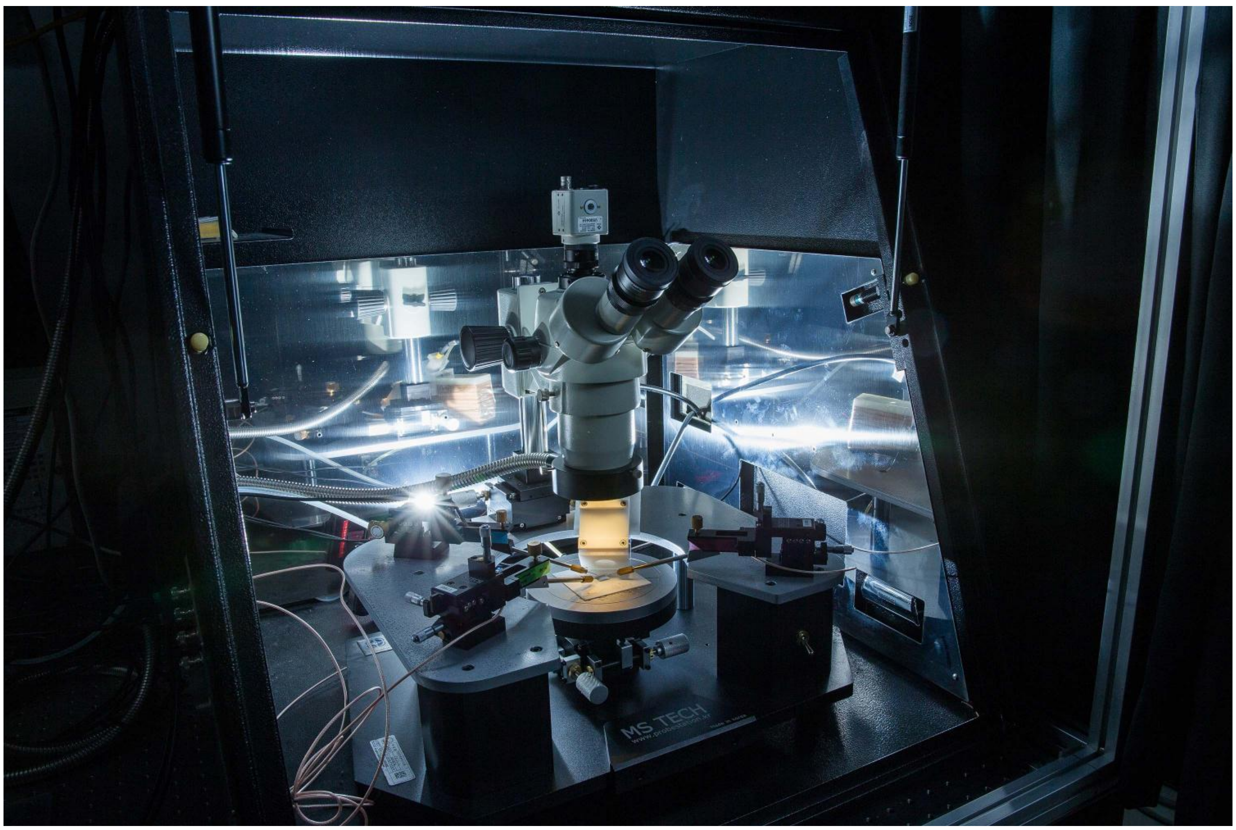
Engineering dream diodes with a graphene interlayer

February 8 2017

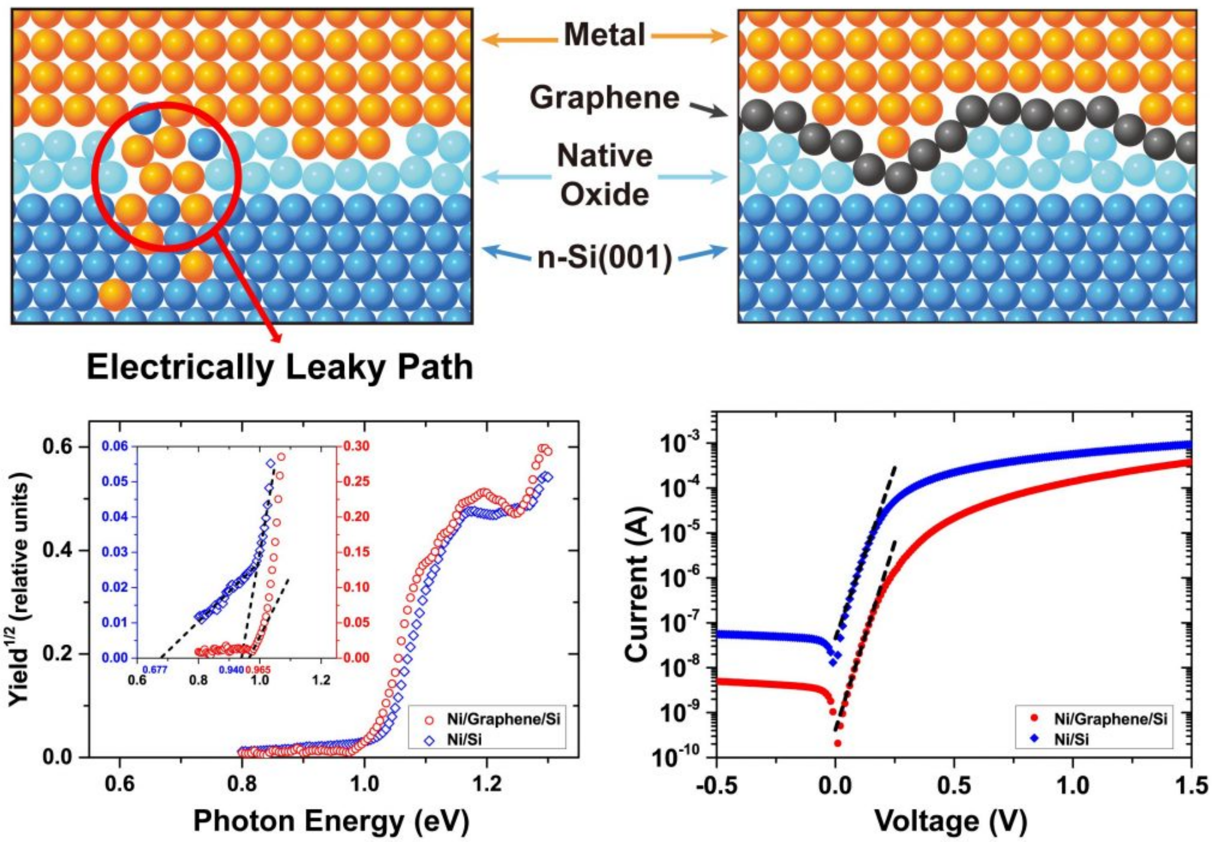


Shown above is the Internal Photoemission (IPE) Measurement System, developed by Hoon Hahn Yoon, combined M.S./Ph.D. student of Natural Science at UNIST. Credit: UNIST

A team of researchers affiliated with UNIST has created a new technique that greatly enhances the performance of Schottky diodes used in electronic devices. Their research findings have attracted considerable attention within the scientific community by solving the contact resistance problem of metal semiconductors, which had remained unsolved for almost 50 years.

As described in the January issue of *Nano Letters*, the researchers have created a new type of diode with a graphene insertion layer sandwiched between metal and semiconductor. This new technique supplants previous attempts, and is expected to significantly contribute to the semiconductor industry's growth.

The Schottky diode is one of the oldest semiconductor devices, formed by the junction of a semiconductor with a metal. However, due to the atomic intermixing along the interface between two materials, it is impossible to produce an ideal diode. Professor Kibog Park solved this problem by inserting a graphene layer at the metal-semiconductor interface. In the study, the research team demonstrated that this graphene layer, consisting of a single layer of carbon atoms, not only suppresses the material intermixing substantially, but also matches well with the theoretical prediction.



The schematic view of internal photoemission (IPE) measurements on metal/n-Si(001) junctions with Ni, Pt, and Ti electrodes for with and without a graphene insertion layer. Credit: Ulsan National Institute of Science and Technology

"The sheets of graphene in graphite have a space between each sheet that shows a high electron density of quantum mechanics, in that no atoms can pass through," says Professor Park. "Therefore, with this single-layer graphene sandwiched between the metal and semiconductor, it is possible to overcome the inevitable atomic diffusion problem."

According to Hoon Hahn Yoon, the first author, the study also confirms the prediction that "in the case of silicon semiconductors, the electrical properties of the junction surfaces hardly change regardless of the type of metal they use."

The internal photoemission method was used to measure the electronic energy barrier of the newly fabricated metal/graphene/n-Si(001) junction diodes. The internal photoemission (IPE) measurement system in the image shown above has contributed greatly to these experiments.

More information: Hoon Hahn Yoon et al, Strong Fermi-Level Pinning at Metal/n-Si(001) Interface Ensured by Forming an Intact Schottky Contact with a Graphene Insertion Layer, *Nano Letters* (2017). DOI: 10.1021/acs.nanolett.6b03137

Provided by Ulsan National Institute of Science and Technology