Research gives insight into using graphene in electronics

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(PhysOrg.com) -- New findings from the laboratory of University of Illinois researcher Joe Lyding are providing valuable insight into graphene, a single two-dimensional layer of graphite with numerous electronic and mechanical properties that make it attractive for use in electronics.

Lyding, a researcher at Illinois's Beckman Institute, and his lab report using a dry deposition method they developed to deposit pieces of graphene on semiconducting substrates and on the electronic character of graphene at room temperature they observed using the method. The paper, by Lyding, lead author Kevin He of the Lyding lab, and their collaborators, is titled Separation-Dependent Electronic Transparency of Monolayer Graphene Membranes on III-V Semiconductor Substrates and appeared last month in the journal *Nanoletters*.

The researchers wrote this of graphene's potential, especially as compared to its elemental cousin, carbon nanotubes, for use in electronics and other applications: "It exhibits the quantum hall effect, even at room temperature, and its optical transparency is directly related to the fine structure constant. Graphene is more and more being thought of as a fairly strong and elastic membrane (with an associated potential as a material for NEMS applications). Unlike carbon nanotubes, graphene can be patterned using standard e-beam lithographic techniques, making it an attractive prospect for use in semiconductor devices."

To reach that goal, issues associated with graphene must be overcome, and this paper gives insight into a much-needed step in that direction: understanding substrate-graphene interactions toward integration into future nanoelectronic devices. The project investigated the electronic character of the underlying substrate of graphene at room temperature and reports on "an apparent electronic semitransparency at high bias of the nanometer-sized monolayer graphene pieces observed using an ultrahigh vacuum scanning tunneling microscope (UHV-STM) and corroborated via first-principles studies." This semitransparency was made manifest through observation of the substrate atomic structure through the graphene.

Lyding's research group had developed a non-chemical (dry) technique for depositing carbon nanotubes (CNTs) on a surface called Dry Contact Transfer that allowed the CNTs to maintain their electronic properties. They later applied the method to graphene and were able to deposit pristine, nanometer-sized graphene pieces in situ onto atomically flat UHV-cleaved Gallium arsenide and Indium arsenide semiconductor substrates with low amounts of extraneous contamination.

The electronic semitransparency of the graphene pieces was observed when the UHV STM probe pushed the graphene 0.05nm closer to the surface, causing its electronic structure to mix with that of the surface.

In summary, the researchers write, their results "highlight the significance of graphene-substrate interactions and suggest that proper control of the substrate can have a major effect on the electronic properties of the graphene it supports."

More information: Link to paper: pubs.acs.org/doi/abs/10.1021/n … 7e?prevSearch=Joseph%2BLyding&searchHistoryKey=

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