Applications of 2D Materials Beyond Graphene

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1. Introduction & Beginnings
   (a) Before graphene
      i. Prior to the mid-1980s (1985) graphite had been used for several practical applications. In 1985 the discovery of Fullerenes fueled expansion of research on the material and its derivatives [2, 3]
      ii. Theories suggested the possiblity of one-dimensional structures of this form, and carbon nanotubes (1991) [1]. This suggested the possibility of synthesizing carbon structures on a larger scale than was previously possible with fullerenes.
      iii. In 2004 single layers of graphite were isolated by Geim et. al [4, 5]. This breakthrough led to a breadth of literature on graphene surfaces and its possible applications.
   (b) After Graphene: Emergence of other 2D materials
      i.
2. Comparisons to 2D materials to Graphene

Notes from class overview

1. TMDs
2. Compare 2D materials to properties of graphene
3. Why are 2D material significant
   (a) Electronic device applications
4. Fundamental materials
5. State of the art ("cutting-edge")
6. Problems/Outlook:
   Contacts, interface, controlled doping, etc...

References

[1] Sumio Iijima. Helical microtubules of graphitic carbon. *Nature*, 354:56–58, 1991.

[2] H. W. Kroto, J. R. Heath, S. C. O'Brien, R. F. Curl, and R. E. Smalley. C60: Buckminsterfullerene. *Nature*, 318:162–163, 1985.

[3] Ruben Mas-Balleste, Cristina Gomez-Navarro, Julio Gomez-Herrero, and Felix Zamora. 2d materials: to graphene and beyond. *Nanoscale*, 3:20–30, 2011.

[4] K. S. Novoselov, A. K. Geim, S. V. Morozov, D. Jiang, Y. Zhang, S. V. Dubonos, I. V. Grigorieva, and A. A. Firsov. Electric field effect in atomically thin carbon films. *Science*, 306(5696):666–669, 2004.

[5] K. S. Novoselov, D. Jiang, F. Schedin, T. J. Booth, V. V. Khotkevich, S. V. Morozov, and A. K. Geim. Two-dimensional atomic crystals. *Proceedings of the National Academy of Sciences of the United States of America*, 102(30):10451–10453, 2005.