



## 1. Preventing Tampering to Integrated Circuits by Integrating Light Sensitive Circuits

[Patent No. 10,204,875](#)

In modern computing, integrated circuits (ICs) are increasing important in creating advanced hardware components. Two common problems encountered in the computing industry are unauthorized modifications to ICs and piracy of proprietary designs and information. Both of these problems can occur when competitors and other individuals have backend access to an IC. For piracy, individuals can inspect and probe an IC to determine the functionality of individual circuits and components. With backend access, an individual can copy proprietary information with ease. For unauthorized modifications, individuals with backend access can make changes to an integrated circuit with a variety of techniques (e.g., a focused ion beam (FIB)). Modifications can include attempts to change the functionality of an IC beyond the manufacturer's intended purpose (e.g., repurpose an IC to function in a competing product) or attempts to subvert the proper functionality of an IC while hiding evidence that the modifications occurred (e.g. diminish the effectiveness of a system).

To solve these problems, NSWC Crane has developed and patented a latch-up circuit (LC) that integrates into an IC so that unauthorized backend access will trigger a binary trip sensor when particular conditions are met. A floating gate loses its charge when it is exposed to photons (such as light), electrons, or ions (like those in a FIB). An excess number of electrons placed on a floating gate bit cell can create a negative channel bias, which places a floating gate bit cell in an "off" state such that the LC will not activate when the IC is powered on. Triggering a floating gate bit cell causes a connected LC to close. Closing the LC results in a positive feedback loop which will short-circuit the integrated circuit. A short-circuit will restrict unauthorized individuals from being able to effectively modify or probe the integrated circuit by rendering the circuit inoperable.

Technology Status: Prototyped

## 2. Evolving Random Number Generator

[Patent No. 9,601,201](#)

[Patent No. 9,685,231](#)

In the fields of trusted electronics, trusted supply chain management, data storage, and communication systems, users are concerned about security and ensuring their devices have not been tampered with. Methods currently used to ensure security include anti-tampering devices, unique identification devices, random number generators, and cryptographic devices. However, there continues to be a need for a new capability or functions associated with creation of a trusted electronics or trusted supply chain solutions such as devices with

irreproducible or a physically uncloneable identification scheme or function. In other words, an aspect of an embodiment of the invention provides a function or effect to be generated that does not allow an unauthorized user to physically clone, copy, or reproduce an original structure manufactured in accordance with an embodiment of the invention.

NSWC Crane has developed and patented an irreproducible and re-emergent unique structure or pattern identifier manufacturing and detection method. A non-volatile floating gate charge storage device includes a block of floating gate transistors that can include a semiconductor region, a source region, a drain region, a floating gate region, a tunnel oxide region, an oxide-nitride-oxide region, and a control gate region. A structure altering stress effect is applied to the block of transistors to create a passage region in a random number of floating gate regions of floating gate transistors which changes charge storage or electrical changes on a floating gate region to escape in a different manner than per-alteration form causing the floating gate region to lose its charge. The patent also includes a design for an apparatus able to record and detect such differences in pre and post alteration.

Technology Status: Prototyped and demonstrated in a laboratory setting.

### 3. SmartSkin

[Patent No. 9,081,409](#)

[Patent No. 8,977,507](#)

[Patent No. 8,788,218](#)

[Patent No. 8,788,220](#)

[Patent No. 9,081,409](#)

[Patent No. 9,235,378](#)

Current structures, such as armor, microelectronics, or critical infrastructure systems, lack effective, real-time sensing systems to detect event causing damage, such as impact from a ballistic object, tampering, physical impact, e.g., airborne or space debris, or other events that cause damage. Event causing damage may affect structural integrity, cause failure, and even threaten people's lives.

Naval Surface Warfare Center, Crane Division (NSWC Crane), has developed and patented an event detection system and device that detects events of interest such as damage events associated with impacts, interactions between structures, or structural integrity events. This patent also incorporates an acoustic detection system including microphones to detect sound waves to determine the direction of the source of the projectile. The processor in this system uses the measurement of the sensors and the sound waves to determine the event origination axis. This invention also has an imaging system to detect fire flash with a camera and correlate with the processor and data from the impact sensing device. A look-up table of signature data associated with the impact sensing devices, acoustic detection system, and the imaging system. This invention also includes a method of detecting a damage event associated with a structure of interest that include damage sensing, sound waves, and flash events to determine damage event origination axis.

Technology Status: Prototyped and demonstrated on a small-scale proof of concept.

### 4. Tunable Detection System and Hyperspectral Imaging

[Patent No. 7,999,230](#)  
[Patent No. 8,368,996](#)

[Patent No. 8,526,097](#)

The Tunable Detection System and Hyper- Spectral Imager was developed to meet the need for an agile detection technology that is capable of detecting both chemical and biological threats. This device has the ability to selectively tune and measure the hyperfine electromagnetic spectra of an ambient environment or of a target of interest. It is a standoff technology capable of analyzing any given environment for both the elements and the molecular makeup. It functions much like a Fiber Bragg Grating; but does not require a fiber, uses electron planes as a grating, and is highly tunable over a range of optical wavelengths. This device could be a game changer in the fields of detection and identification in a myriad of uses

Technology Status: Conceptual, although some work has been done to reduce it to practice.

#### **5. Apparatus for Assembling Multi-Element Assemblies to Predetermined Tolerances and Alignments**

[Patent No. 9,325,073](#)  
[Patent No. 9,595,763](#)

[Patent No. 9,647,343](#)  
[Patent No. 10,109,924](#)

Construction and maintenance of complex assemblies which require disassembling and reassembling, with small tolerances for fit and alignment, have been a substantial challenge. If initial assembly results do not meet the required specification, the equipment must be reworked. Costs associated with existing methods and equipment rework include tear down, realignment, etc. which can lead to exceeding funding allowances for overhaul and restoration of equipment. Existing methods do not manage or control critical elements of each body or were unsuitable due to use of cast elements which have some degree of variation in body elements.

NSWC Crane has developed, patented, and uses an “Apparatus for Assembling Different Categories of Multi-Element Assemblies to Predetermined Tolerances and Alignments Using a Reconfigurable Assembling and Alignment Apparatus.” The device allows for small or very small alignment adjustments to be made while permitting other elements of the multi-element assembly to remain fixed in relation to each other. The tool also allows for assembly, measurement, adjustment, and reassembly of the multi-element assembly with final configuration elements which hold the multi-assembly together in an end use configuration. It is operable with more than one multi-element assembly so that support equipment requirements are reduced and reconfiguration time and effort are reduced to a minimum.

Technology Status: In use at NSWC Crane to help rebuild and repair legacy systems.

#### **6. Power Generation System for UAV Accessories**

[Patent No. 10,173,784](#)

Drones, or unmanned aerial vehicles (UAVs), have become more popular and are being used broadly for everyday tasks that will require more and more power for different accessories on board. Types of accessories can include cameras for photographs or videos, sensors for crop monitoring or security, GPS for location, manipulator arms for simple tasks, and new innovations all the time. Along with the increased accessories available for UAVs, the demand for more power to run these accessories has become a problem. UAVs have finite payload available and a higher demand for power demands

more and more space on the UAV taken up by batteries. There is a tradeoff between more complex accessories and power available to utilize the accessories.

Engineers at NSWC Crane have prototyped and patented a portable power system with multiple power generation modes and mode based adjustable drag configuration for both UAVs and aircraft to provide additional power to accessories. The design is an add-on, aftermarket auxiliary power unit that can be attached for on-demand power. The auxiliary power system is attached to a wing or hard point and utilizes an air path that enters through a variable inlet structure with an aperture that adjusts depending on the power demand. A wind turbine drives a power train, which drives a power generation section. As power demand declines, the inlets close and reduce drag and power projection. The power system allows UAVs or aircraft to reduce their load and carry fewer batteries while enabling them to create power on-demand.

Technology Status: Early stage proof of concept prototype built.

## 7. Drone Tracker

[Patent Application No. 16/111,204](#)

Radio controlled model aircraft equipped with video systems are increasingly being used by adversaries or unauthorized person for undesirable or illegal activities. Examples include paparazzi taking unauthorized photographs of celebrities or drones being flown into aircraft flight paths on or near airports. As commercial RCMA technology becomes more advanced, cheaper, and readily available, the need to detect and respond to these will continue to grow.

NSWC Crane has developed a tracker for drone detection and remote control of unauthorized vehicles. The drone tracker is able to scan, track, intercept video feed, acquire line of bearing, and slew-to-cue (integration of radar or other target detection device that tells a PTZ camera where to point) for identification and defeat of the intruding drone. The tracker has the ability to not only receive signals but also to transmit them, including sending legitimate but spoofed signals to deceive the drone's operator.

Technology Status: Prototyped and demonstrated in an operational environment.

## 8. Extending Communication Coverage

[Patent No. 10,091,664](#)

[Patent No. 9,877,208](#)

A need exists to extend communications coverage (i.e. cell signal, data, etc) in areas such as national parks, remote rural areas, or even hostile areas where parties may wish to tamper with a router/relay system. Such communication systems must blend into their surroundings so they do not spoil the natural beauty of the landscape, and they should remain dormant until required for use.

Naval Surface Warfare Center, Crane Division has patented an unobtrusive router and relay system (URRS) that accomplishes extending communications in remote locations. The URRS is

configured to communicate with radio frequency (RF) systems including cell phones, unmanned aerial vehicles (UAVs), remotely operated vehicles (ROVs), relay nodes, cell towers, control centers, and other communications systems.

Locations are identified along a transit path where the RF communications hub does not transmit or receive coverage. URRS are positioned in the locations and are configured to route and/or relay the system's signals to the communications hub directly or through one or more other URRS systems. URRS are designed to blend with their surroundings such as appearing as a rock or a fallen tree.

Technology Status: Conceptual

## **9. Improved Adaptive Heat Flow Calorimeter**

[Patent No. 10,288,497](#)

[Patent No. 10,001,417](#)

[Patent No. 9,739,670](#)

Calorimeters are used to measure the heat of chemical reaction or physical changes as well as heat capacity. Batteries can be tested in calorimeters to determine the energy density and other characteristics. However, it is difficult to measure these high energy dense systems or to measure the characteristics of complex battery cell configurations such as multiple cells or oddly sized or shaped arrangements. It was necessary to adapt a calorimeter system to measure heat capacity, thermal efficiency, and actual heat load from each surface of the cell.

NSWC Crane has patented an adaptive heat flow calorimeter that proves flexible and repairable testing capabilities for heat generating or absorbing systems such as energy storage systems. The calorimeter includes a temperature bath adapted to maintain a fluid bath at a predetermined temperature, a containment structure for inserting into the temperature bath, heat sinks, thermal sensor assemblies, an internal containment structure, and thermal barriers between different elements of the invention to isolate different sections from each other. The thermal sensor assemblies and heat sinks are removable so it is possible to measure the heat flow into or out of the containment structure's different section without being altered by direct thermal contact with other inner sections. Other aspects of this calorimeters design that are an improvement over previous designs include: samples can be rapidly inserted and removed, ability to obtain separate thermal measurements for different section of the sample under test, and capability to insert or substitute components with different sized element to accommodate different types or sizes of samples.

Technology Status: Built and in use in NSWC Crane laboratories.

## **10. Battery charger and power reduction system and method**

[Patent No. 7,573,235](#)

This technology is related to the charging, and recharging of batteries. The invention is a shunt-type, battery charging device that is designed to reduce the likelihood of overcharging and the

possible deleterious effects associated with heat that is caused by the charging process. One embodiment of the invention is used with lithium ion batteries and is currently in use at NSWC Crane.

Technology Status: Built and in use in NSWC Crane laboratories.