Liquid field-effect transistor

The control of current flow in a liquid field-effect transistor (LiquiFET) via electrowetting between competing insulating/conducting fluids has been reported by Andrew Steckl and Duk-Young Kim at the Univ. of Cincinnati, Ohio. This is the first liquid transistor that has been reported by researchers in the U.S. The LiquiFET is similar to an electronic FET but operates using liquids, directly converting charge-related information from fluid into electronic, measurable signals.

The LiquiFET consists of dielectric/hydrophobic layers (40- and 300-nm thick); source/drain regions (200-nm thick); a gate electrode; and hydrophilic/hydrophobic grids (30-µm tall/3 × 3 mm^2) for liquid containment. Current flow in a channel occurs by controlling one of two fluids: a conducting aqueous electrolyte or an insulating non-polar oil.

Generally, the LiquiFET works by placing a water droplet containing potassium chloride (KCl) and an oil droplet on a hydrophobic surface. Due to the different surface energy between the two droplets, the oil positions itself between the hydrophobic surface and the electrolyte water.

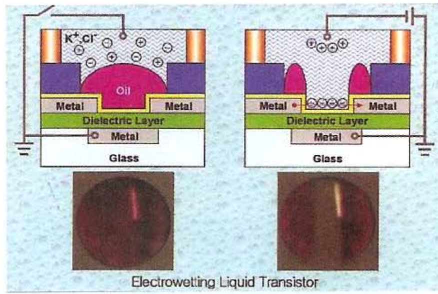

Fig. 1. LiquiFET. ***Left)*** OFF state. ***Right)*** ON state. *Source:* Applied Physics Letters.

Electrowetting does not occur when there is 0 V, so the oil layer fills the entire hydrophobic surface in a channel region. This represents the OFF state as the source to drain channel is closed to charge transport (Fig. 1). However, when a voltage is applied to the electrolyte water droplet, the oil layer is pushed away as the water droplet is attracted to the hydrophobic surface. Here, current flows between the source and drain, creating an ON state.

Anions that are on and/or close to the hydrophobic surface form an electrical channel, which is similar to one found in a metal oxide semiconductor field-effect transistor (MOSFET). When this channel forms, the electrons flow from the source to the drain through the negative ion channel, creating the LiquiFET drain current.

Potential applications are flat panel displays, microelectronics, and drug delivery.

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Nanotechnology and Process and Measurement

Perfectly aligned arrays for electronics

Dense, aligned arrays of linear single-walled carbon nanotubes (SWNTs) that act as an effective thin-film semiconductor for use in electronic devices have been reported by lead investigator John Rogers at the Univ. of Illinois, Urbana-Champaign.

Generally, in the process, strips of iron (Fe) nanoparticles are deposited on a single-crystal quartz wafer. The Fe acts as a catalyst for the growth of SWNTs by chemical vapor deposition (CVD). As the SWNTs grow past the Fe strips, they lock onto the quartz crystal, which aligns the SWNTs' (~1-nm dia; up to 300-µm tall; ~100-nm apart) growth. Using a transfer method, the SWNTs are lifted off the quartz and printed down on a target substrate, leaving the SWNTs' position and orientation intact.

The arrays function as a thin-film semiconductor material in which a charge moves independently through each SWNT. This configuration can be integrated into electronic devices using conventional chip-processing methods. In one example, measurements on *p*- and *n*-channel transistors that involve ~2,100 SWNTs show device-level mobilities and scale transconductances approaching ~1,000 cm^2 V^{-1} sec^{-1} and ~3,000 S m^{-1}, respectively. And, current outputs of up to ~1 A are seen in devices that used interdigitated electrodes.

The work is described in the April 2007 issue of *Nature Nanotechnology.*

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BUSINESS NEWS

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IBM (www.ibm.com), Armonk, N.Y., has demonstrated the viability of 3-D chip stacking using a new method called through-Si vias that extends Moore's Law beyond its expected limits.

Austria-based **NANOIDENT Technologies AG** (www.nanoident.com) opened **NANOIDENT ORGANIC FAB GmbH,** Linz, Austria, the world's first manufacturing facility for the delivery of printed semiconductor-based optoelectronics.

Toshiba Corp. (www.toshiba.com), Tokyo, achieves a breakthrough in imaging electron-carrier paths and impurities in semiconductors that allows analysis at the 1-nm level based on a scanning spreading resistance microscope (SSRM).

Richardson, Texas-based **Zyvex** (www.zyvex.com) announced its first company spinout, **Zyvex Performance Materials,** Columbus, Ohio, and will add ~25 people to the new facility over the next 12 months.

Tokyo-based **Sony Corp.** (www.sony.net) will sell ultra-thin TVs using organic light-emitting diode (OLED) technology this year, mass-producing ~1,000 of the 11-in. OLED sets a month. The pricing has not been announced.

Zurich-based **NanoDimension** (www.nanodimension.com) established a new investment vehicle, **NanoDimension Limited Partnership** with ~$60 million in committed capital that will focus on investments in nanotech companies. European and North American investment opportunities include IT and electronics, life sciences, materials, and energy sectors.

Both South Korea-based, **Dongbu Electronics** (www.dongbuelec.com) and **Dongbu Hannong Chemicals** (www.dongbuchemical.com) merged into a bio-semiconductor enterprise, **Dongbu HiTek Co. Ltd.,** and will provide wafer foundry services and advanced chemicals and materials for bioengineering, nanotechnology, and semiconductor processing.

ROFIN-SINAR Technologies Inc. (www.rofin-sinar.com), Plymouth, Mich., acquired **Corelase,** Finland, and **ES Technology Ltd.,** UK. Corelase products include fiber-coupled diode laser systems, continuous-wave and ultra short pulse mode-locked fiber laser systems, and diode lasers for material processing. It will continue to operate as a stand-alone company and supply products to other laser companies. ES Technology Ltd. develops customized laser marking solutions based on various laser technologies.