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LASERS AT 50

Life Before and After the Birth of the Laser

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hold the atoms of DNA together in the microorganism. If the damage is severe enough, the bacteria cannot repair the damage and will die. In contrast to chemical treatments, UV light penetrates the cells but does not alter the water being treated.

"Although UV light kills microorganisms, it generally has no impact on chlorine, heavy metals or other chemical contaminants. However, these types of pollutants are not life threatening and can be removed with many filtration devices on the market today."

The STER UV is designed to disinfect as well as to thoroughly boil drinking water. "The process of boiling water in the home typically means doing so in large batches, filling up pots with water, boiling over high heat and letting the water cool before distributing it into plastic bottles which then need to be stored. The STER UV could be a tool to ensure the availability of clean drinking water without advance planning or a long wait," Blechschmidt said.

She added that it could be useful in any location that experiences boil-water advisories, particularly for rural homes that do not rely on a municipal water supply.

The product is not commercially available as of March 2010, but Blechschmidt said she would be happy to pursue its development for mass production if the opportunity to do so should arise.

The device has not been tested because the project was not taken as far as a fully functional prototype. However, the technology that it is based on – the application of UV light to sterilize water – has been tested and proved to be effective.

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Argonne offers integrated approach

DoE lab combines materials design, systems analysis and more in developing solar technologies

BY GARY BOAS
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Researchers anticipate that the world's energy needs will double by 2050. To help meet these ballooning needs, the US Department of Energy (DoE)'s Argonne National Laboratory in Illinois recently launched an Alternative Energy & Efficiency Initiative. The initiative seeks, in part, to achieve advances toward the large-scale implementation of solar energy by drawing on the laboratory's strengths in basic and applied research and in collaborating with industry and other research organizations.

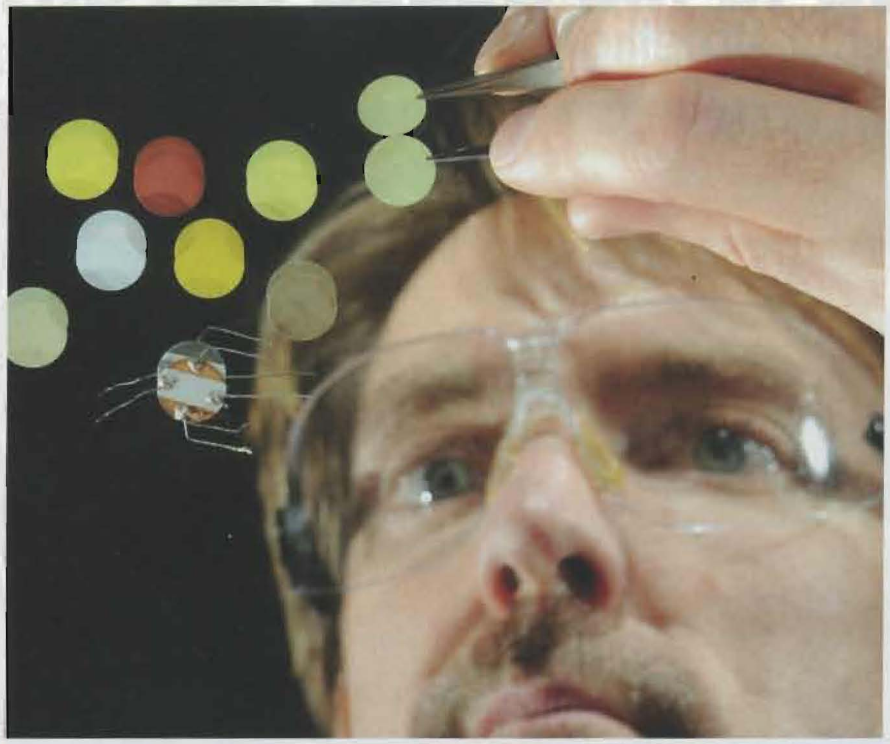
"Solar energy has more potential than any other renewable source," said Seth B. Darling, a researcher with the laboratory. But realizing that potential is always going to be challenging – particularly with respect to cost. "Government subsidies can artificially lower the cost of a technology, but you need the unsubsidized cost to be competitive."

And then, it must be competitive in the long term. Consider cadmium telluride. Using this, we could reach grid parity – the point at which renewable energy costs as little as or less than grid power – in a relatively few years. But tellurium, which comprises half of cadmium telluride, is one of the rarest materials on Earth. "It will be great as a stopgap," said Darling, "but, ultimately, it cannot supply the world's needs." Therefore, we need new materials and new technologies.

The US Department of Energy's Argonne National Laboratory in Illinois has launched an Alternative Energy & Efficiency Initiative, through which it seeks to develop new technologies, working toward large-scale implementation of solar energy, for example. Photos courtesy of Argonne National Laboratory.

This much is generally understood. The trick, of course, is to identify the technologies that will successfully address the energy security issue. "What we believe here," Darling said, "is that having a basic researcher sitting in his or her lab developing a new technology, hoping to serendipitously hit upon something that will solve the problem, is not the most efficient approach. Likewise, endlessly tweaking an existing technology may not be the answer."

Argonne is working toward an integrated approach combining its materials design, device science and process engineering. This will help to determine early in the process, for example, whether a technique can be scaled up to the necessary extent. Systems analysis is another



Argonne National Laboratory is exploring the potential of atomic layer deposition, among other techniques. Here, researcher Jeffrey W. Elam examines solar cell materials prepared using the method at various stages of fabrication.

strength that Argonne will add to the mix, studying the impact and interplay of resource limitations, the variability of sunshine, consumer behavior and more, with respect to a potential technology.

This approach is not necessarily unique, but applying it to technologies that look promising can help us to achieve energy security more quickly than we would otherwise, Darling said. And that, of course, is the ultimate goal.

One technology the researchers are exploring is atomic layer deposition (ALD), which allows them to prepare extremely thin layers of transparent conductors, essential components of most solar cells. With conventional dye-sensitized solar cells, performance is limited by sluggish charge transport through the photoanode. "ALD offers the potential to improve DSSC [dye-sensitized solar cell] efficiency by enabling the fabrication of high-surface-area photoanodes with high conductivity," said Jeffrey W. Elam, director of the atomic layer deposition program at Argonne.

The technique has further advantages: It produces highly conformal coverage, even on three-dimensional structures, and allows synthesis of a broad range of materials relevant to dye-sensitized solar cells, including titanium dioxide, indium oxide and tin oxide.

Elam noted a significant challenge in working with the technique: Every new material one might want to prepare requires research to develop the appropriate atomic layer deposition "recipe," providing the necessary self-limiting surface chemistry.

Early in its DSSC development work, the Argonne group encountered the lack of an appropriate atomic layer deposition chemistry for indium oxide, the main ingredient in indium tin oxide (ITO), one of the best transparent conductors known. To address this, he said, "we invented a method for preparing highly conformal ALD ITO coatings on nanoporous structures and used this method to fabricate DSSCs with excellent charge-transport properties."

The researchers believe that applying the technique to the deposition of ITO will help usher in the next generation of photovoltaics, enhancing the performance and reducing the cost. Also, extending it to alternative, Earth-abundant transparent conductors ultimately could enable production of efficient solar energy devices on a massive scale.

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