

# Researchers Seek to Advance Thin-film Electronic Devices

*Researchers in California have made a discovery that could advance organic thin-film electronic devices.*

According to a report on the US Department of Energy's Lawrence Berkeley National Laboratory website, researchers have determined the pathways by which electrical charge is transported from molecule to molecule in an organic thin film.

Their results also show how such organic films can be chemically modified to improve conductance.

'We have shown that when the molecules in organic thin films are aligned in particular directions, there is much better conductance,' said Miquel Salmeron, project leader and director of Berkeley Lab's Materials Sciences Division.

'Chemists already know how to fabricate organic thin films in a way that can achieve such an alignment, which means they should be able to use the information provided by our methodology to determine the molecular alignment and its role on charge transport across and along the molecules. This will help improve the performances of future organic electronic devices.'

Salmeron and Shaul Aloni, also of the Materials Sciences Division, are the corresponding authors of a paper in the journal NanoLetters that describes this work.

Organic electronics, also known as plastic or polymer electronics, are devices that utilise carbon-based molecules as conductors, rather than metals or semiconductors. They are prized for their low costs, light weight and flexibility. Organic electronics are also expected to play a big role in molecular computing, but to date their use has been hampered by low electrical conductance in comparison with metals and semiconductors.

The team used electron diffraction patterns to map the crystal structures of molecular films. However, obtaining structural crystallographic maps of monolayer organic films using electron beams posed a major challenge.

'These organic molecules are extremely sensitive to high-energy electrons,' said Aloni. 'When you shoot a beam of high-energy electrons through the film, it immediately affects the molecules. Within a few seconds, we no longer see the signature intermolecular alignment of the diffraction pattern. Despite this, when applied correctly, electron microscopy becomes an essential tool that can provide unique information on organic samples.'

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It is reported that the team overcame the challenge through the combination of a unique strategy they developed and a transmission electron microscope (TEM) at the Molecular Foundry's Imaging and Manipulation of Nanostructures Facility. Electron diffraction patterns were collected as a parallel electron beam was scanned over the film, then analysed by computer to generate structural crystallographic maps.

'These maps contain uncompromised information of the size, symmetry and orientation of the unit cell, the orientation and structure of the domains, the degree of crystallinity and any variations on the micrometer scale,' said first author Virginia Altoe. 'Such data are crucial to understanding the structure and electrical transport properties of the organic films and allow us to track small changes driven by chemical modifications of the support films.'

While the combination of organic molecular films and substrates in this study conduct electrical current via electron holes (positively charged energy spaces), the team claims that structural mapping can also be applied to materials whose conductance is electron based.

'We expect our methodology to have widespread applications in materials research,' said Salmeron.

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