

Energy and Environment

ENERGY AND ENVIRONMENT

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Aerobic Waste Sludge Digestion with Intermittent Ozone Dosing

Ozone-Assisted Advanced Sludge Digestion

The waste sludge which is aerobically digested in 15-30 days in the standard procedure with 30-40% performance; is now being digested with 70-80% performance in 4 days. Residual sludge is disinfected and it is toxicant free.

Environmental, friendly and economical solution for waste sludge disposal

Anaerobic sludge digestion is preferred over the aerobic owing to its lower energy consumption; yet it is not suited for the new-age treatment plants. Whereas contact period in ozone assisted process reduces to 4 days from 15 days and extent of digestion goes up to >80% from the early 30-40%. The process is well suited to the modern plants by preventing phosphorus leakage and by producing toxicant free final residue.

With this invention ozone is intermittently dosed during 4 days into aerobic sludge digestion to give a particular ozone concentration in the liquid. At the end of this application sludge digestion increased >80% from 30-40% and the process duration reduced to 4 days from early 15-30 days. Residual sludge is disinfected and free from toxic contaminants.

Advantages

- Reduced contact period, smaller footprint
- Higher digestion percentage
- Entrapped phosphorus in sludge
- Disinfected peat-like residue
- Residual sludge, free from toxic contaminants



CMOS Compatible Microchannel Heat Sink for Electronic Cooling and Its Fabrication



Micro-Cooler

The invention allows cooling of microchips with integrated microfluidic channels in a fast and efficient manner. The channel fabrication process is very simple and CMOS compatible.

Advantages

Low-Cost

MEMS fabrication reduces cost

CMOS Compatibility

Fabrication process of the microchannels is CMOS compatible

Simple Fabrication

Very simple fabrication process of the microchannels

Effective Cooling

The approach can cool down microchips much faster than the previously reported approaches

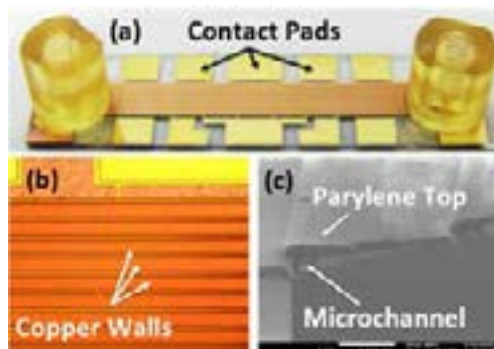
Wide applicability

Same device concept can be used to for other systems such as laser systems where cooling is necessary

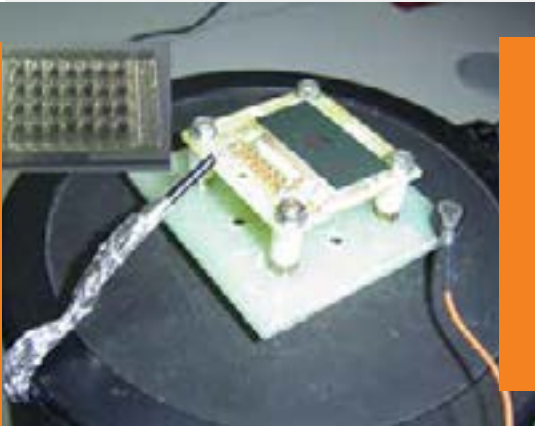
Microchips are cooled with integrated microfluidic channels in a fast and efficient manner

Microchannel heat sinks are basically compact heat exchangers with very high area/volume ratio. In order to minimize the thermal resistance, and for easy system integration the microchannels should be integrated with the circuit; therefore having a CMOS compatible fabrication flow for the microchannels is very important.

In this invention, a new, CMOS compatible, simple, low-cost fabrication technique for microchannels has been developed using metal and polymer materials. The microchannel heat sink can be fabricated monolithically with the circuit on the same process flow without requiring any change in the design of the circuit, unlike the available techniques. Moreover, the polymer coating prevents the excess heat from expanding to other system elements.



Method of Energy Harvesting Using Built-in Potential Difference of Metal-to-Metal Junctions and Device Thereof Vibration to Electrical Energy Converter Over Large Areas



Electricity Through a Touch

Scalable so that random vibration sources in different points over large areas can be harnessed to yield a single electrical output.

Advantages

Low-Cost

Simplicity of the device reduces cost

Scalable

Multiple devices can be placed on large surfaces

Embeddable

The device can be embedded within structure allowing covert integration

Flexible

The electrodes can be made of flexible materials to be integrated on alike

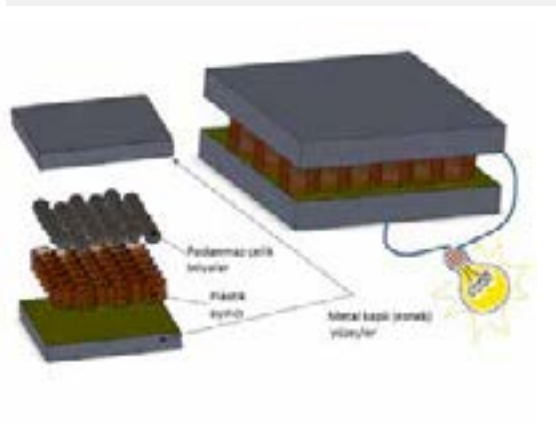
Wide applicability

Same device concept can be used to harness random vibration contraction-extension, or rotation

Converts motion to electricity realizing wireless/battery-free autonomous systems

It shakes steel balls between two different electrodes yields charge transfer induced by contact potential difference and encapsulating a large number of freely-moving balls within insulating guide channels between two electrodes allows a simple vibration harvester. Each ball acts like an independent electrical charge shuttle to contribute to overall generated electricity.

It does not require a redesign for different vibration sources. It is possible to merge the generated electricity from completely uncorrelated vibration sources into a single output and generate electricity over large surfaces with a accost-effective device.



Energy Dissipating Connector

A Replaceable Energy Dissipating Connector for Light-Gage Steel and Wood Structures

The invention is a connector that has superior stiffness and load capacity and can be fabricated simply and inexpensively. It also allows high energy dissipation through plastic deformation of anchor rod.

A safe and efficient force transfer between wall panels and from wall panels to foundation system

Connections between wall panels and from wall panels to the foundation system are required in light-gage and wood structural systems in order to resist the effects such as those caused by wind and earthquake. For this purpose, connection elements called "hold-down" are used in practice. In addition to their stiffness and load capacity, energy dissipation characteristics of these connections become very important for performance of the structural system under lateral loads.

The invention utilizes a geometry that significantly differs from most of the hold-down devices widely used in the industry. This geometry results in a more efficient force transfer mechanism in the connection. This new geometry also allows the plastic deformations to be localized within the anchor rod with no major deformations occurring in the rest of the structural system during disasters such as an earthquake or a hurricane.

Advantages

The hold-down device possesses superior load capacity and stiffness

No plastic deformation is expected on the hold-down device under lateral load effects such as those due to earthquake and wind

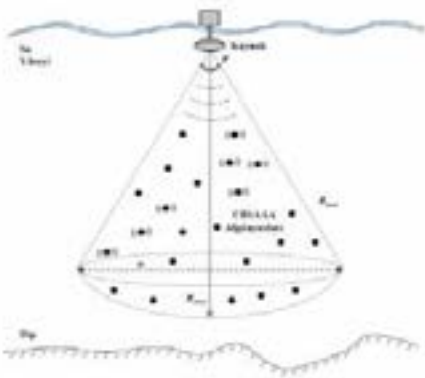
Fabrication of the hold-down device can be made with low-cost and simple fabrication techniques using conventional equipment

Major deformations in the remaining parts of the structure can be eliminated by having all plastic deformations concentrating on anchor rods

The damaged anchor rods can be replaced when needed



A Sensor for Remotely Powered Underwater Acoustic Sensor Networks



Continuous, Economical, Maintainable Sensing

With the novel system and method developed, supplying battery-free and nature-friendly underwater sensors with energy from a remote acoustic source prolongs network lifetime indefinitely.

Advantages

Battery free

Avoids battery weight, hardware, and charging/changing difficulties

Network lifetime

Energy is not a parameter in battery-free sensor network design

Maintainable

Infinite network lifetime enables long-time untethered operation

Economical

Removes the electrical and mechanical design cost required for battery

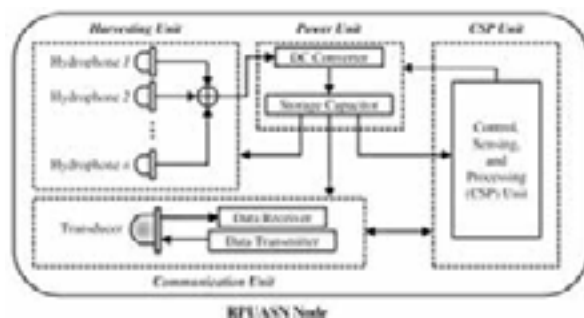
Environment friendly

Avoids possible chemical damage of battery to the nature

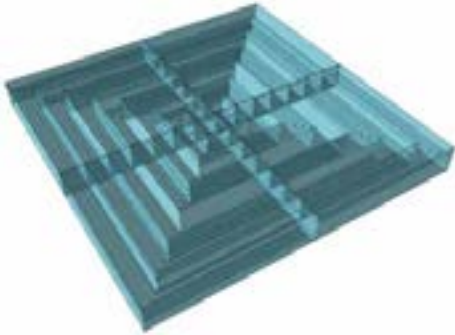
Battery-free sensors enable infinite lifetime and maintainable underwater networks

In critical applications such as harbor security, oil industry, aquaculture, communication with unmanned underwater vehicles, fishing, and defence, relatively infinite lifetime sensor networks free from energy constraints will yield crucial economical profits, enable environment-friendly operation owing to the battery-free structure, and will seriously increase the technical capabilities of these systems.

Piezoelectric structures converting acoustic energy into electrical energy and rapidly charging supercapacitors providing instantaneous high power enable the development of battery-free underwater sensors, removing the energy constraint in the design of network technologies. In this novel design, communication range and sensing coverage are shown to be feasible with realistic parameters.



Acoustical Diffuser-Absorber Panel System for Interiors



Aesthetics of Sound Scattering

Provides controlled and even distribution of sound within acoustically sensitive spaces such as concert halls, conference halls or studios and sound generating spaces like malls, foyers, terminals.

Advantages

High acoustical performance

In a wide range of frequency bands in terms of absorption, diffusion or scattering

Light-permeable

Applicable to transparent or translucent materials; glass, acrylic-PVC, polycarbonate

Lightweight, thin

Minimum widths, occupies less space, thin section, movable, hang-able

Unique design

Aesthetic/decorative

Portability and flexibility

Different design alternatives, can be located anywhere in the room

Sound absorptive and diffusive decorative panel system for interiors

In standard applications, thick diffusers or panels with deep air gaps behind are being used for providing enough scattering or absorption of low frequency sound energy content. The widths of those panels often lead to undesired space losses within interiors either applied on walls or ceilings.

The designed product is superior in terms of its moderate dimensions which are preserved at minimum while keeping its low frequency performance at maximum by applying various acoustical methods and theories (micro-perforation, QRD and Helmholtz approaches). The panel system has different surface properties on both sides providing different acoustical and visual qualities.



Microwave Assisted Synthesis Method of Orthoborates Having Phosphorous Properties



Fast and Easy Way to Produce Phosphorescent Borate Materials

Our method is facile and fast to produce phosphorescent products for LED.

Advantages

Short-time preparation

No extra synthesis step

Easy application

Color and intensity can easily be adjusted as the mixture of compounds is prepared in the desired combination

Saving time and energy

Shorter heating times

Homogeneous distribution

It is easier to prepare composite or slurry solution during fabrication

Clean product

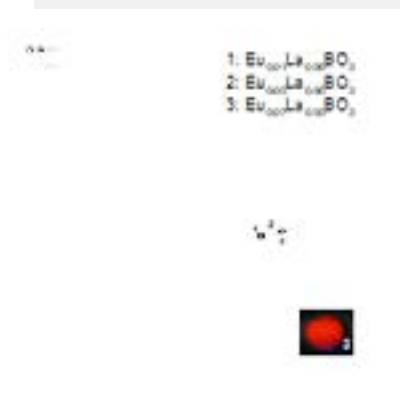
The product obtained can be used without purification

Easy and possible to tune all luminescent properties of materials

In the synthesis method of the present invention, various metal orthoborate compounds (such as MBO_3 or $\text{M}_3(\text{BO}_3)_2$, M: earth alkali or rare earth metal) and their rare earth element ion-containing states are prepared and mixed in a short time, then heated at high temperature for 2 hours to obtain a powder product having pure and very small particle sizes

With the microwave assisted synthesis method in the invention, the heating time at high temperature was shortened from 12 hours to 2 hours and the formation of side (unwanted) products was also abolished.

In economical terms, a clean product that does not require purification is obtained in a short time, saving energy and time.



Structural, Energy Storing, Adaptive, Modular Elements



SESAME

The invention is for retrofitting buildings and for spreading the use of the renewable sources in dwellings.

Advantages

Use of Renewable Sources in Dwellings
Uninterrupted power generation is provided in the dwellings

Economical
Energy storage by means of concrete, known as one of the cheapest building materials, is very economical

Efficient
A more efficient system is achieved by using the available construction material, i.e. concrete, for also storing energy

Compatible with Building Architecture
Since the invention is also a reinforced concrete element, it is no different from any element in construction

Environmentally Friendly
Unlike lithium-ion batteries, SESAME could be used as a filling material in construction sites without the requirement for a special recycling process when battery life is over

It is possible to store energy from renewable energy sources

SESAME could be integrated into the frame system of new buildings or into the exterior frames of existing buildings by means of specially-designed connectors for the purpose of retrofitting and/or for the utilization of renewable energy sources in dwellings. The invention has a layered nature. In the innermost layer, a concrete layer resistant to high temperatures is placed for the storage of heat energy.

The use of the invention is to store energy from renewable energy sources for supplying energy when renewable energy source is not accessible. In addition, it could be utilized for retrofitting existing buildings with inadequate earthquake performance and for satisfying the necessary earthquake performance of new buildings.

The modular nature of SESAME allows the battery to be replaced when it is damaged or its life is over. In addition, it is also possible to integrate SESAME into the existing buildings by virtue of specially-designed connectors.



Solar Concentrator, Based on Horizontally Staggered Light Guide

Hor-Con Solar Panel

Solar cell having only one fortieth of the panel area can efficiently convert light into electrical energy.

Solar electricity with less cost

The invention relates to a waveguide for solar collectors and a solar collector employing such a waveguide to be used for concentrated solar power generation.

In this invention, a waveguide having an array of directing surfaces is developed, such that the waveguide and the array of directing surfaces lie on a plane nonparallel to the direction of incident light. Moreover, a solar collector having an array of concentrator cells and a waveguide lying on a plane nonparallel to the direction of solar radiation from said array of concentrator cells is developed.

Advantages

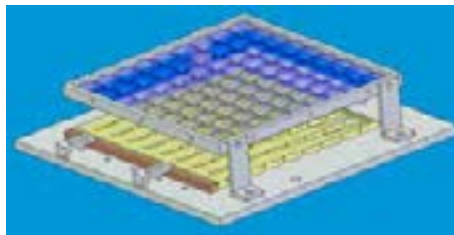
Low Cost

Passive cooling is sufficient even in hot climates despite concentration

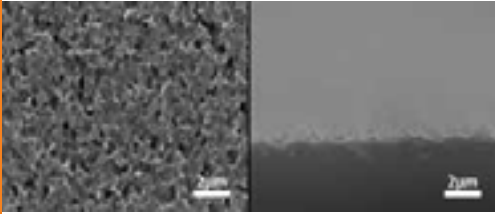
High recycling at the end of life

High capacity increase in the short term with the use of existing plastic and sheet production infrastructure

Ability to work with low cost tracking systems with wide acceptance angle



Nickel Assisted Single Step Etching of Silicon Wafers



Nickel Assisted Single Step Silicon Etching Process

Different than the other processes that use two step etching mechanism, this process can etch silicon via single step solution method.

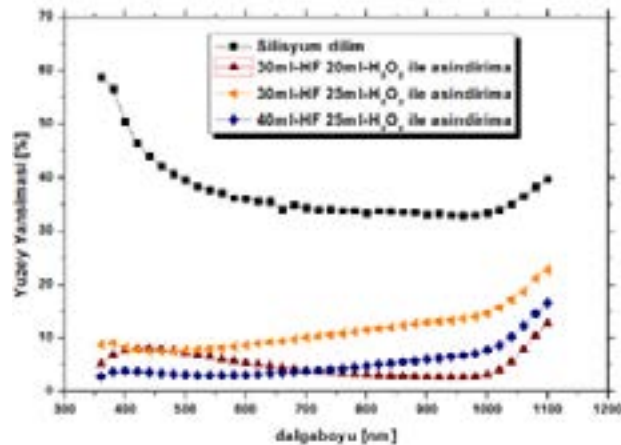
Advantages

- Single step etching
- Use of Ni, less expensive
- Low reflection
- Usable for diamond cut wafers
- Industrial applicability

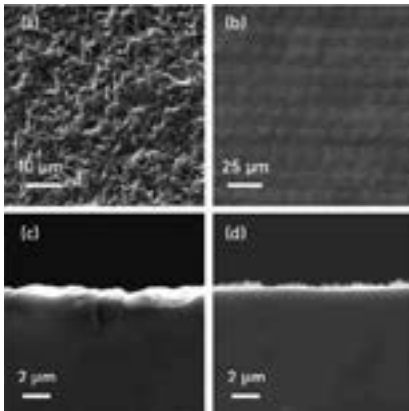
Desired reflection and surface roughness via Nickel assisted etching

Crystalline Silicon technology is the most widely used technology in photovoltaics throughout the world. This technology is composed of both mono-crystalline and multi-crystalline technologies. For both, light trapping and reflection are important parameters that affect the cell performance.

This invention aims a new and single step “Nickel assisted etching process” so that the reflection and process cost is minimized. In addition, solves the problems that occur for multi-c texturing.



Method of Surface Texturing Using a Laser Heating Step That Contributes to Small-Sized Texture Morphology



Laser-enabled Small Pyramids and Less Saw Damage Etch

A laser processing is applied before the texturing step to heal the saw damage region which also modifies the surface to obtain much smaller pyramids.

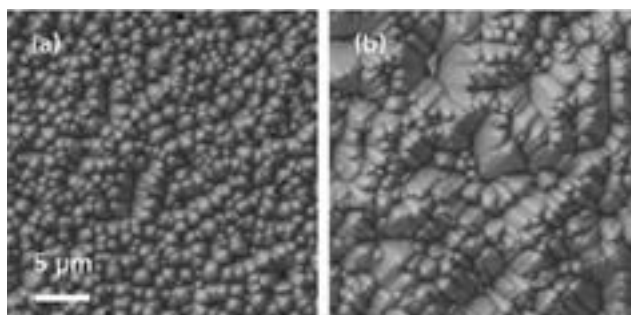
Advantages

- Smaller random pyramids
- Partial healing of the saw damaged region
- Especially suitable for ultrathin silicon wafers

Small pyramids and less saw damage etch

Currently, more than 85% of photovoltaics market is dominated by crystalline silicon solar cells. Silicon wafers are typically obtained from a silicon ingot which is then sliced into thin silicon wafers by method of wire sawing. The slicing and wire sawing processes create physical damage to the silicon such as high surface roughness and microcracks that penetrate up to 10 μm into the silicon. This top most layer of damage is called saw-damage region. To achieve high efficiency solar cells, a process of saw-damage removal is often required.

In the present invention, damages created in the process of wire sawing are removed without the need of chemical etching process. Instead, laser beam is scanned throughout the wafers to eliminate saw-damage region. Upright pyramids with controlled sizes are fabricated in the same laser scanning process.



A Neutron Detector with Solid-Liquid Moderators for Measuring Neutrons at Different Energy Ranges



Neutron Spectrometer with Variable Moderator

The most important innovation of the invention is that solid and liquid moderators can be controlled by robotic systems. Thus, variable moderator thickness is reached around the detector.

Advantages

Variable

The invention may vary so as to work efficiently in different applications

Innovative

It provides the user with the opportunity to change detector parameters with remote access

Practical

It provides great ease of use when its volume and weight are evaluated

It can be developed

It can be developed by the user using different materials in line with various needs

Wide Range of Usage

The usage range problem encountered in neutron detectors is solved thanks to variability

A user-adjustable moderator instead of a fixed-thickness moderator

The invention provides a user-adjustable moderator instead of a fixed-thickness moderator found in commercially used neutron detectors. Thus, in different radiation applications where neutrons are produced in different energies, the detector can be ensured to be sensitive to a different energy range in each moderator thickness. The limited working range, the most common problem in commercial neutron detectors, can be increased by changing the energy range to which the detector is sensitive.

The invention allows the user to change the detector parameters with remote access thanks to the mechanical and electronic design realized. In addition to automatic measurements such as the highest energy and average energy, the measurement ranges of the device can be changed by pre-programming the detector by the user or by intervention at the time of measurement.



Picture 1: Front View of the Detector. There is a Solid Moderator Chamber at the Top, a Measuring Chamber at the Middle and a Liquid Moderator Storage Chamber at the Bottom.

Picture 2: Side Section Image of the Detector. Rotating System Drops the User-Determined Solid Moderator into the Measuring Chamber.

Clean High-Yield Recycling Method of Polylactic Acid

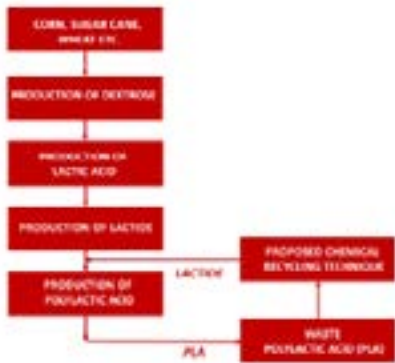


Figure 3. Polylactic Acid Production Cycle from Waste Polylactic Acid

High-Yield Green Recycling of Polylactic Acid

The invention provides high yield production of lactide, which is used as a raw material in polylactic acid production, from waste PLA in one step, without the necessity of the costly separation process. It also reduces the production cost of PLA by eliminating the production of lactic acid and conversion of lactic acid to lactide.

Advantages

Production of lactide from waste PLA in one step

High yield production of lactide

Requirement of no separation processes for the production of lactide in high purity

Shortening the production process of lactide from PLA

Shortening the PLA production process from waste PLA by eliminating all the process steps required for the production of lactide

The invention provides recycling of PLA in a batch reactor at low temperature, in short reaction time, without producing wastes or emissions

Polylactic acid (PLA) is an industrially produced, biodegradable polymer that is widely used in the market. PLA is commonly used in many medical applications due to its biodegradability and biocompatibility. In recent years, due to its mechanical and thermal properties, PLA replaces the commonly used traditional plastics.

The increasing demand for the polymer leads to an increase in its production capacity and a decrease in its production cost. However, the biodegradation of the polymer needs to be carried out in industrial composting facilities under certain conditions, which renders the biodegradation of PLA wastes ineffective and leads to the continuity of waste. With the proposed recycling technique, lactide, which is used as a raw material in the production of polylactic acid, can be produced from the waste polylactic acid with high yield and without waste generation. The direct recovery of lactide as the recycling product of PLA, eliminates the conversion step of lactic acid to lactide in the production of PLA.

This innovation provides the elimination of the negative impacts of biodegradable plastic wastes on the environment without creating further emissions or wastes while protecting water resources. Thus, it supports the development of sustainable plastic technologies.

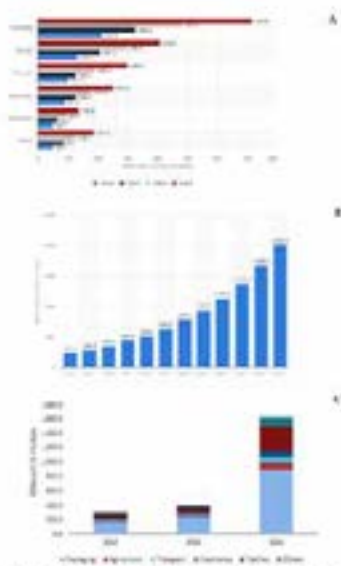


Figure 2. A) Market value (million of polylactic acid) in the United States from 2014 to 2022, by application (in million U.S. dollars); B) Market value of polylactic acid in the United States from 2014 to 2022 (in million U.S. dollars); C) Market value of polylactic acid in Europe from 2014 to 2022 (in million U.S. dollars)

¹Statista, 2021.
²Global Market Insights, 2020.

Sinus Output Buck-Boost Inverter for Variable Frequency Variable-Voltage Applications



Sinus Output Buck-Boost Inverter

Operation at very low input voltages.
Sinus output voltage without a filter.
Suitable for variable frequency operation
Low cost.

Advantages

Even at very low input voltage levels the output voltage is kept at desired level

3-phase or single-phase variable frequency sinus output without filter

Low cost compared to existing circuits with similar function

Device protection under abnormal conditions

Isolated input and output stages

Extended range for electric cars when necessary.
Energy conversion, in wind and solar electric conversion systems, even at very low input voltages without an additional boost stage.
Lower cost than comparable circuits.

This device is a converter capable of converting DC voltage to 3-phase sinus output. It is composed of a power stage and a control stage. It is suitable for motor drives, solar and wind energy conversion systems and UPS systems and similar applications.

The power stage is composed of 3 "Non-Inverting Buck-Boost" converter, one for each phase.

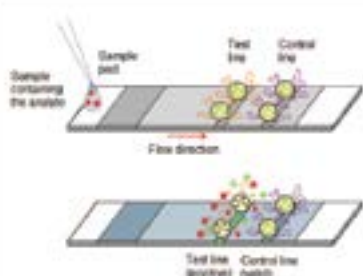
This converter is capable of buck-boost operation. Each phase of the converter has 4 switches. The switches are turned on or off depending on the operating mode. To prevent saturation of the inductances of the circuit Hall-Effect sensors are used to sense the current and control current level.

The control stage drives the power stage to produce variable-frequency, variable-voltage sinus output. Furthermore protects the circuit from over voltage or over current under abnormal conditions. The input voltage is measured and considering the reference value for the output, switching signals are controlled by the microprocessor. "CPLD" sends the appropriate signals to the power stage switches, using the signals from the inductor current measurements. In case of abnormal output voltage the microprocessor reduces output voltage. Input and output stages are isolated by optical links.

Separation of alcohol vapor from alcohol vapor and nitrogen mixtures by mixed matrix membranes

Recovery of high value volatile organic compounds by membranes

This invention is about the development of membranes with high flux and selectivity for the recovery of high value volatile organic compounds that have low concentrations in air or nitrogen. The membrane developed for the separation process is an elastomeric polymer and filled leaf-shaped microporous crystals.



Advantages

Very high VOC flux through the membranes

Very high VOC/nitrogen selectivity

Membranes allow the separation of VOCs from gas mixtures with very low concentrations of VOCs.

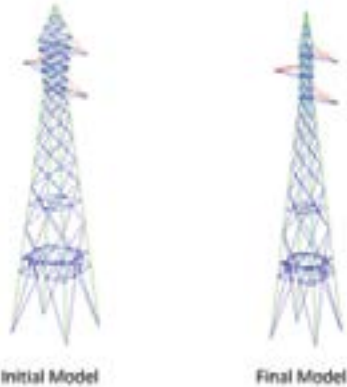
Increased concentration of VOC after membrane separation increases the condensation temperature significantly so that the VOC recovery process will be more efficient.

The developed membranes can be used before or after the adsorption cycle in the solvent recovery process.

the VOC recovery process is more efficient and economic

Membranes are semi permeable materials that allow the permeation of some molecules while reject the others. The membrane based separation processes are economical, energy efficient and can be easily scaled-up, which are the major advantages over the other separation processes. In this invention, polyether block amide membranes were produced. The flux through and selectivity of membranes were substantially improved by incorporating ZIF-L type microporous materials in to the membrane formulation. Owing to the high flux and selectivity of membranes, the concentration and condensation temperature of the permeated volatile organic compounds is increased. This provides that the condensation step that takes place in the VOC recovery process can be performed at temperature higher than cryogenic conditions, hence the VOC recovery process can be more efficient and economic.

CAD Integrated Size and Shape Optimization of Steel Lattice Energy Transmission Line Towers Using Simulated Annealing



Size and Shape Optimization of Energy Transmission Line Towers

This invention focuses on preventing design error/mistakes of energy transmission line towers sourced by human-being and automation weight optimization which is one of the most important goals of energy transmission line tower design process.

Advantages

Efficient: To reach better results compared to classical structural optimization and design techniques.

Useful: The invention can be used in both academic and practical engineering applications.

Fast: Achieving results faster than conventional structural optimization techniques.

High performance: Achieving global optimum results without getting stuck with local optimum ones.

Sensitive: Ability to reach practical engineering results with higher precision than the results obtained with conventional structural optimization techniques.

The most prominent purpose of the energy transmission line towers at the design stage is to design a cost-effective structure providing the strength and the displacement constraints defined by the specifications. This purpose is provided effectively and in a reasonable time period accepted in design offices by this invention.

The purpose of the structural design is to obtain a cost-effective structure providing the strength and the displacement constraints specified by the specifications. This corresponds exactly to the general definition of the optimization problem. For this purpose, after a standard structural design problem is transformed into a mathematical optimization problem, the optimum solution is obtained by using an appropriate optimization technique. With this invention, the optimization technique suitable for energy transmission line towers has been developed and made usable in practical life.

