

# R&D Highlights

## Editor's Recommendation: Moving quantum information

Semiconductor nanowires provide a powerful platform to bridge the worlds of quantum transport and quantum optics. Due to the nanowire geometry, they are well suited for an efficient interface between electron spins and photons, which is required for long-distance transfer of quantum information.

For the latest in this area of research, SPIE Fellow Akhlesh Lakhtakia, editor-in-chief of the *Journal of Nanophotonics*, recommends reading an article from the March issue of the journal: "Single photon emission and detection at the nanoscale utilizing semiconductor nanowires."

Michael Reimer of Delft University of Technology (The Netherlands) and his co-

authors explain how they have integrated an InAsP quantum dot in the depletion region of a p-n junction in an InP nanowire. By injecting current into the quantum dot, light is emitted with a wavelength that is precisely controlled by the size of the quantum dot.

The researchers were able to detect photons with high sensitivity and large gain using only a single Si nanowire comprised of a p-i-n diode.

"Combining InAsP quantum dots in Si nanowire p-n junctions opens up the possibility to perform quantum-optics experiments on-chip," the authors state.

**Source:** *Journal of Nanophotonics* 5, 053502 (2011); doi:10.1117/1.3562279

## Robotic ankle puts the spring in the step

A robotic tendon that acts like a spring has helped reduce energy requirements for a new robotic ankle while also advancing the development of a computer-controlled prosthesis that allows a user to climb stairs and even jog.

Thomas Sugar of the Human Machine Integration Lab at Arizona State University (USA) demonstrated the new device called SPARKy, for Spring Ankle with Regenerative Kinetics, in March at SPIE Smart Structures /NDE.

SPARKy has overcome the large moment, power, and energy challenges needed for a bionic ankle, Sugar says, through the addition of springs in series with a motor.

"We developed a robotic tendon that reduces the peak power by altering the required motor speed. By changing the required speed, the spring acts as a 'load variable transmission'," Sugar says.

The new device, whose actuator is optimized through a spring that is customized for each person, can actively support a user under normal conditions, such as walking forward and backward, ascending and descending stairs and slopes, and even jogging.

It is described in "Walking with Springs," a paper Sugar co-authored for the Electroactive Polymer Actuators and Devices conference.

**Source:** *Proceedings of SPIE* 7976, 797602 (2011); doi:10.1117/12.882214

## Progress reported in EUV lithography

Flare levels below 5% in extreme ultraviolet (EUV) lithography, once thought to be practically impossible, have been achieved and EUV scanners have been installed at chip manufacturers for early process development, it was reported at SPIE Advanced Lithography earlier this year.

EUV Lithography conference co-chair and SPIE Fellow Bruno La Fontaine writes in the *Proceedings* for that conference that the introduction of EUV lithography in industrial pilot lines is in "full swing."

"Although the throughput of these scanners and source power is not at the expected levels yet, many wafers have been printed with these beta tools with excellent results down to approximately 20-nm half-pitch resolution and with good overlay,"

La Fontaine writes. "Source manufacturers report progress in the stability, lifetime, and average usable power for the scanner."

In addition to providing updates on the status of tools and process development, papers presented at the conference address critical issues for EUV technology, such as sources, masks, resist performance, and components lifetime.

The EUV mask infrastructure also continues to make progress, according to researchers presenting papers at the conference. "A lot of effort is devoted to put in place actinic inspection tools," says La Fontaine, whose co-chair was Patrick Naulleau.

**Source:** *Proceedings of SPIE* 7969, 796901 (2011); doi:10.1117/12.897483

## New record for LED efficacy

Cree has reported what it says is an industry-best efficacy record of 231 lumens per watt for a white LED.

The result improves upon Cree's previous industry record of 200 lumens per watt in 2010. The LED efficacy was measured at 231 lumens per watt using a single-die component at a correlated color temperature of 4500 K.

Standard room-temperature 350 mA testing was used to achieve the results, which were reported in May.



Photo courtesy Michael Arellano

Thomas Sugar testing the mechanical, prosthetic ankle that stores and releases energy during the gait cycle.

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