**Electronic supplementary information**

# A graphene-$Mo_2C$ heterostructure for a highly responsive broadband photodetector

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| Heterostructure | Condition | Responsivity $AW^{-1}$ | Response time | wavelength | Ref. |
|---|---|---|---|---|---|
| Graphene-$Cu_{3-x}P$ | $V_{sd}$ = 1 V 405 nm | $1.59\times10^{5}$ $AW^{-1}$ | 540 ms | 405-1550 nm | 1 |
| Graphene-Au NRs | $V_{sd}$ = 1 V 1300nm | $4\times10^{4}$ $AW^{-1}$ | 8200 ms | 400-1310 nm | 2 |
| Graphene-$MoTe_2$ | $V_{sd}$ = 1 V 1064 nm | 972 $AW^{-1}$ | 78 ms | 532-1064 nm | 3 |
| Perovskite-organic | $V_{sd}$ = -0.1 V 720 nm | 0.43 $AW^{-1}$ | 56 ns | 300-1000 nm | 4 |
| Graphene-$Mo_2C$ | $V_{sd}$ =1 V 405 nm | 9381.4 $AW^{-1}$ | 5.4 ms | 405-1550 | This work |

**Table S1**. Comparison between graphene-$Mo_2C$ device and other similar devices based on graphene or other composite materials.

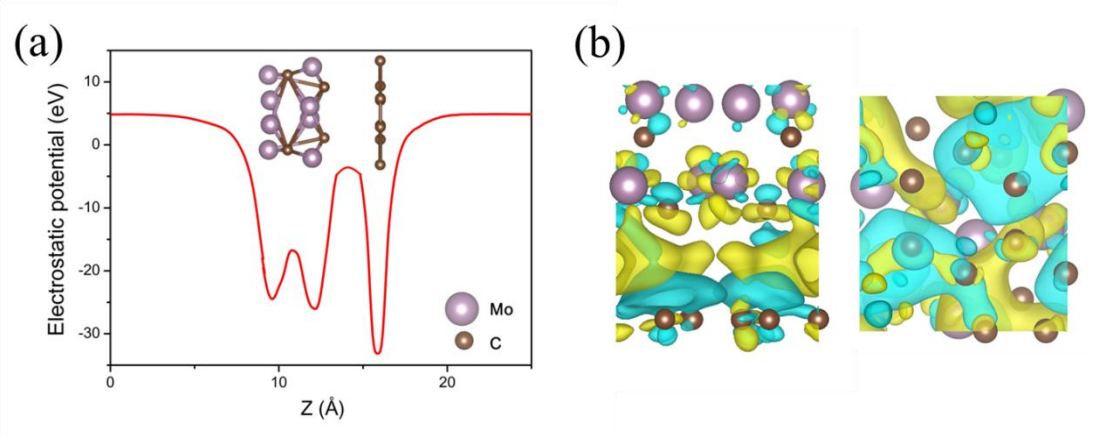


**Figure S1**. a) Effective electrostatic potential profile of graphene-$Mo_2C$ heterostructure. The corresponding structure diagram is shown in the illustration. b) Side view and top view of charge density difference for graphene-$Mo_2C$ heterostructure. The blue areas indicate the depletion of electrons and yellow areas indicate the accumulation of electrons.

Computing method:

The first-principles calculation method based on density functional theory is adopted, and the whole calculation process is performed in Vienna ab initio simulation package (VASP). The van der Waals correction of opt-PBE is taken into account in the calculation. The plane-wave basis cutoff energy is uniformly set at 400 eV. The atomic positions were optimized until the forces on atoms were less than $10^{-2}$ eV $Å^{-1}$, and the criterion of $10^{-6}$ eV per unit cell was sufficiently strict to obtain during the during structural relaxation. To eliminate the spurious interaction between the periodically repeated images of the slabs, the vacuum layer was set to more than 20 Å. The 6×6×1 Monkhorst-Pack K mesh was for the geometric optimization and state calculation.

**Notes and references**


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