Top Stories of 2015 from Photonics.com

From a new smartphone microscope that can noninvasively detect and quantify bodily infection, to the "reinvention" of optical gyroscope technology, and from visualizing light's duality to light-reflecting flexible film and growing nanowires for more efficient and tunable lasers, 2015 has been a year of advancement, innovation and celebration of the International Year of Light.

As 2015 wraps up, the Photonics Spectra staff searched the Photonics.com archives to find the top most viewed articles of the year, providing updates on researchers' work and progress. Enjoy this trip down a well-lighted memory lane.

Flexible Film Creates Colors from Reflected Light

June 2015

A team at the University of Central Florida's College of Optics and Photonics (CREOL) in June developed an ultrathin, color-changing film that reflects rather than emits light. This could potentially change the clothing we wear, in addition to enhancing displays.

A National Geographic photograph of an Afghan girl is used to demonstrate the color-changing abilities of the nanostructured reflective display. Photo courtesy of University of Central Florida.

the compound silicon naphthalocyanine, which fluoresces when exposed to near-infrared light. In addition to highlighting cancerous tissue, the drug also generates cancer-killing reactive oxygen species when illuminated. The silicon naphthalocyanine was irradiated at 785 nm with a laser power density starting at 0.3 W/cm^2.

At power densities up to 1.3 W/cm^2, the drug also gave off heat, the researchers said, showing it could be useful for photothermal therapy, as well. Meanwhile, the compound continued fluorescing during the phototherapeutic procedure and was not photobleached.

Naphthalocyanine is not water-soluble and can aggregate in the body, making it difficult (or potentially impossible) to find its way through the circulatory system and reach strictly cancer cells. To overcome this problem, the researchers earlier this year originally used a dendrimer — a water-soluble polymer and extremely tiny nanoparticle — which they said allows the napthalocyanine "to hide within a molecule that will attach specifically to cancer cells, not healthy tissue."

Now, the researchers have developed a new technique that employs a copolymer, PEG-PCL, as a biodegradable carrier; this is an alternative to the dendrimer-based system the researchers introduced earlier this year. This new technique causes the silicon naphthalocyanine to "accumulate selectively in cancer cells and reach a maximum level in them after about one day," according to information from OSU about these latest developments. At that point, surgery and phototherapy treatments could be done.

"We've now developed an improved formulation that's biodegradable, simple, robust and reproducible," said Olena Taratula, a research assistant professor at the OSU Oregon Health and Science University College of Pharmacy.

Taratula noted that this newer system is highly efficient. "A single-agent based system is simple and very good at targeting only cancer tumors and should significantly improve outcomes."

Next, the team plans to test their technique on live dogs that have malignant tumors before progressing to human trials.

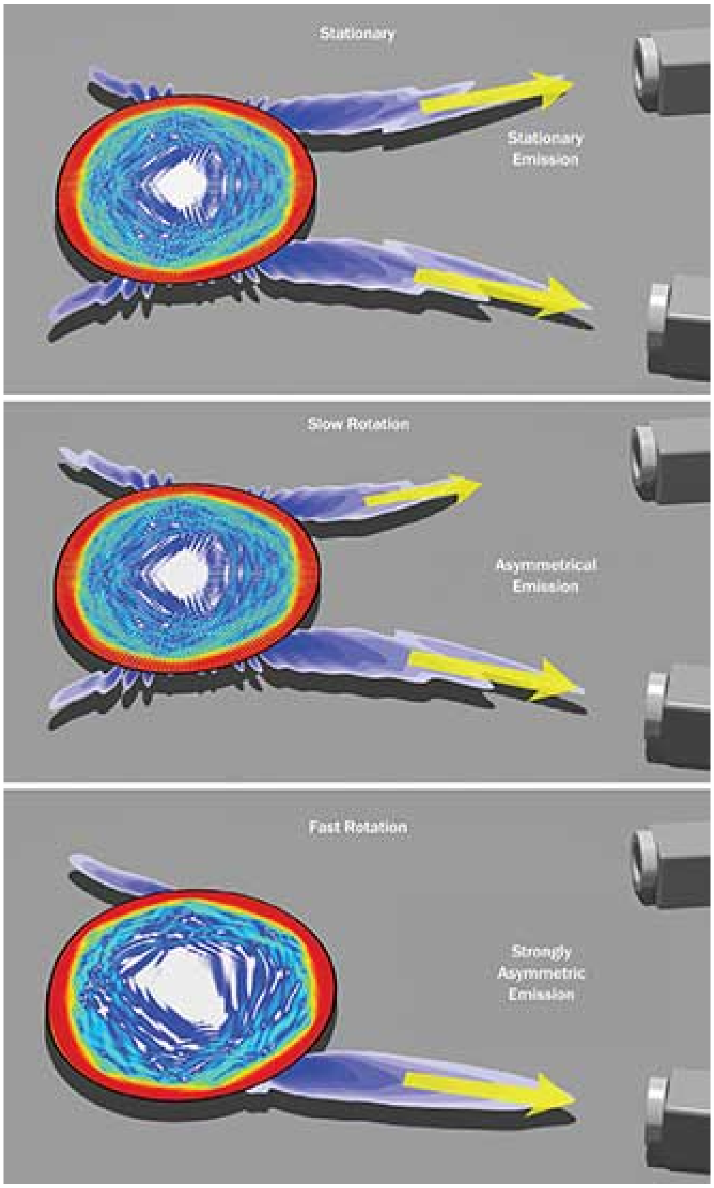
Reinvented Optical Gyroscope Smaller, More Sensitive

April 2015

Optical gyroscope technology could prompt an increase in sensitivity for such devices, while shrinking them to about 10 µm in size.

Researchers at the City University of New York (CUNY) and Yale University demonstrated this ability in April, showing that far-field emission patterns of light can interact strongly with rotating microdisk optical cavities. The findings present an alternative to current optical gyroscopes, which are limited by their dependence on the Sagnac effect. This phenomenon creates a measurable interference pattern when light waves split and then recombine after leaving a spinning system.

Schematics showing the far-field emission pattern of a microdisk cavity changing from symmetric to strongly asymmetric. Two cameras on the *right monitor the change. Photo courtesy of Dr. Li Ge/Graduate Center and Staten Island College, CUNY* .



The new optical gyroscope works by pumping light waves into an optical cavity; it then begins travelling in both clockwise and counterclockwise directions. By carefully designing the shape of the optical cavity, the researchers can control where both waves exit. Based on these developments, gyroscopes could be made small enough to be integrated into circuit boards, according to the researchers. Currently, such devices are baseball- to basketball-sized, and operate on different principles relating to the Sagnac effect — a phenomenon that creates a measurable interference pattern when light waves split and then recombine upon leaving a spinning system — one kind uses an optical cavity to confine light, while the other uses an optical fiber to guide light.

At this point, Dr. Li Ge, a professor at CUNY's Graduate Center and Staten Island College, said he and fellow researchers are considering experimental realization. Ge added that the team would like to design a proof-of-concept demonstration to, in part, secure funding to further the research.

"We expect to perform further numerical modelings to optimize the design and address practical issues such as the precision of fabrication, selective excitation of the desired optical mode(s), packaging the microcavity with on-chip optical detectors, etc.," Ge said. "Once we come up with an optimal design and perform the proof-of-concept experiment, we will explore commercializing the technology."