Intrinsic potential barriers of heterojunctions formed by multi-terraced indium selenide nanosheets

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Following the route path marked by graphene, many others layered materials have managed to be exfoliated until the single-layer unit, these exhibiting a distinctive semiconducting behaviour [1-5]. These two-dimensional semiconductors can constitute the building blocks of new heterostructures based on 2D materials [6] with potential applications in optoelectronic [7], spintronic [8,9] and valleytronics [10,11].
The fabrication of 2D heterostructures with clean and sharp interfaces is essential for preserving optoelectronic properties driven by the interlayer or intralayer coupling [12]. Van der Waals heterostructures could be created by stacking diferent 2D materials using mechanical transfer techniques [13]. However, the control of the interface quality remains challenging. Only under controlled interface conditions, abrupt interfaces have been realized and allowed, for instance, the realization of interlayer excitonic states in van der Waals bound heterobilayers [14]. In this work, we show that the particular and distinct properties of two-dimensional indium selenide nanosheets can open the door for the development of new heterjunctions and related devices. In particular, we have analysed the electronic properties of interfaces formed in multi-terraced InSe nanosheets, by nano-photoemission and photocurrent response measurements, demonstrating that abrupt interfaces naturally appear in multi-terraced nanosheets of 2D InSe which can be used for the fabrication of planar devices based on this 2D semiconductor.

References

[1] H. Zeng, et al., Nat. Nanotechnol., 7 (2012) 490.
[2] X. Xu, et al., Nat. Phys., 10 (2014) 343.
[3] G. W. Mudd, et al., Adv. Mater., 25 (2013) 5714.
[4] J. F. Sánchez-Royo, et al., Nano Res., 7 (2014) 1556.
[5] M. Brotons-Gisbert, et al., Nano Lett., 16 (2016) 3221.
[6] T. Niu, et al., Prog. Surf. Sci., 90 (2015) 21.
[7] X. Li, et al., Appl. Phys. Rev., 4 (2017) 021306.
[8] K. F. Mak, et al., Science, 344 (2014) 1489.
[9] Y.-J. Chen, et al., Nat. Photonics 11, (2017) 431.
[10] N. Zibouche, et al., Ann. Phys., 526 (2014) 395.
[11] W. Han, APL Mater., 4 (2016) 032401.
[12] A. K. Geim, et al., Nature, 499 (2013) 419.
[13] Y. Gong, et al., Nat. Mater., 13 (2014) 1135.
[14] P. Rivera, et al., Nat. Comm., 6 (2015) 7242.