"The SPEED of electrical charges across the channel determines the response time of a thin film transistor (TFT), and essentially the speed of the display on your smartphone or e-book," explains Aram Amassian, Assistant Professor of Materials Sciences and Engineering. "For charges to move fast, such as in a video, the material they move through should not offer too many obstacles. One of the challenging questions for printed electronics has been to print semiconductors on patterned surfaces without causing structural changes that can stifle TFT performance."

A new x-ray microbeam technology addresses this problem by providing a breakthrough in the way structural heterogeneities are studied within the channel of organic TFTs. The groundbreaking work was conducted by Dr. Ruiping Li and Prof. Aram Amassian, the head of KAUST's Organic Electronics and Photo voltaics group, in a close collaboration with Dr. Detlef Smilgies of the Cornell High Energy Synchrotron Source (CHESS), as well as researchers from Wake Forest University (NC, US) and the University of Kentucky in Lexington (KY, US). The paper describing the research was published in Advanced Materials and is featured on the front cover of the November 2 issue of the journal.

"When printing an organic semiconductor on a patterned surface," Prof. Amassian says, "you initiate phase transformation in the presence of surface corrugations and chemical changes. One of the consequences is that the film can form undesirable polymorphs and crystal orientations." Researchers have long suspected that irregularities within the microstructure of the semiconductor film act as bottlenecks to slow down charge transport. "All of us suspected a problem but could not locate it and correlate it with any certainty," Prof. Amassian says. "This is where the new technique developed by Dr. Li came in very handy."

Dr. Li, one of KAUST’s founding postdocs, joined the University from CHESS, where he specialized in synchrotron science. "Synchrotron is a very bright x-ray source," Dr. Li says. "We used a ORGANIC TRANSISTORS | Continued on p2
ORGANIC TRANSISTORS | Continued from p1
very thin capillary to focus x-rays to a spot size much smaller than the transistor, combining the high flux x-ray beam with an optical microscope and fast 2D x-ray detectors, we are now in a position to stitch together a detailed microstructural map of the semiconductor in dozens of printed devices without destroying them.

With the newly developed tools, the researchers were able to identify the source of the defects and correlate them to device performance. The team from Wake Forest subsequently demonstrated improved device performance by addressing the structural irregularities identified by the KAUST team.

“We’re very excited about the next steps of this collaborative project”, says Prof. Amassian. “The high-speed imaging capabilities of Prof. Sigurdur Thoroddsen’s group have emerged as a structural irregularities identified by the KAUST team.

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