Yale Engineering Technologies available for license 2019

1. INFORMATION SCIENCE

**Rapid Chain**
Highly scalable consensus protocol which offers open membership and distributed public ledger with improved transaction latency which can address the high overhead and scalability issues of the blockchain.
✓ OCR #7460 Patent application

**CertikOS**
Certified Operating System development ‘Certified Concurrent Abstraction Layers’. Bug-free mathematical proof based architecture and verification for secure operating system OS micro-kernel design and build hardware platform for smart cities, smart devices, smart vehicles.
✓ OCR #7324 Patent application

**Social network mapping and influence**
Population level emergency response, mitigate spread of fake news. Strategies for placement and tuning automated agents to improve network outcomes.
BreadBoard software – online participation games to improve collaboration of teams.
Trellis software – mapping social networks in companies, villages, cities.
✓ OCR #7275 Software
✓ OCR #6782 Patent application

**Hard ID**
Intrinsic hardware fingerprint based on DRAM latency PUF (Physically Unclonable Function). Demo in Galilleo, enables high degree of freedom in the consignment and inventory of IoT devices.
✓ OCR #7236 Patent application

**Deterministic Parallel Database System**
Faster transactional database - compliant DB system that replicates remotely and scales near-linearly in the cloud for developers, marketers and businesses. Yale prototype Calvin matches Oracle and IBM database transaction speeds on low-cost NoSQL commodity servers.
✓ OCR #5479 Pat. 8,700,563
http://db.cs.yale.edu/
Scalable Software Defined Networks (SDN)
Fastest SDN controller on the market and suite of tools that makes network switches easier to program. Maple is a substantially simplified programming interface for existing or new controller platforms.
✓ OCR #6121 Patent application; Software

System and Method for Anomaly Detection And Extraction
Algorithm that learns patient or system patterns without training sets.
✓ OCR #5875 Pat. 9,786,275

Sparse Superposition codes
Computationally efficient encoding and decoding algorithms with predicted feasibility at network information theory limits where current LDPE and Turbo codes will no longer be rate optimal.
✓ OCR #5421 Pat. 8,913,686

Lightweight sensor networks and subject sensing
Uses existing low-cost building CMOS camera infrastructure to locate and track subjects, and an heirarchical programming architecture ‘Sensory Grammars’ to infer subject behavior; jointly developed with UMD.
✓ OCR #5473 Pat. 9,922,256
✓ OCR #4218 Pat. 8,630,695

Compositional Certified Resource Bounds
Accurate prediction of resource usage of computer programs across all functions (memory usage, clock usage, network traffic) to precisely predict execution time and also detect malware and trojans in many applications.
✓ OCR #6701 Software

2. COMPUTER GRAPHICS

Bi-Scale Material Design
Interactive High Quality Surfacing material design editor for cosmetic, textile, architectual and industrial design. Define the bulk material, and achievable geometries and reflectance and then realize the appearance at scale, or do the inverse.
✓ OCR #5864 Software

Texture Exemplars
Software that extracts texture from images and synthesizes seamless randomized surfaces, for renderers and games developers.
✓ OCR #5733 Pat. 9,007,373

http://www.cs.yale.edu/
http://graphics.cs.yale.edu/
3. SEMICONDUCTOR MATERIALS AND DEVICES

**Unipolar CMOS**
Next generation transistor. High electron mobility CMOS based on tri-gate architecture but using only n-doping, also offers lower power operation for thin film CMOS.
- OCR #4977 Pat. 8,384,156
- OCR #6375 Pat. 10,200,038, Patent applications

**Ferroelectric devices**
Synthesis of Ferroelectric Devices including a Layer Having Two or More Stable Configurations.
- OCR #5272 Pat. 9,536,975

**High power HBT**
High power high frequency Heterojunction Bipolar Transistor.
- OCR #1518 Pat. 6,809,400

**Gecko-foot inspired dry cleaning material**
Removal of sub 10nm Particulate Contamination from Solid Surfaces Using Polymeric Microfibrils.
- OCR #6761 Patent application

**Next Generation high speed Mid-IR thermal sensor**
Available in both graphene and silicon demonstrating sub wavelength resolution with much higher speed and smaller NETD compared to commercial bolometers.
- OCR #7572 Patent application

4. PHOTONICS MATERIALS AND DEVICES

**Lateral etch for GaN**
The use of etchants in GaN production enhances light extraction and provides GaN manufacturers with other processing capabilities that can easily be integrated into their processing steps.
- OCR #5705 Pat. 9,583,353; Patent applications

**Epitaxial GaN wafers (GaN tiles)**
Large area laterally grown epitaxial semiconductor layers GaN.
- OCR #5943 Pat. 9,711,352

**GaN-on-Insulator (GaNOI)**
High quality GaN growth without the need for any seed GaN crystal is the enabler for heterogeneous integration of GaN in CMOS.
- OCR #5811 Patent application
**GaN VCSEL and edge emitters**
VCSEL laser technology is a new laser advance for Solid State Lighting suitable for LED manufacturers, applications include automobile headlighting. A method to make III-Nitride edge emitting laser diode of high confinement factor with lattice matched cladding layer.

✓ OCR #6385 Patent application
✓ OCR #6283 Patent application
✓ OCR #6504 Patent application
✓ OCR #7421 Patent application
✓ OCR #6697 Patent application

**Photon Detector with integrated mode converter for Direct Fiber Coupling**
Efficient coupling of Superconducting photon detectors to waveguides.

✓ OCR #6574 Know-how

**Light Force Device**
Today’s electronic devices all rely on operating on electron charges through electrostatic interactions. This discovery opens up a new class of nanomechanical photonic devices that operate on gradient optical forces.

✓ OCR #4952 Pat. 8,639,074

**CAD for photonic circuits**
Photonic CAD plug-in for design of integrated photonic circuit layouts, apparatus for automatic characterization of devices and circuits.

✓ OCR #6223 Software #6224 Prototype

[http://www.eng.yale.edu/tanglab/](http://www.eng.yale.edu/tanglab/)

**On-chip Low Coherent Laser with Directional Emission**
Spatially incoherent random laser emission enables speckle-free and cross-talk free illumination. The discovery of spatially incoherent lasers enables a transition from serial to parallel image acquisition for Optical Coherence Tomography (OCT), confocal microscopy and non-medical applications such as digital light projectors and barcode reader systems.

✓ OCR #5659 Pat. 14/110,937
✓ OCR #7736 Patent Application

**Anti-Laser**
Coherent Perfect Absorber that completely absorbs incoming radiation with zero reflection, controls absorption of light in a cavity, applications in free-space and on-chip optical communications.

✓ OCR #5248 Pat. 9,041,996

[http://www.eng.yale.edu/caolab/](http://www.eng.yale.edu/caolab/)
5. QUANTUM COMPUTING

Brillouin Laser in Silicon and NIBS
Opto-acoustic signal processing. No isolators or circulators are available for integrated photonics – the NIBS (Nonlocal Inter-band Brillouin Scattering) device produces broadband nonreciprocal modulation and mode conversion in an integrated silicon waveguide, potential for on-chip. Also, frequency shifter, active mode conversion, tunable acousto-optic filter and spectral analysis. Traditional MEMS filters are limited in tunability and resolution – low noise microwave filter and RF spectrum analyzer.
  ✓ OCR #7245 #7493 Patent application

New Class of Cavity Optomechanics using bulk acoustic phonons
Light waves meet high frequency sound waves in diverse range of macro-scale bulk crystalline solids instead of traditional micro/nano-scale optomechanical systems, leading to longer lived phonons for Quantum information storage applications and microwave to optical conversion, and for self-cooled room temperature low phase-noise Brouillon laser type microwave oscillators for precision metrology (time-keeping and radar).
  ✓ OCR #7190 Patent application

6. ADVANCED MATERIALS

Bulk Metallic Glass (BMG) alloy discovery
High throughput screening tool for the discovery and optimization of new BMG alloy compositions.
  ✓ OCR #6186 know how

Bulk Metallic Glass (BMG) ribbon
Ribbon processing methods for mechanical watch springs or other energy storage strips, switches.
  ✓ OCR #5589 Pat. 10,047,420 Patent applications
  http://www.schroerslab.com/

Silicon nanowire and biomarker sensor chips
Breakthrough reproducibility for functionalized silicon nanowires to enable point of care molecular diagnosis and cell detection. The patent portfolio includes physiologic sample preparation, parallel array calibration, measurement of cellular response, regenerative nanowires.
  ✓ OCR #4496 Pat. 9,076,665
  ✓ OCR #5364, OCR #6055 Patents
  ✓ OCR #5164 Pat. 9,599,614
  http://www.eng.yale.edu/reedlab/

Inertial sensors
Inertial wineglass resonators for guided munitions and mass measurement cantilevers exhibit two orders magnitude higher quality factors than the state of the art, enabled by specific annealing and thermoplastic forming techniques.
  ✓ OCR #6172 Know-how
  http://www.schroerslab.com/
Stable Black Phosphorous epi-wafer
Wafer scale Black Phosphorous 2D thin film wafer ready for device manufacturing.
✓ OCR #7199 Patent application

Piezoelectric and pyroelectric nanowire electrodes
Simple sensor material comprising polymer/copolymer nanorods for high resolution 2D pressure and temperature sensing.
✓ OCR #4801 Pat. 8,179,026

Metallic conductivity in protein nanowires
✓ OCR #7406 Patent application

7. NANOSCIENCE

Robust catalyst supports
A hybrid CNT catalyst support overcomes carbon poisoning in Direct Methanol Fuel Cells. Stable at high temperatures.
✓ OCR #5427 Know-how

Nanotubes
Synthesis of high yield Carbon nanotubes, superconducting Boron nanotubes, GaN nanowires, and AlGaInN nanowires.
✓ OCR #1250 Pat. 7,357,983
✓ OCR #1613 Pat. 7,531,892
✓ OCR #1614 Pat. 7,258,807
✓ OCR #1736 Pat. 7,407,872

http://www.crisp.yale.edu/

8. GREEN CHEMISTRY

Enone reduction to saturated alcohols
One step full reduction using heterogeneous copper catalyst Cu-PMO/NaBH4.
✓ OCR #7449 Patent application

Water repellant process for cotton fabrics
Hydrophobic silicon polymer impregnated into cotton, is color fast and washable.
✓ OCR #7436 Know-how

Neutral pH stable oxidation catalyst
Easy deposition, low cost heterogeneous Cobalt Phosphine catalyst, stable at neutral or alkaline pH operation for distributed hydrogen or fuel cell applications.
Performance coating for electrowinning
Low cost Iridium oxide film reduces energy costs and enhances corrosion resistance. Easy deposition, low surface loading iridium complex sets activity and stability records for water oxidation and C-H oxidation. Iridium Oxide monolayer.

Supercritical CO2 improved biofuel fractionation
Single step transesterification and fractionation of algae and other biofuels provides energy efficiencies and produces high value-added byproducts.

Lignin feedstock conversion to monomer building blocks for manufacturing
Depolymerization of lignin into simple monomers using abundant commercial feedstocks (sugar cane bagasse, palm waste, wheat straw).

9. ENERGY & ENVIRONMENT

Lithium metal battery system
A rechargeable battery based on a protected lithium metal anode that can offer two times higher energy density than the state-of-the-art lithium ion batteries. Deeply cyclable lithium metal electrode stabilized by Li Nitrate – electrode and system with cathode 99.8% CE (coulombic efficiency) target. Current car battery cycle life is 50 this battery will challenge the market with 500 cycles. Also Na metal electrode in development.

CO2 converter for flue gases
An oxygen-tolerant catalytic electrode for electrochemical reduction of carbon dioxide, electrochemical cell based on earth abundant catalysts.

Environmental Performance Index (EPI) manual
A capacity building manual for corporate, national or global ecosystem index developers, based on the Yale EPI launched at 2012 World Economic Forum.

The Criticality of Metals Calculator
From the founders of Industrial Ecology, data assimilation software for business and government that evaluates the vulnerability to supply risk for metals (Cu group metals expanding to 62 metals).
ThermalGreenWall™
Modular green wall system for heat rejection. Transformation of the living greenwall into a low environmental impact cooling tower replacement for urban buildings and power islands.
✓ OCR #6114 Patent
http://climate.yale.edu/

Bulk Metallic Glass electrode
High surface area fuel cell electrode for optimal triple phase energy conversion and storage.
✓ OCR #5451
http://www.schroerslab.com/

10. WATER TREATMENT

Anti-fouling membrane coating
Nanoparticle coatings for pretreatment of RO/FO and UF membranes, also post-processing and repair, Cornell collaboration.
✓ OCR #6378 Pat. 14/122,535; Patent application

In-situ anti-fouling membrane coating
In-situ formation of silver nanoparticles on a Reverse Osmosis membrane (thin film composite).
✓ OCR #6221 Patent application
http://www.yale.edu/env/elimelech/

Healing of membranes
In-situ healing of compromised ultrafiltration polymeric membranes.
✓ OCR #6416 Pat. 10,183,256
http://www.eng.yale.edu/polymers/

Nitrosamine Capture
A nitrosamine destruction process that offers control over amine scrubbing efficiency and emissions in carbon capture and storage (CCS) projects.
✓ OCR #5372 Pat. 9,937,466

Self-assembled porous thin film 1nm pores for ultra-filtration
Liquid Crystal polymeric composites with oriented nanopores high permeability
✓ OCR #6640 Patent application

Magnetically aligned thin film 10 nm lengthsacle for ultrafiltration
Block co-polymer membrane manufacturing for roll-to-roll deployment.
✓ OCR #5540 Pat. 8,748,504

Thermolytic Brine Heat Engine
From the founders of OASYS, a membrane distillation technology that enables low-cost power generation from waste heat, and membrane vapor gap heat engine for converting low grade heat to energy.
http://www.yale.edu/env/elimelech/index.html
11. ROBOTICS

Knee orthotic
Compliant Control KAFO (Knee-Ankle-Foot-Orthosis) allows a natural amount of knee flexion in the stance phase, and offers swing phase control and stair descent/ascent assistance.

✓ OCR #6047 #6555 Patent application

Prosthetic Hand
The GrabLab Body-Powered Multi-grasp Prosthetic Hand, adaptive low cost thumb manipulated.

✓ OCR #6696 Patent application

http://www.eng.yale.edu/grablab/

12. MEDICAL DEVICES / CARDIOLOGY

Wireless Power Delivery for thoracic devices
Constant power transmission over 15cm range and fully implantable controller allows leadless operation of Left Ventricular Assist Devices (LVADs) eliminating the primary cause of infection in LVAD patients, a collaboration with University of Washington.

✓ OCR #5966 Pat. 8,827,889; Patent applications
✓ OCR #6024 Pat. 9919088

RVAD
RVAD Cavo-arterial pump

✓ OCR #6667 Patent application

LVAD Interrogation device
Diagnosis, and maintenance of LVAD function performed in a catheter lab.

✓ OCR #6122 Patent application

Boletz pump
The first percutaneously delivered fully implantable heart assist device with long-term LVAD function.

✓ OCR #6362 Pat. 10,293,090

http://medicine.yale.edu/lab/bonde/index.aspx

Software for Intraoperative Endocrine Surgery
Intraoperative software that shortens operating time and increases the accuracy of prognosis for parahyperthyroidectomy (PTH) procedures.

✓ OCR #6076 Software

http://medicine.yale.edu/surgery
4D Stress Echo exam
Software upgrade in stress echocardiography scanners precisely and automatically maps out the injury zone, a collaboration with University of Washington.
✓ OCR #6131 Know-how

PEGylated Amnion scaffold
PEGylated Amnion scaffold sheets for use in wound management
✓ OCR #6517 Patent application

PremieBreathe
Portable compact High Flow Nasal Cannula (HHFNC) therapy for neonates and infants
✓ OCR # 7111 Patent application

Humanized lung model
Realistic Humanized Model of disease matrix environment for evaluation of therapeutic reversal or cell fate. Current use case in drug efficacy evaluation and monitoring of pulmonary fibrosis.
✓ OCR #6977 Patent application

13. TISSUE ENGINEERING/IMMUNOBIOLOGY/AG TECH

Heterotypic microtissue assembly
Immuno-DNA directed cell assembly technique, tethering of heterotypic cells creates specialized stem cell niches for injectable therapy.
✓ OCR #5507 Know-how

Large-scale bioengineered vascular tissue
De novo bioengineering of large-scale (1 cm² +), perfusable, functional endothelialized microvessel networks on a chip (in vitro).
✓ OCR #6215 Know-how

Vessel-on-a-chip
Inflammatory model of the microvessels of the lung, skin, eye and heart (bilayers) in a microfluidics flow assay format improves pre-clinical data.
✓ OCR #5980 Know-how

Autologous T-Cell culture system
Bedside carbon nanotube based culture cartridge and incubator for selective rapid expansion of T-cells for adoptive therapy.
✓ OCR #4699 Pat. 8,658,178
Genotype independent hybrid cereals
Methods for Altering the Rate of Plant Development; Method for Controlling Flower Development in Plants; Control of sexuality by Sk1 gene to breed hybrid rice, wheat, barley, sorghum.
✓ OCR #809 #5025 #7073 Patents and patent applications

Detection, fate and transport of fungal pathogens
Environmental fungal monitoring for food safety and supply chain management: expertise determining the type of contamination and how it got there and designing aptamers for detection.
✓ OCR database, software

Foliar bio-stimulant formula
A vitamin, anti-oxidant and amino acid formula to enhance plant growth and stress resistance.
✓ OCR #5800 protocol

15. RESEARCH TOOLS

Backpack strap mounted air quality measurement device
Scientific quality measurement of VOCs, NOx, Sox with an online calibration system where traditional sensors require service visit with gas cylinder calibration.
✓ OCR #7482 Patent application

Pulsed IR Mass Spec
Use of Cryogenic Ion Chemistry to add a structural characterization capability to Mass Spectrometry through Linear Action Spectroscopy.
✓ OCR #5537 Pat. 8,890,059 Pat. 9,401,267

Tuned-Oscillator Atomic Force Microscopy (TO-AFM)
Simple upgrade for existing Atomic Force Microscopy instruments enables reliable atomic resolution imaging in a vacuum.
✓ OCR #6466 Patent application

NeuroProbe
Multiplexed implantable multimodal Brain Monitor in the Neuro-ICU.
✓ OCR #7050 Device and Patent application

Microfluidics design made easy
A simple, fast and plasma-free method of fabricating PDMS microstructures on glass by pop slide patterning, also optical tweezers coverslip patterning to 3 micron, high throughput or benchtop tool.
✓ OCR #6489 Patent application
Mass Accurate mass spectrometry database
Next generation mass spectrometry software offers greater yield, faster turnaround and mobility. ‘Mass Accurate Databasing Identification and Confirmation’ (MADIC).
✓ OCR #5969 Know-how http://keck.med.yale.edu/index.aspx

High Throughput Imaging Cytometry kit
A minor modification to the standard slide allows a microarray scanner to perform cellomic assays and high throughput screening as effectively as a high throughput laser scanner.
✓ OCR #6013 Know-how http://www.eng.yale.edu/fanlab/

Electrospray system
Systems and methods for sorting aerosols
✓ OCR#1441 Pat. 7,190,450

Super Resolution Microscope
Ultra-high resolution 3D fluorescence nanoscopy reveals Sub-20 nm nanoarchitecture throughout thick cells. Continuous scanning technology eliminates cell bleaching and allows seamless zoom.
✓ OCR #6735 #7757 Patent Application

Multicolor imaging using salvaged fluorescence
Plug-in modification in the microscope stand allows multicolor super resolution imaging including broader use of fluorescence dye wavelength and greater resolution.
✓ OCR#7525 Patent Application

Liquid Xenon Gamma ray imager
High energy and angular resolution imager for imaging radiation sources. Two orders of magnitude improvement in Compton imaging for medical applications.
✓ OCR #5186 Pat. 8,476,595 http://physics.yale.edu/

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