

# 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 [3]. In 1985 the discovery of fullerenes ( $C_{60}$ ) initiated the postulation of the interesting and beneficial properties of the structure and its derivatives, assuming that it could be synthesized in large amounts [2].
- ii. Theories suggested the possibility 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. Around the mid-2000s there was push for performance improvements in semiconductors as the industry neared silicon's limits.
- iv. In 2004 single layers of graphite were isolated by Geim et. al [4, 5]. They observed field effects in an atomically thin layer of graphene. They prepared the sample using exfoliation (define later). At the time, it was the leading candidate for metallic transistors and other electronic components. As a result, this began a breadth of research on graphene.

### (b) After Graphene: Emergence of other 2D materials

i.

## 2. Properties of 2D materials compared to graphene

### (a)

## 3. Why are 2D materials significant?

### (a)

## 4. Fundamental Materials

### (a)

## 5. State-of-the-art

### (a)

## 6. Problems & Outlook

### (a)

## 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.  $C_{60}$ : 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.