Annals of the Academy of Romanian Scientists
Series on Physics and Chemistry
ISSN 2559 – 1061 Volume 5, Number 1/2020

PROPERTIES AND APPLICATIONS OF GRAPHENE

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Abstract. *The paper presents the properties and applications of graphene, focused on the results obtained by the author. Because in graphene the charge carriers satisfy a massless Dirac equation, it can serve as testing material for several predictions of high-energy physics. Graphene applications are based on its unique mechanical, optical and electrical properties, which generally lead to devices with superior performances compared to those fabricated with other materials. However, to fully benefit from the distinctive properties of graphene, novel device configurations should be searched for instead of implementing common devices*.

Keywords: graphene, charge transport, nanodevices

https://doi.org/10.56082/annalsarsciphyschem.2020.1.155

1. Introduction

Graphene is a one-atom thick crystal containing carbon atoms in a hexagonal lattice, which can be obtained by peeling graphite [1]. Although the theory of graphene has been known for a long time [2], it was actually fabricated in 2004 [3] and has attracted interest ever since, being the first known two-dimensional material. The mechanical properties of graphene and of few-layer graphene materials are a consequence of the strong in-plane σ bond that forms between the sp^2 hybridized carbon orbitals, while the optical and electronic properties are determined by the π bonds, which form between the out-of-plane un-hybridized p orbitals. Although the mechanical properties of graphene are among the best [4], this material being characterized by an elastic limit of about 20%, the interest in graphene is mainly related to its particular bandstructure. Some properties of graphene are summarized in Table I. It should be mentioned that the actual properties of graphene flakes depend on the fabrication method [5].

Table 1) Properties of graphene

Property	*Value*	*Observation*
Young modulus	1 TPa	5 times higher than in steel
Breaking strength	42 N/m	100 times greater than in steel
Room-temperature mobility (in suspended graphene)	200,000 $cm^2V^{-1}s^{-1}$	100 times higher than in Si
Current density	> 108 A/cm	100 times larger than in Cu
Thermal conductivity	5000 $Wm^{-1}K^{-1}$	10 times higher than in Cu
Light absorption coefficient	2.3 %	50 times higher than in GaAs

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