Composite film shows promise as a replacement for transparent electrical conductors in displays

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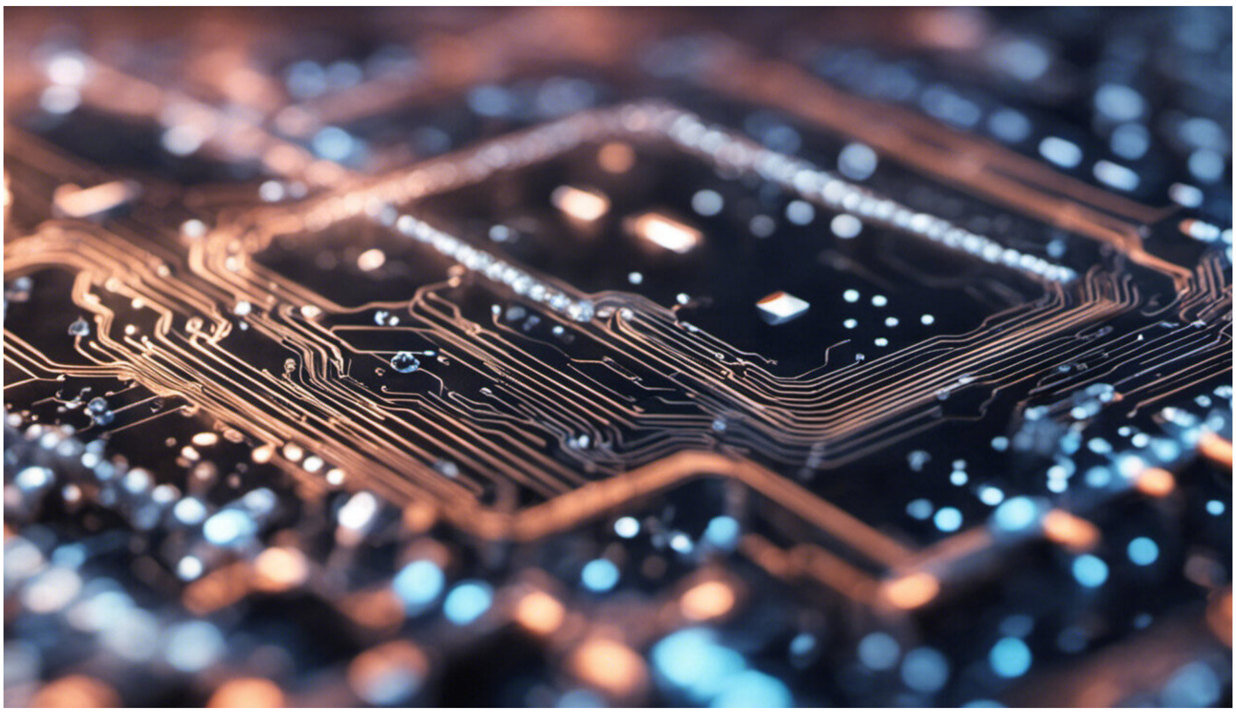

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Flatscreen televisions, computers and mobile phone displays all require transparent electrical conductors to connect embedded electrical devices without obstructing back illumination. Indium tin oxide (ITO) is currently used for this purpose, but it is expensive and fragile. A lowcost alternative, based on a composite film made of graphene and a ferroelectric polymer, is now available thanks to an international research team, including researchers from the A*STAR Institute of Materials Research and Engineering (IMRE) in Singapore.

Graphene is transparent since it consists only of a single layer of carbon atoms. "Graphene can show a high electrical conductivity and is also stronger and much more flexible than indium tin oxide, and thus could even be used for foldable displays and thin solar cells," explains Guangxin Ni, a PhD candidate in the research team.

Although very thin, graphene's single layer of carbon atoms forms strong, tough bonds that explain its good mechanical and electrical properties. In its pristine state, however, graphene's electrical conductance is low because it has very few free electrons that can carry an electrical current. Injection of electrical charges, usually by applying an electrical voltage, can increase conductivity; however, this is undesirable in consumer devices because it uses electrical power.

Ni and his co-workers' thin film offers a more permanent solution. They combined graphene with a ferroelectric polymer, which has a constant electrical charge on its surface. They grew the graphene on a copper foil by evaporating organic precursor molecules, and then deposited the polymer on top as a thin film from solution. When brought in close contact, the electrical field from the polymer induced electrical charges in graphene. This increased graphene's electrical conductivity by a factor of 12.

The advantage of this approach is that this charge donation is extremely long lasting, indefinitely in theory, and does neither damage to the material nor substantially compromises the high optical transparency of graphene, notes team member Kui Yao from IMRE. Moreover, the fabrication process is very scalable and suitable for industrial applications.

Before developing commercial applications, even higher conductivities are desirable: the conductivity of ITO is still about 20% better than the hybrid graphene—ferroelectric polymer. Nevertheless, the research team is striving to overcome this barrier and even double the conductivity of the films by optimizing and enhancing the design and fabrication of these graphene/polymer devices. If successful, the team will greatly enhance the commercial potential of this transparent conductor, and bring the broad commercial application of graphene a step closer.

More information: Ni, G. -X., Zheng, Y., Bae, S., Tan, C. Y., Kahya, O., Wu, J., Hong, B. H., Yao, K. & Özyilmaz, B. Graphene–ferroelectric hybrid structure for flexible transparent electrodes. *ACS Nano* 6, 3935–3942 (2012). pubs.acs.org/doi/abs/10.1021/nn3010137

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