

# Atomically thin device promises new class of electronics

As electronics approach the atomic scale, researchers are increasingly successful at developing atomically thin, virtually 2-D materials that could usher in the next generation of computing. Integrating these materials to create necessary circuits, however, has remained a challenge.

Northwestern Univ. researchers have now taken a significant step toward fabricating complex nanoscale electronics. By integrating two atomically thin materials—molybdenum disulfide and carbon nanotubes—they have created a p-n heterojunction diode, an interface between two types of semiconducting materials.

“The p-n junction diode is among the most ubiquitous components of modern electronics,” said Mark Hersam, Bette and Neison Harris Chair in Teaching Excellence in the Dept. of Materials Science and Engineering at Northwestern’s McCormick School of Engineering and Applied Science and director of the Northwestern Univ. Materials Research Center. “By creating this device using atomically thin materials, we not only realize the benefits of conventional diodes but also achieve the ability to electronically tune and customize the device characteristics. We anticipate that this work will enable new types of electronic functionality and could be applied to the growing number of emerging 2-D materials.”

The isolation over the past decade of atomically thin 2-D crystals, such as graphene, has prompted researchers to stack two or more distinct 2-D materials to create high-performance, ultrathin electronic devices. While significant progress has been made in this direction, one of the most important electronic components—the p-n junction diode—has been notably absent.

Among the most widely used electronic structures, the p-n junction diode forms the basis of a number of technologies, including solar cells, light-emitting diodes, photodetectors, computers and lasers.

In addition to its novel electronic functionality, the p-n heterojunction diode is also highly sensitive to light. This attribute has allowed the authors to fabricate and demonstrate an ultrafast photodetector with an electronically tunable wavelength response.

The research appears in the *Proceedings of the National Academy of Sciences*.

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Published on Research & Development (<http://www.rdmag.com>)

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