Photovoltaics for Underwater Applications

Naval Research Laboratory

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At a Glance

What is it?

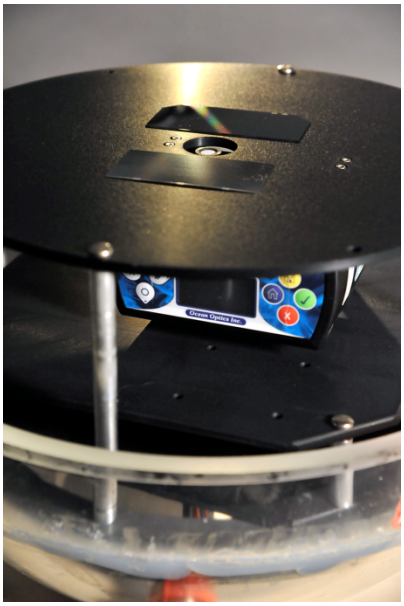
NRL is developing photovoltaics (solar cells) “tuned” to the filtered light underwater to provide power for underwater unmanned vehicles (UUVs) and deployed sensors.

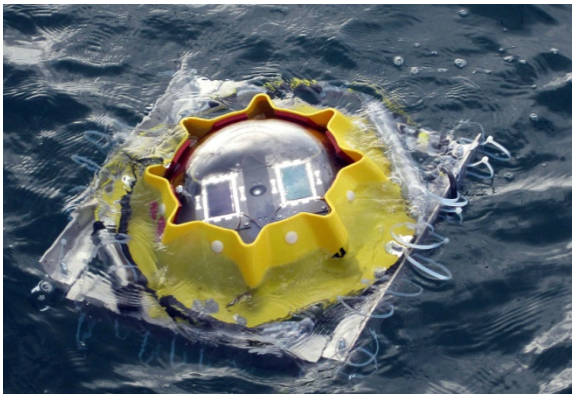
How does it work?

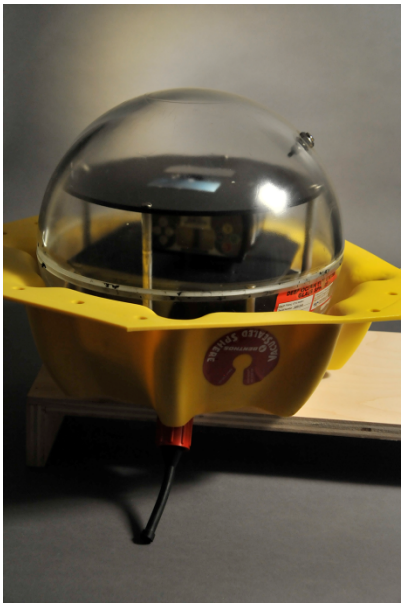
As sunlight penetrates the water, it loses intensity and is spectrally shifted toward the blue. Conventional solar cells lose efficiency under this bluer spectrum. Using high bandgap semiconductors designed for space applications, high bandgap solar cells can take advantage of the bluer spectrum underwater.

What will it accomplish?

Underwater photovoltaics will provide continuous power for long-duration remote sensor missions in depths up to 20 meters. They will eliminate the need to replace or recharge batteries, making missions less expensive and longer lived.







Conventional solar cells are designed to take advantage of the broad solar spectrum. For underwater applications, a solar cell with a broad response suffers significant loss of efficiency due to the water’s filtering of sunlight toward the blue end of the spectrum. NRL is developing a photovoltaic cell designed to efficiently exploit the blue-green transmission band-pass of littoral sea water, and to make use of low intensity sunlight underwater.

The solar cell will be formed out of InGaP (band gap of 1.8 eV) developed for high efficiency space solar cells. InGaP is a mature solar cell technology capable of high energy conversion efficiency under monochromatic illumination (similar to the light filtered by seawater). Charge control electronics will be developed for the most appropriate form (i.e., voltage and current) for use by the underwater system (e.g., a UUV or a remote sensor node). Testing to date has verified performance to 9 meters. It's estimated useful power can be generated depths up to 20 meters in littoral waters.

Research Challenges and Opportunities

- Design solar cells for the low-intensity, blue-shifted underwater spectrum
- Develop charge control electronics for continuous underwater power
- Develop and deploy prototype underwater sensor system

List of publications:

"High Band Gap Solar Cells for Underwater Photovoltaic Applications," Phillip Jenkins, Scott Messenger, Kelly Trautz, Sergey Maximenko, David Goldstein,

David Scheiman and Robert Walters, to be published in the proceedings of the 38th IEEE Photovoltaic Specialists Conference, held in Austin, TX, June 3-8, 2012.

“Photovoltaic Cells Tap Underwater Solar Energy”, //2012 - NRL Press Release 77-12r, Contact: Daniel Parry, (202) 767-2326