

emeraldine salt) mixed with carbon black, the team obtained experimental thresholds of 10 ppt (parts per trillion) for butylamine and 1 ppt for cadaverine, while the thresholds for the non-amine vapors were comparable to those of the previous device built. For comparison, the human detection threshold for butylamine has been reported to be between 0.1 and 1 ppm.

IULIA C. MUNTELE

### Strong Directional Emission Observed in Lasing Characteristics of a Pendant Drop Deformed by an Applied Electric Field

In an article published in the April 1 issue of *Optics Letters*, Xiao-Yun Fu and Wing-Kee Lee from the Chinese University of Hong-Kong, Department of Physics, report the results of their studies of the lasing properties of an oval-shaped resonant cavity (ORC) with a continuously variable aspect ratio. The ORC was formed with a dye-doped pendant drop (rhodamine 6G dye in an ethylene glycol solution) placed inside a variable static electric field. Pumped with a nitrogen laser, the ORC drop was found to have strong directional emission characteristics and an intensity enhancement factor as great as 19.5, results that are in good agreement with the theoretical calculations. The anisotropy was found to increase as the eccentricity was increased. Also, the lasing threshold was found to decrease with the increase in eccentricity; for  $e = 0$ , the threshold was 6.2  $\mu\text{J}$ , while for  $e = 0.38$ , the threshold dropped to 3.8  $\mu\text{J}$ . Although no previous investigation on the optical properties of a continuously deformable pendant drop has been reported, tiny whispering-gallery-type lasers, such as microdisk, microcylinder, and microdroplet (circulatory symmetric resonators) have been previously studied, and are known to have two intrinsic disadvantages: the lack of high output power and directional emission. The use of asymmetric resonant cavities is believed to overcome these disadvantages.

CLAUDIU MUNTELE

### Uniform Monolayer of Organic Molecules Provides Precise Control of Semiconductor Device Properties

The functions of organic molecules are so diverse that their inclusion in electronics would provide an extensive range of possibilities. However, the observation of these molecules' electrical properties has been impeded by incongruities in the

structure of organic molecules themselves. Layers of organic molecules that are used in this kind of research contain "pinholes" which are small defects that are very difficult to detect but radically sway conductance. Determining whether measurements resulted from the passage of the current through the organic molecules or through a pinhole was very difficult.

Researchers at the Weizmann Institute have found that changing the type of organic molecules in a monolayer led to a predictable, systematic change in the electrical characteristics of a semiconductor device. Not only were the researchers able to control the properties of the semiconductor in the device, but they also were able to predict the kind of control that would be exerted by different types of organic molecules over the device.

The researchers chose to analyze the molecules indirectly by focusing on the influence that the molecules were suspected to have on semiconductors. Using a series of molecules synthesized by Abraham Shanzer of the Weizmann Institute's Organic Chemistry Department, Ayelet Vilan, a graduate student working with David Cahen of the Materials and Interfaces Department, constructed a one-molecule-thick layer of very short organic molecules. The organic materials used were the so-called "di-carboxylic acids," which are tartaric acid derivatives; tartaric acid is also known as "fruit acid," and found, for example, in wine. Vilan placed the monolayer on a common semiconductor, GaAs, and directed an electric current through it. The monolayer was so thin that, for the most part, the electric current passed by the molecules without interacting with them. In an article published in the March 9 issue of *Nature*, the researchers report that this fact meant that it was of minimal importance if the electrons went via a molecule or a pinhole. According to the researchers, though, it is important to note that while the organic molecules barely affect the passage of the electrical current through them, they very much influence the electron affinity of the semiconductor, the energy that an electron gains when it comes from infinity into the semiconductor's conduction band.

Along with the decision to work with monolayers of organic molecules, Vilan developed a method for preparing semiconductor devices. The technique is founded on a widely used semiconductor device (diode), which is comprised of a semiconductor connected to a metal. She inserted the di-carboxylic acid organic monolayer between these two components—placed by self-assembly of the

molecules on the GaAs. Since the organic molecules were sandwiched between the semiconductor and the metal sheet, it was critically important to ensure that the delicate monolayer would not be crushed underneath the metal sheet. Vilan used a thin gold leaf as the metal sheet and gently floated it onto the monolayer. Thus, the monolayer remained intact. Vilan said that this study "provides new insights into the emerging field of molecular electronics. So little is known about the effects that occur between molecules and the electric conductors we normally use. This approach may provide a basis for the design of novel types of semiconductor-based devices, from improvements in relatively simple devices such as solar cells, to possible new types of computer chips."

### Sn/Li<sub>2</sub>O Nanocomposites Synthesized as Negative Electrode Materials for Lithium-Ion Batteries

A team of researchers, D.L. Foster, J. Wolfenstine, J.R. Read, and W.K. Behl, at the U.S. Army Research Laboratory, reported a method for the preparation of lithium oxide/tin nanocomposites in the May issue of *Electrochemical and Solid-State Letters* which show promising properties as electrode materials. The straightforward synthesis yields tin particles on the order of 100 nm or less which are uniformly distributed within a lithium oxide matrix. The composites showed improved performance as electrode materials compared to other SnO electrodes with the elimination of most of the irreversible capacity on the first cycle.

In an effort to enhance safety and rechargeability of lithium batteries, pure lithium anodes have been replaced by other lithium-containing compounds in recent years. Among the promising candidates are lithium/tin oxide nanocomposites that are transformed to tin/lithium oxide composites during the first cycle. This reduction "leads to a large irreversible capacity loss on the first discharge cycle," said Foster. Therefore, the team investigated the possibility of using a chemical reaction to form a tin/lithium oxide nanocomposite.

The successful process utilizes the commercially available precursors lithium nitride and tin oxide. The reactants are jar milled under a dry argon atmosphere for five days at room temperature, leading to the formation of tin, lithium oxide, and nitrogen gas. X-ray diffraction confirmed that the product contained a mixture of crystalline tin and an amorphous component that is most likely lithium oxide.