enables large areas to be etched -More cost effective than laser ablation

PRF No. 65732 Vibratory Analysis of Batteries

Technology Readiness Level: 6

The prediction of future failure, either gradual or catastrophic, plays a vital role in many applications that employ lithium-ion battery technology. Failure prediction in lithium-ion batteries is currently based on visual inspection or measurement of global properties, such as overall cell voltage, current, etc.; however, these techniques are ineffective in the preemptive detection of localized damage in an individual cell because the qualities are measured as an average of the whole cell. Techniques that are more precise are needed in order to more effectively detect current defects and predict future failures.

Researchers at Purdue University have developed a 2D pressure sensor for use in lithium-ion batteries. The device directly determines the state of charge and detects levels of damage that traditional inspection techniques ignore, sensing localized damage before it propagates throughout a cell. This technology allows for the direct detection of failure and the prediction of future failure well before it has become an operational issue, thus allowing appropriate action to be taken.

Domains: Electrical Engineering

Advantages:

- Exact measurement of battery charge state
- Capable of monitoring general battery health
- Can predict future failures

PRF No. 2013-NOF-66347 Failure Prevention and Repair for Energy Distributions

Technology Readiness Level: 4

The United States electricity grid is a complex system including numerous utility companies distributing power across large distances, with it often being bought by or sold to other companies before eventually reaching the consumer. This distributed system has many lines operating at near capacity on older equipment. These factors greatly increase the probability of a node failure in the system, which can easily damage other nodes causing a cascade of node failures. Repairs to these failures in the grid are currently completed in random order. This does nothing to minimize the further propagation of failures in the grid and increases the cost of the failures.

Purdue University researchers have developed a new method for selecting the nodes to repair in an electrical grid. The method analyzes the network topology to schedule repairs in a way to minimize the damage caused and prevent additional failure. The repairs can be done in a centralized or decentralized manner, depending on the resources available, providing a customized repair strategy for any failure. In a demonstration modeling daily activity in the Western United States power grid, the new model outperformed the current practice taking 50% less time to respond to and complete repairs, 80% less damage cost, and increased prevention of additional node failure by 300%.

Advantages:

- Customized repair strategy for any failure
- Outperforms current process

PRF No.66439 Wireless Antenna for Mobile Phone

The increasing complexity of integrated circuits has seen a rise in the need for wireless antennas that can fit the low area and high performance needed. With current devices, the antenna is usually bonded to the chip prohibiting compact integration, or included on the chip suffering from substrate loss. To stay current with device miniaturization and increasing data rates, there needs to be a new type of antenna.

Purdue University researchers have developed a new type of antenna that can be implemented with a low area and high efficiency by using solder bumps connected together. The antenna can easily be implemented in standard flip-chip bonding technology or three-dimensional integrated circuits; it utilizes the existing solder bumps, so area overhead is minimal. Antenna radiation performance is also greatly improved because of the size and distance from the lossy substrate.

Advantages:

- Reduced size
- Improved bandwidth and efficiency
- Easily integrated into existing manufacturing technologies

PRF No. 66539 Integrated Scalar Power Meter and Reflectometer

Technology Readiness Level: 4

Meter data analytics refers to the methods of reading electric energy consumption recorded by meters. A growing trend in this field is the replacement of traditional scalar meters with smart meters with modern capabilities, allowing utility companies to operate more efficiently.

Researchers at Purdue University have developed a device that utilizes the broadband capabilities of a scalar power meter, the phase information of a reflectometer, and compatibility with couplers within the range of 1 MHz to 6 GHz. The measurement of phase information is capable of producing complex impedances of the input signal. This information is then communicated to the user through both an onboard display and web-hosted server, which can be viewed via internet browser.

Domain: Electrical Engineering

Advantages:

- Graphical and web-based display of power and impedance measurements
- Integration of measurement devices for easier monitoring of energy consumption

PRF No. 66590 Metasurfaces for the Advanced Control of Waveguiding Properties

In the radio frequency portion of the electromagnetic spectrum, metallic components can provide ideal electric and magnetic boundary conditions. In this regime, the frequencies of interest are so far away from the plasma frequency of the material that the electrons within can respond almost instantaneously to changes in the applied field to maintain the boundary conditions of the metal. Moving into the optical regime of the electromagnetic spectrum, such conditions are not necessarily true. The loss of these ideal boundary conditions leads to several detrimental effects such as lack of modal confinement and large dispersion.

Researchers at Purdue University have designed metasurfaces to generate perfect boundary conditions for an optical waveguide. These metasurfaces allow the control of the waveguide properties, such as pulse width and mode shape, by the manipulation of phases at the interface. Metasurfaces are extremely thin films of metamaterials, assemblies that contain features, patterns, or elements, such as tiny antennas or alternating layers of oxides that can greatly reduce interface reflection by enabling the control of air permittivity and permeability. These metasurfaces can be integrated into existing manufacturing processes, which make them very practical for commercialization.

Advantages:

- Reduces light permittivity and modal leakage
- Can be incorporated into existing manufacturing processes

PRF No. 66591 Metasurfaces to Enhance the Efficiency of Semiconductor Light Sources

The properties of reflection and refraction have been used to develop extraordinary technologies, such as waveguides and polarization filters, but in many cases, these effects limit the performance of a system. For semiconductor-based light sources, there is an impedance mismatch between the structural properties of the material and the surrounding air. This difference causes a significant reflection to occur at the interface and can limit the output efficiency of the light source.

Researchers at Purdue University have developed new optical technologies called metasurfaces that enable the ultra-efficient control of light. Metasurfaces are extremely thin films of metamaterials, assemblies that contain features, patterns, or elements, such as tiny antennas or alternating layers of oxides that can greatly reduce interface reflection and increase the output efficiency of the semiconductor light source. These metasurfaces can be integrated into computer chips for information processing and telecommunications and can be manufactured using the same materials and methods as current industrial processes.

Advantages:

- Unprecedented control of light in semiconductor applications
- Easy integration into existing manufacturing systems

PRF No. 66592 Metasurfaces to Enhance the Efficiency of Solar Cells

The properties of reflection and refraction have been used to develop extraordinary technologies such as waveguides and polarization filters, but in many cases, these effects limit the performance of a system. For semiconductor solar cells, there is an impedance mismatch between the structural properties of the material and the surrounding air that causes light to be reflected, significantly limiting the amount of light absorption into the cell.

Researchers at Purdue University have developed new semiconductor applications called metasurfaces that improve the efficiency of light absorption in solar cells. Metasurfaces are extremely thin films of metamaterials, assemblies that contain features, patterns, or elements, such as tiny antennas or alternating layers of oxides that can greatly reduce interface reflection by enabling the control of air permittivity and permeability. These metasurfaces can be integrated into existing manufacturing processes, which make them very practical for commercialization.

Advantages:

- Increase the light-harvesting capacity of solar cells
- Reduce the size and charging time of solar cells
- Improved customization to meet a wider array of applications

PRF No. 66596 Flexible Printed Coil for Stringed Instruments

Technology Readiness Level: 4

Traditional inductive pickups, such as those used in electric guitars, feature one or more permanent magnets surrounded by a wire coil.

String vibrations cause the electromagnetic field to oscillate and induce a voltage in the stationary coil. The electric signal generated is then carried to a power amplifier and speaker. Unfortunately, the wire coils in the pickup often produce undesired feedback and need to be potted with wax or a polymer. In addition, manufacturing the coils involves winding copper wire, with the diameter of a human hair, around thousands of turns, which makes the process tedious, time consuming, and difficult to produce coils with identical shape and sound.

Researchers at Purdue University have developed a flexible, printed circuit board that emulates the wire coils of a traditional pickup. A conditioning circuit is also in place to ensure that the output signal matches that of a traditional pickup, but with greater sound quality and reliability. By eliminating the coil, the weight of the pickup is reduced and the manufacturing process is greatly simplified.

Domain: Electrical Engineering; Mechanic Engineering

Advantages:

- Reduces undesirable feedback
- Greatly reduces weight of pickup
- Can be used in a larger range of stringed instruments
- Simplifies and reduces cost of manufacturing process

PRF No. 66606 Advanced Structure for Power DMOSFETs and IGBTs

Double-implanted metal oxide semiconductor field-effect transistors (DMOSFETs) are transistors used for amplifying and switching electronic signals. One of the main materials used in DMOSFET construction is Silicon, which is starting to be replaced by Silicon Carbide (SiC) due to its superior ability to block voltages above 600 V. Unfortunately, at lower voltages SiC's on-resistance becomes dominated by the channel resistance.

Researchers at Purdue University have developed a method that reduces the specific on-resistance of SiC transistors by a factor of two or more. This is done by incorporating "fins" and "trenches" into the SiC surface, thereby, increasing total surface area without increasing the lateral surface area of the transistor. With a larger surface area, the on-resistance is reduced and the current carrying capacity of the channel is increased. This method can also be used with insulated-gate bipolar transistors (IGBTs); it only requires a structural change and not the inclusion of advanced materials.

Advantages:

- Increases on-resistance without increasing the size of transistor
- Does not require advanced materials