Flexible Nanoscale Organic Thin-Film Transistors

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Abstract: Organic thin-film transistors (TFTs) can often be fabricated at temperatures around or below 100 degrees Celsius and thus on a wide range of unconventional substrates, including flexible and transparent polymers, such as polyethylene naphthalate (PEN). This makes organic TFTs a potential alternative to TFTs based on inorganic semiconductors, such as low-temperature polycrystalline silicon (LTPS) and indium gallium zinc oxide (IGZO), which typically require higher process temperatures that limit the choice of flexible substrate materials to ultrathin glass and polyimide. For circuit and display applications, an important TFT parameter is the transit frequency, which is the highest frequency at which transistors are able to switch or amplify electrical signals. A field-effect transistor’s transit frequency depends critically on the channel length and the parasitic gate-to-source and gate-to-drain overlaps. Most of the highest transit frequencies reported for organic TFTs to date have been achieved with channel lengths and gate-to-contact overlaps of around 1 µm. To explore the static and dynamic performance of flexible organic TFTs with nanoscale dimensions, we have used electron-beam lithography and fabricated low-voltage organic TFTs with channel lengths and gate-to-contact overlaps as small as 100 nm on flexible PEN substrates. These TFTs display useful static and dynamic characteristics, including on/off current ratios of nine orders of magnitude, subthreshold swings below 100 mV/decade, turn-on voltages of 0 V, negligibly small threshold-voltage roll-off, contact resistances below 1 kOhm-cm, and switching delays below 20 ns.

Bio: Dr. Hagen Klauk received his Ph.D. degree in electrical engineering from Pennsylvania State University in 1999. From 1999 to 2000, he was a Postdoctoral Researcher at Penn State. In 2000, he joined Infineon Technologies, Erlangen, Germany. Since 2005, he has been Head of the Organic Electronics Group at the Max Planck Institute for Solid State Research, Stuttgart, Germany. His research focuses on organic thin-film transistors.