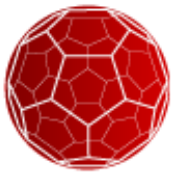

THERMONEUTRONICS

Request for Corporate Partner

Carbon NanoTube-Based Infrared Solar Cells Initiative
Development of Enhanced CNT IR/NIR OPVs
For Integrated Energy Modules

Submitted by

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ABSTRACT

ThermoNeutronics LLC (TN) is seeking corporate partners to commercialize the next generation of specialized Carbon Nano-Tube (CNT) products for application to infrared (IR) and near infrared (NIR) organic photovoltaics (OPV).

The CNT-IR/NIR OPV Program represents:

- **A "cutting edge, market disruptive" technology**
- **A technology that can be ready for commercialization within 24 months**
- **A technology that has widespread application in both developed and developing nations**

The benefits derived from the CNT-IR/NIR OPV Program include:

- **Natural resources will be conserved through a more efficient technology.**
- **Since this is a "green technology," environmental pollution will be reduced through a more efficient technology.**
- **Developing nations will have access to this technology, in fact, the applications in developing nations may exceed those for developed nations.**
- **Developing nations will have an opportunity to improve their economies and the lifestyle of their citizens. It has been proven that the key to a sustainable economy is the availability of reliable energy, especially electricity.**
- **The CNT-IR/NIR OPV Program will create jobs and help the overall economy.**

The Energy Source: The Sun

The world runs on energy.

One of the primary forms of energy is electricity. Because of the low cost of this energy, and the ease with which it can be transmitted from its source of generation to the ultimate location of its end use, electricity is probably the best overall source of energy in the world.

Solar power can be even more attractive in terms of being located at the location of its end use, rather than hundreds of miles away. For many parts of the world, the lack of conventional electrical generation capacity and high voltage transmission lines limits the use of electricity, except for solar systems.

The key is to increase the power density of the solar system by harvesting more energy from the sun, which is the technical focus of the CNT-IR/NIR OPV Program.

Much of the energy from the sun arrives on earth in the form of infrared radiation. Sunlight at zenith provides irradiance of about 1 kilowatt per square meter at sea level. Of this amount, about 53% is infrared radiation, 3% is ultraviolet radiation, 44% is visible light, in the "red, orange, yellow, green, blue, violet" spectrum that we normally associate with prism light. This is shown in Figure 1.

Infrared light has a higher wavelength than visible light, corresponding to a frequency of about 1 to 400 THz, and includes most of the thermal radiation emitted by objects near ambient room temperature.

Conventional solar cells essentially capture only the visible light spectrum, and only a minimal percentage of the infrared spectrum. Thus, a new generation solar cell that can capture significantly more infrared light will produce more electricity.

CNT Infrared Energy Cells

Working with Dr. Somenath Mitra, New Jersey Institute of Technology (NJIT), ThermoNeutronics LLC is developing a patented printable and coatable organic solar cell using Fullerene-single wall carbon nanotube (SWNT) composites. The carbon nanotubes are lightweight, have high mechanical strength (hundreds of times higher that stainless steel), extremely high electrical and thermal conductivity, and offer non-linear optical properties.

Dr. Gary Sorensen, Co-Founder of ThermoNeutronics, and Dr. Mitra, NJIT, will collaborate to enhance the existing patented CNT OPV solar technology by adding Infrared (IR), Near Infrared (NIR), and Ultraviolet (UV) to the visible light spectrum light to electrical energy conversion process. This will add 40 - 56% of solar radiation exposure to the solar cells. Further, much of this spectrum is available during cloudy weather and even re-radiated at night. Thus, the new solar system would have some level of performance 24 hours per day, 365 days per year, irrespective of the sun shining.

IR and NIR direct light and reflected light would allow the CNT IR-NIR OPV technology to perform at many exposure angles and surfaces. No longer would you be limited to flat plate "roof mounted" panels. CNT IR/NIR OPVs could be sprayed or coated on vertical glass walls and windows. CNT IR/NIR OPVs could also be created on flexible thin plastic or polymer films to offer curved or folded shapes. The CNT-IR/NIR OPV Program will incorporate the spraying and coating of thin transparent CNT IR/NIR OPV film on current market ready PV cells and films to create hybrid systems, thereby incorporating IR, NIR and UV.

Overview of Integrated Energy Circuits

The research and development and the technologies envisioned by ThermoNeutronics to date will culminate in Integrated Energy Circuitry which will include the advanced CNT solar cell design, advanced CNT IR/NIR solar cell design, advanced CNT battery and rechargeable flex battery designs, CNT glare control design, and proprietary configurations to allow integration of these different technologies. We envision an energy system in a printable film format that can be applied to building windows, as shown in Figure 2. The system would harvest both visible and infrared light and, depending on operational mode, either generate electricity for immediate internal building use or store the electricity in the battery system for subsequent internal building use. Depending on the time of day, and time of year, the system can adjust overall light transmissivity for glare control, etc. Unlike other PV devices, the CNT IR/NIR OPV could be applied directly on to many substrates such as glass, polymeric, ceramic, wood, metal skin and paperboard.

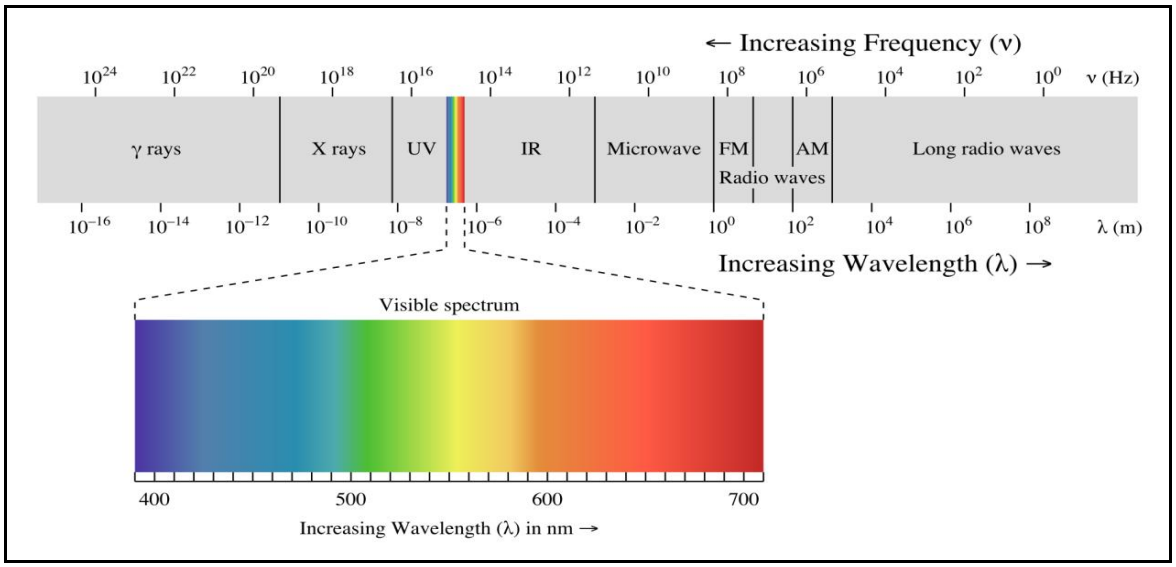

Figure 1
Visible Light Spectrum

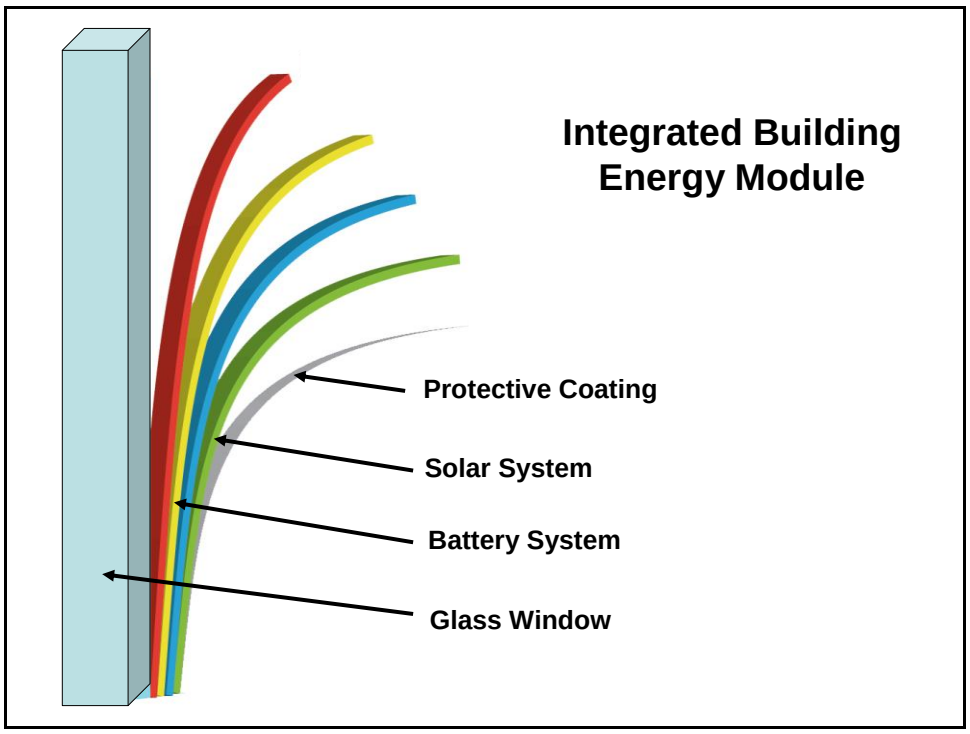

Figure 2
Integrated Energy Circuitry

The New Technology

Current OPV technology is limited to the visible light spectrum. As such, in many respects, the technology is quickly reaching a technical plateau. We propose to construct a solar power module that can capture both IR and NIR solar radiation, and convert this radiation into useable and transferable electricity.

In highly technical terms, this translates into developing a novel OPV using single wall carbon nanotubes (SWNTs) decorated/functionalized with strong electron acceptor moieties, such as, C_{60} and quantum dots (QDs). The C_{60} functionalized SWNTs in P3HT will provide a novel bulk heterojunction for exciton dissociation, but with enhanced ballistic charge transport associated with the SWNTs.

Status of the Technology

The current status of commercialization of the CNT-IR/NIR OPV Program is based on the combined capabilities and experience of ThermoNeutronics and a Confidential Subcontractor[1]. The proposed Project Team has extensive experience in CNT science and research, application of CNT technology to various commercial devices, and experience in solar power cell systems.

The initial prototypes will focus on CNT IR/NIR OPV coatings applied to glass and thin polymer films that would be transparent or translucent. The BIOPV prototypes will target window and glass wall commercial production for both new construction and re-adaptive use. The hybrid prototypes with replace or enhance existing roof top and grid power generation.

Dedicated Project Team

The principal engineers and scientists who will lead the Project Team include:

- **Dr. Gary Sorensen, Founder, ThermoNeutronics LLC**

  Dr. Sorensen is a materials scientist who specializes in thermal circuitry, thermo neutronics, CNT applications and business development. Dr. Sorensen will be the Project Manager for the CNT IR/NIR OPV Initiative.

- **Dr. Somenath Mitra, New Jersey Institute of Technology**

  Dr. Mitra is a chemist who specializes in the research and development of CNT-related technologies and devices. Dr. Mitra will provide technical guidance and direction.

- **Randy D. Horsak, PE, Founder, ThermoNeutronics LLC**
  Mr. Horsak is an electrical engineer with both program and project management experience. Mr. Horsak will coordinate the work of the Confidential Subcontractors.
