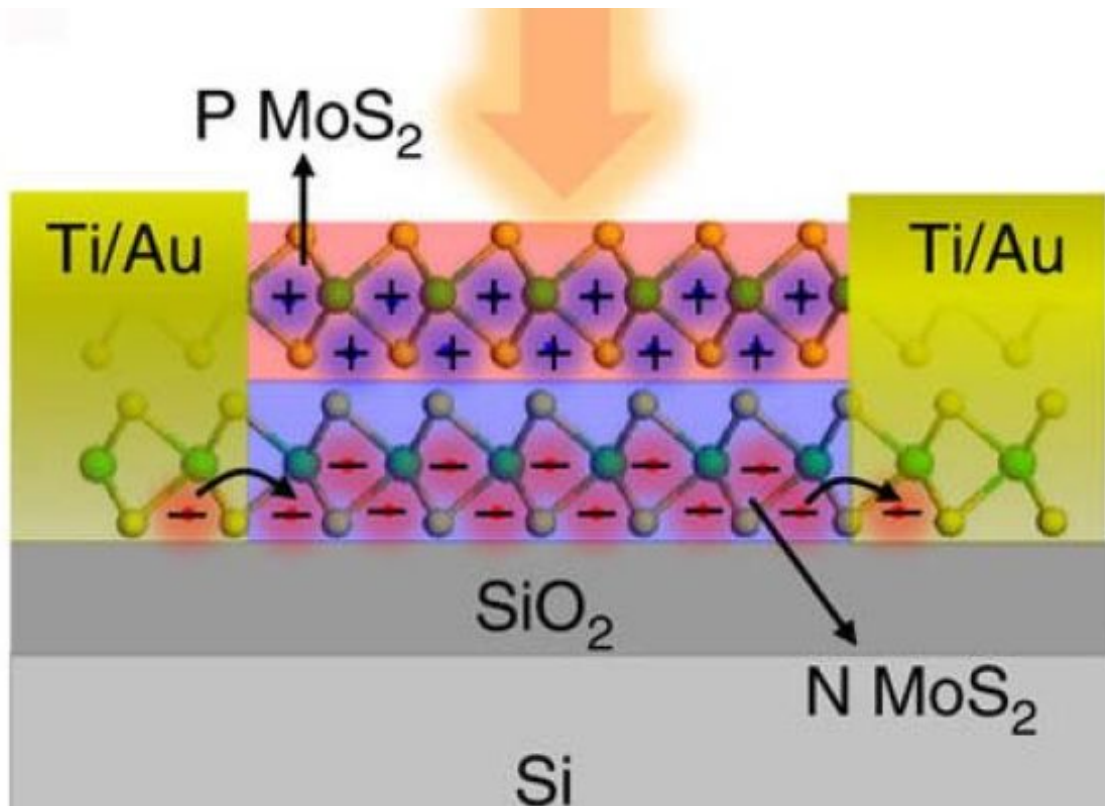




2D material photodetectors get even more sensitive

An ICFO study published in Nature Communications reports of the development of very sensitive all-2D photodetectors.

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Substantial progress in photonic devices based on 2D materials, due to their exceptional electronic and optical properties, has been achieved, converting them into a potential material for optoelectronic applications that range from laser applications to the next generation of photodetectors or flexible devices. However, to date, their sensitivity has not been able to surpass those of other standard CMOS current technologies like Silicon detectors.

In a recent study published in Nature Communications, ICFO researchers Nengjie Huo and ICREA Prof. at ICFO Gerasimos Konstantatos report on the development of an ultrasensitive two-dimensional photodetector employing an in-plane phototransistor with an out-of-plane

vertical MoS2 p-n junction as a completely novel sensitive scheme.

In their study, the team of scientists exfoliated a few layer MoS2 flakes on the SiO2/Si substrate using a micromechanical exfoliation method. To fabricate the MoS2 out-of-plane PN junction, they used AuCl3 P-type chemical surface doping and made the bottom N-MoS2 serve as the carrier transport channel while the top P-MoS2 was effectively isolated from the metal contacts. The PN junction served as a novel sensitizing scheme for all-2D based phototransistors by providing a charge separation mechanism that suppresses recombination in MoS2 and therefore has allowed to reach a quantum efficiency of nearly 10%, orders of magnitude higher than prior reports in 2D based phototransistors. Moreover, the device achieves a photoconductive gain of $>10^5$ electrons per photon, a responsivity of $7 \times 10^4 \text{ AW}^{-1}$, and a time response on the order of tens of ms. Most importantly the device exhibits very low noise offering specific detectivity on the order of 10^{14} Jones in the visible, almost an order of magnitude better than the standard high performance silicon detectors.

The results of this study pave the way towards the use of these ultra-sensitive phototransistors in other 2D semiconductors or in combination of those to facilitate sensitization, particularly those possessing low band gap to extend the spectral coverage of the 2D materials realm.