

# DISCOVERY OF GRAPHENE

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## Coming Up

1. Introduction of Winners.
2. What is Graphite and Graphene??
3. History of Discovery Practices.
4. Methods of Successful Discovery.
5. Importance of this Discovery.
6. Recent Research Trend on Graphene.
7. Conclusion.



## 1. Introduction to winners



Andre Geim

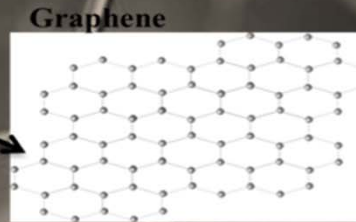
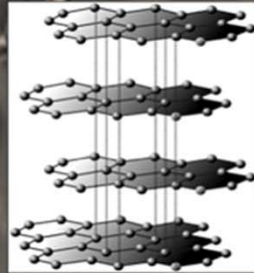
Konstantin Novoselov

University of Manchester , England  
Awarded Noble Prize in Physics in 2010

## 2. GRAPHITE AND GRAPHENE



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Graphite

1. 3D allotropes of Carbon.
2. Stack of graphene layer one over another attached by Vander Waal force.

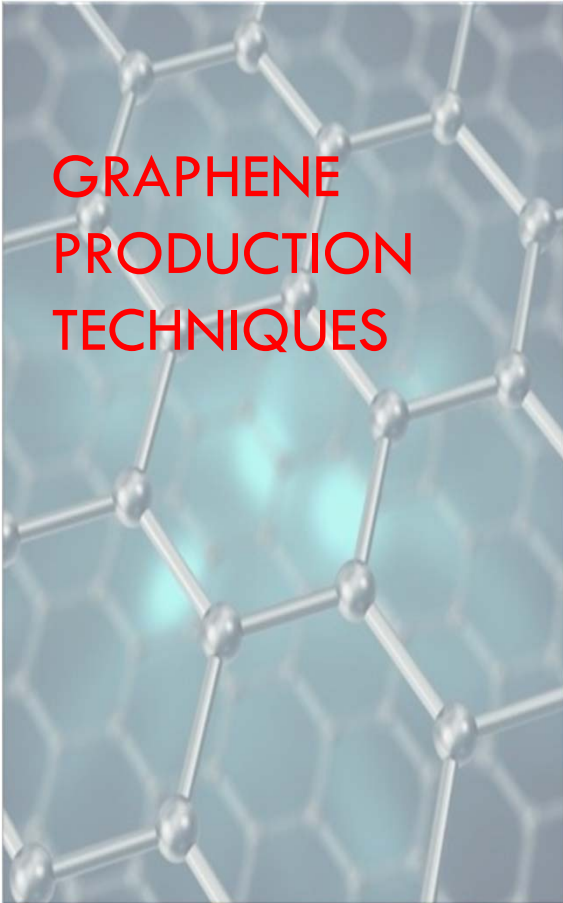
Graphene

1. 2D thinnest layer of Graphite .
2. One atom thick layer of carbon atoms in hexagonal honeycomb lattice.

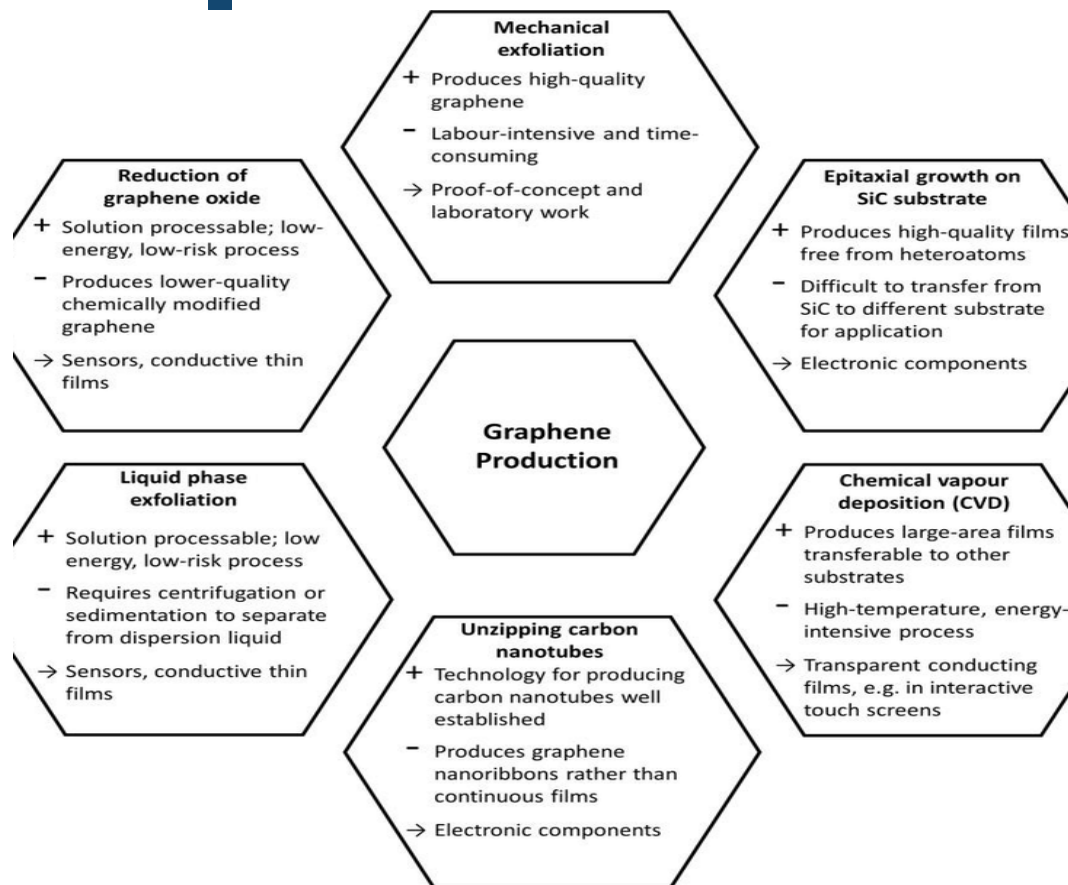


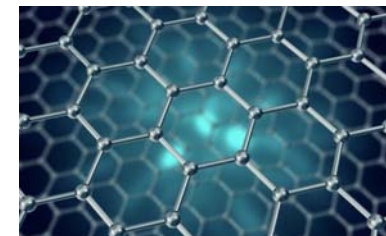
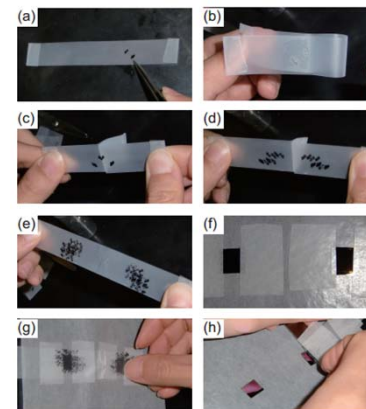
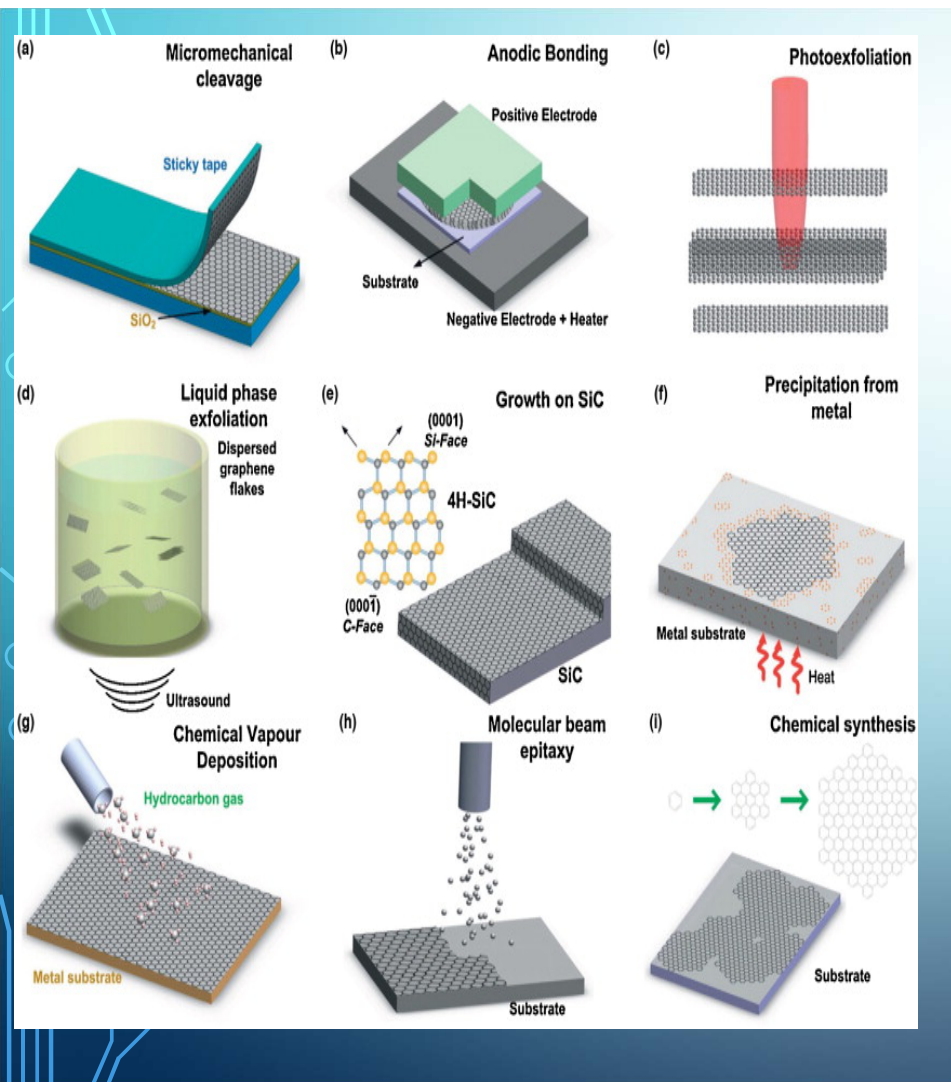
## HISTORY

1. The theory of graphene was first explored by [P. R. Wallace](#) in 1947 as a starting point for understanding the electronic properties of 3D graphite.
2. The term *graphene* was introduced in 1986 by chemists [Hanns-Peter Boehm](#), [Ralph Setton](#) and [Eberhard Stumpp](#).
3. In 2004 Geim and Novoselov extracted single-atom-thick crystallites from bulk graphite. They pulled graphene layers from graphite and transferred them onto thin [silicon dioxide](#) ( $\text{SiO}_2$ ) on a silicon wafer in a process called either micromechanical cleavage or the [Scotch tape](#) technique.



# GRAPHENE PRODUCTION TECHNIQUES



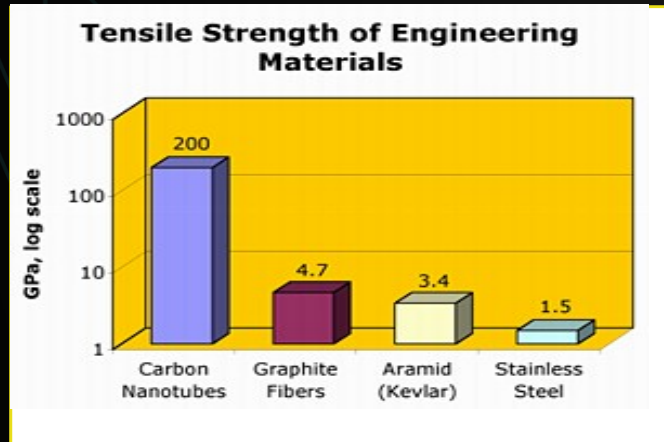




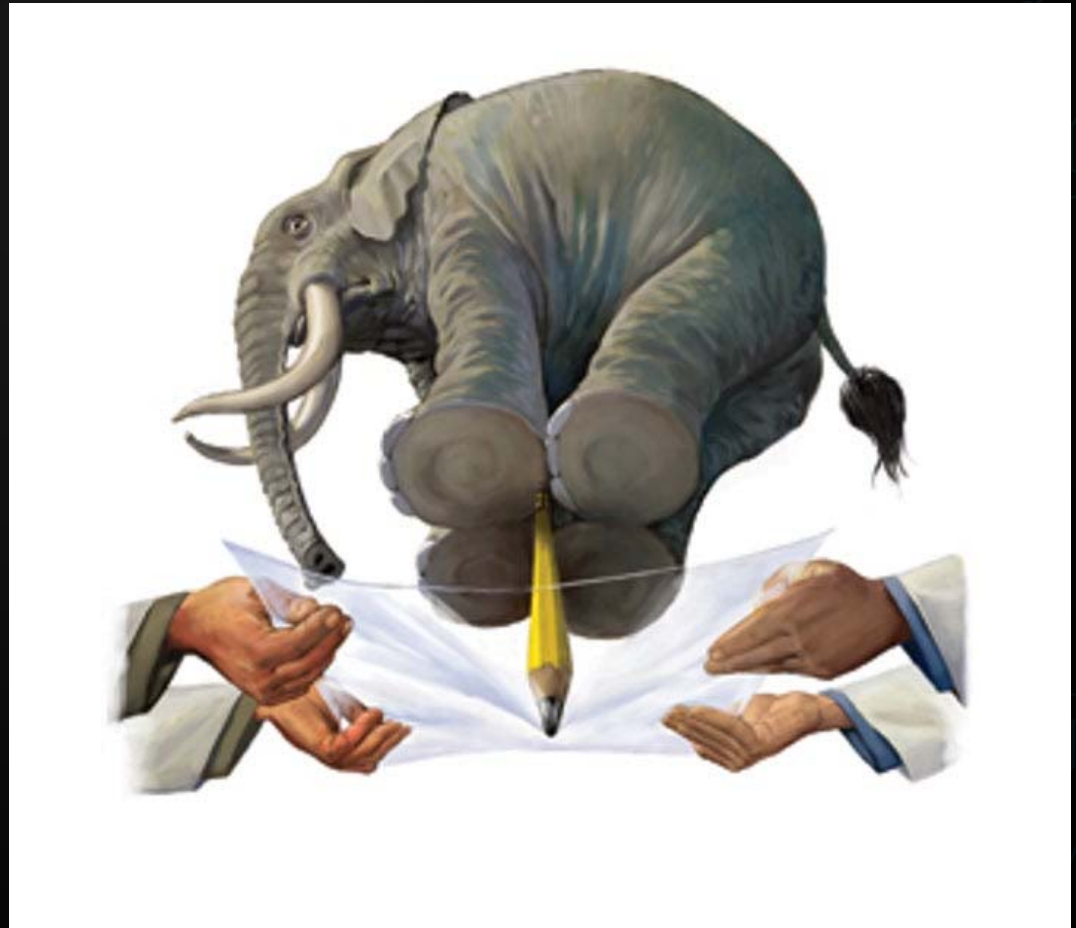
## INTERESTING PROPERTIES OF GRAPHENE.

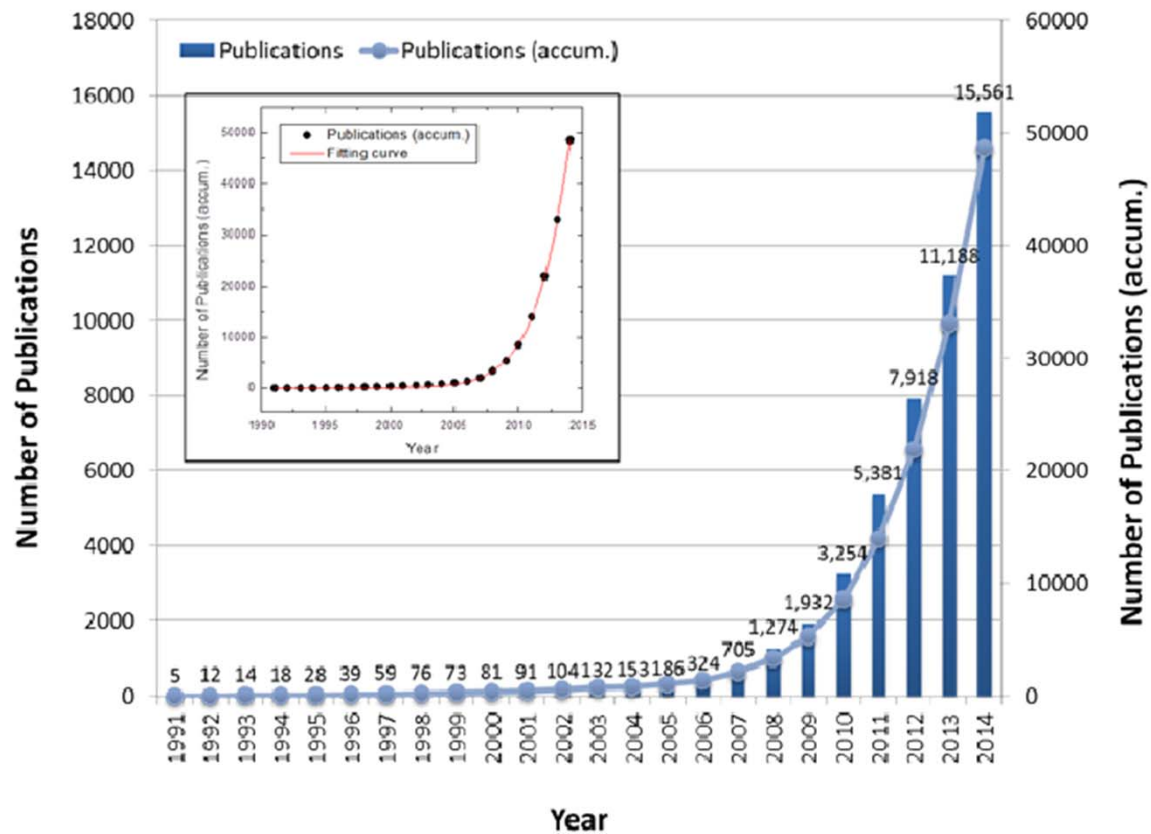
1. **Strongest Material.** 100 to 300 times stronger than the steel
2. **Highly Transparent.** It is 97.7% transparent.
3. **Highly Conductive.** It conducts heat two times better than Diamond.
4. **Electron Mobility** is 100 times faster than silicon.
5. **Highly impervious.** Smallest atom Helium also cannot pass through it.





Physical Properties	Graphene	Carbon nanotube	Si	Cu
Melting point (K)	3800	3800	1687	1357
Thermal conductivity ( $10^3 \text{ W/mK}$ )	3-5	1.75-5.8	0.15	0.385
Current density ( $\text{A/cm}^2$ )	$> 10^8$	$> 10^9$	-	$10^7$
Electron mobility ( $\text{cm}^2/(\text{V.s})$ )	$> 10,000$	$> 10,000$	1400	-
Mean free path (nm)	$1 \times 10^3$	$> 10^3$	20-30	40







# APPLICATION OF GRAPHENE

1. BIOLOGICAL ENGINEERING
2. OPTICAL ELECTRONICS
3. ULTRAFILTRATION
4. COMPOSITE MATERIALS
5. PHOTO VOLTAIC CELLS
6. ENERGY STORAGE



Flexible/Transparent  
Electrodes,  
Touch Panels



Conductive Ink EMI  
shielding coatings Gravia  
printing electrodes

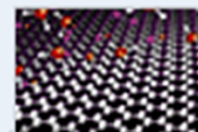
Transparent  
Electrodes

Printable Ink



Ultrafast  
transistors  
RFIC Photo  
/Bio sensors

Semicon-  
ductor



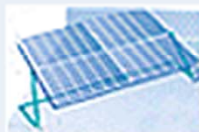
Gas/Water  
barrier  
Oxidation  
protectants

Gas Barriers

Graphene



Graphene Complex  
materials

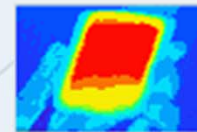


Solar cells  
Secondary batteries  
Fuel cells  
Super capacitor

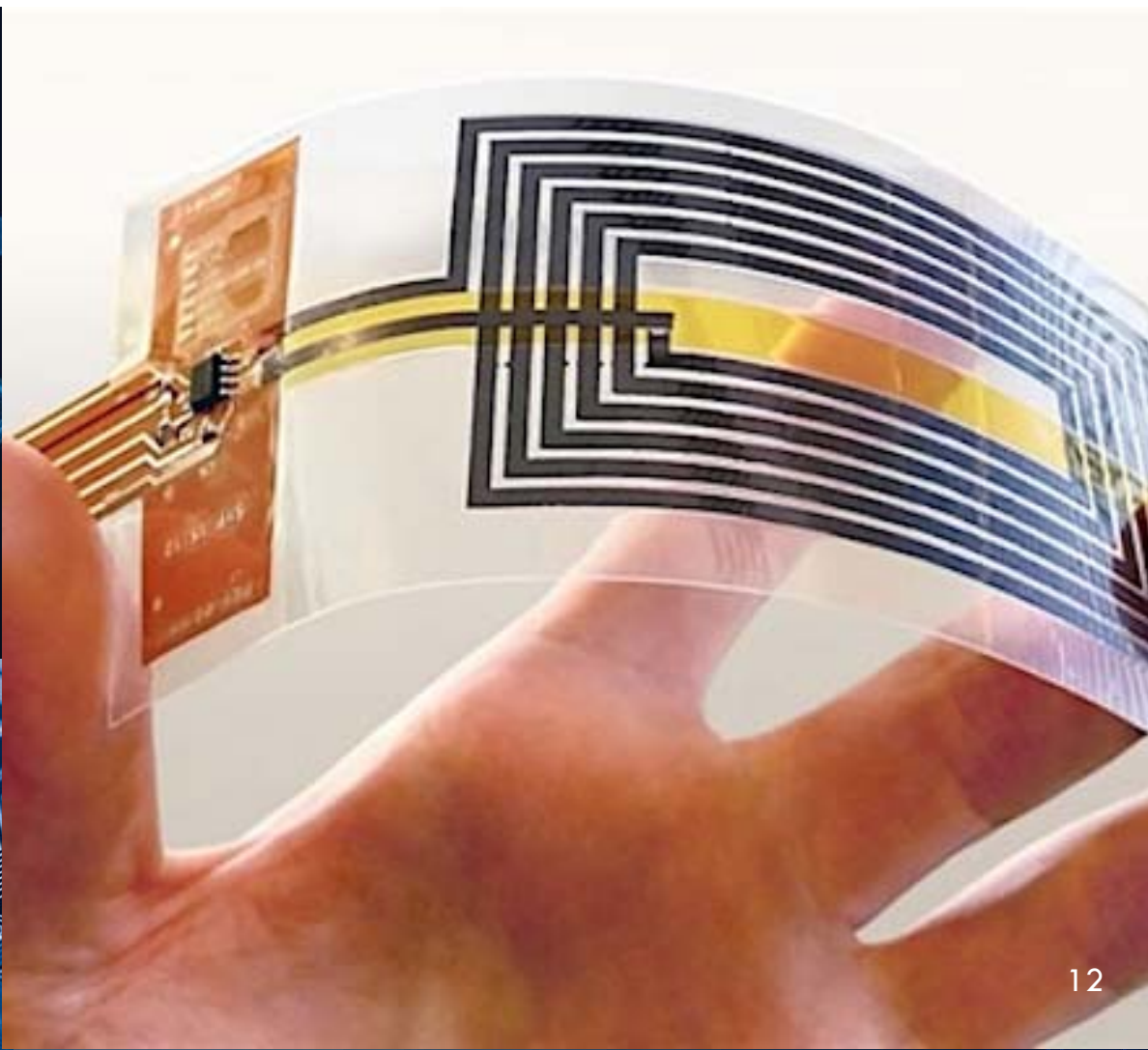
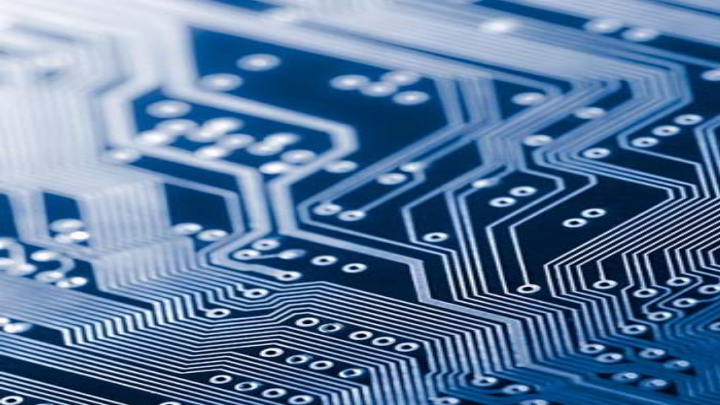
Energy  
Electrodes

Light  
Materials

Heat  
Dissipation



Led, BLU etc.





## References.

1. [nobelprize.org/prizes/physics/2010/geim/lecture](http://nobelprize.org/prizes/physics/2010/geim/lecture)
2. Geim, A. K.; Novoselov, K. S. (26 February 2007). "The rise of graphene". *Nature Materials*.
3. [www.graphenea.com](http://www.graphenea.com)
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5. [en.wikipedia.org/wiki/Graphene](http://en.wikipedia.org/wiki/Graphene)