Researchers realize vertical organic permeable dual-based transistors for logic circuits

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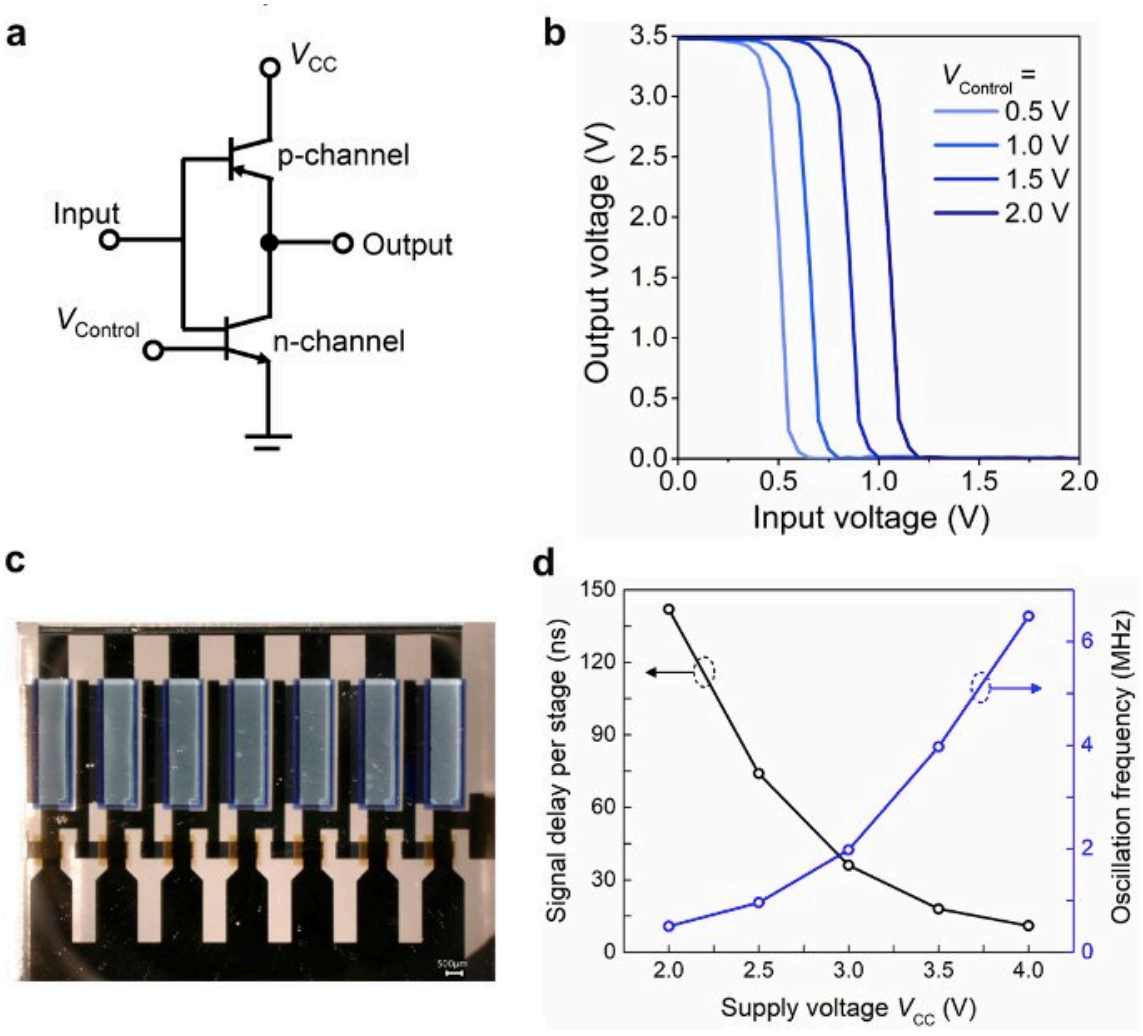

a,b, Circuit diagram (a), static transfer characteristics (b) of the organic complementary inverter measured with VCC = 3.5 V and VControl = 0.5, 1.0,

1.5 and 2.0 V. c, Photographs of a seven-stage ring oscillator fabricated by integrating seven complementary inverters. d, Oscillation frequencies and signal propagation delays per stage of a seven-stage complementary ring oscillator plotted as a function of the supply voltage VCC. The circuit can operate with supply voltages as low as 2.0 V and with signal propagation delays as short as 11 ns per stage. Credit: Guo et al.

Integrated circuits (ICs) based on organic transistors have many valuable applications, for instance, in the fabrication of paper-like displays or other large-area electronic components. Over the past few decades, electronics engineers worldwide have developed a variety of these transistors.

A promising alternative to these transistors are vertical-channel dual-gate organic thin-film transistors. These transistors have several advantageous properties, such as short channel lengths and tuneable threshold voltages (VTH). Despite these advantages, due to a lack appropriate p- and n-type devices, developing complementary inverter circuits for these transistors has so far proved challenging.

Researchers at Technische Universitat Dresden, Helmholtz-Zentrum Dresden Rossendorf (HZDR) and Northwestern Polytechnical University have recently developed vertical organic permeable dual-base transistors that could be integrated in logic circuits. In a recent paper published in *Nature Electronics*, they evaluated the potential use of these transistors in complex integrated circuits.

"The dual-gate transistor we developed as part of our previous research in *Nature Communications* consists of a single vertical-channel thin-film transistor with an additional second gate and second dielectric, which can be used to tune its threshold voltage," Erjuan Guo, one of the

researchers who carried out the study, told TechXplore. "In our new study, we studied the function and benefit of the vertical-channel dual-gate transistors in more complicated integrated circuits, for example, organic complementary inverters and ring oscillators, further.

Guo and her colleagues created integrated complementary inverters by connecting vertical n-channel organic permeable dual-base transistors (OPDBTs), and vertical p-channel organic permeable base transistors (OPBTs). Notably, the second gate in the OPDBTs can control the on and off-states of the transistors, thus influencing the states of the inverters.

"Based on the measurements we collected, we find that dual-base transistors enable a wide range of switching voltage controllability of a complementary inverter over 0.8 V, at an input voltage of