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A Review on the Potential Applications for Cadmium Selenide and Graphene Materials

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Abstract

The unique physical and chemical properties for nanomaterials make them suitable to be used in different applications such as optoelectronic devices, sensors, and biomedical applications. Physical and chemical methods are used to prepare material in nanoscale region. Physical methods depend on the technique used, temperature, and substrate. Cadmium selenide is highly sensitive to technique used. Its absorbance and photoluminescence changed with increased size of particles. The surfaces of CdSe can adsorbent different atoms and molecules to saturate dangling bond. Therefore, CdSe nanoparticles are used in chemical and biological sensors. In this review some of recent applications and properties of CdSe are analyzed. Graphene considers one of the important materials in the present time, because of unique properties such as high conductivity, high luminance, more hardness materials than diamonds. It has wide applications in the physical and chemical sensor, also suitable material in the photonic device. In the present review paper, we present the application of graphene materials in the gas sensor and solar cell application.

1. Introduction

Richard Feynman states that "There is plenty of room at the bottom" in 1959 during his presentation about the advantages of having better control over things at smaller dimensions which spurred the drive for miniaturization and beating Moore's law [1]. Nanomaterials have attracted a wide interest in the last decades. For this, the unique combination of small size, interesting properties, and a good process ability, are opening the flexibility of their use in many technical and biomedical applications [2]. Nanomaterials may have unique physical and chemical properties not found in their bulk counterparts, such as the unusually large surface area to volume ratios or high interfacial reactivity. Such properties give a hope for new chemical capabilities arising from exciting new classes of nanomaterials [3].

The cadmium-selenide (CdSe) molecular clusters have long been attractive for both theoretical and experimental investigators [4]. In the last decade, a main attention has been given to the study of characterization of CdSe thin films to get new applications and increase the performance of the device [5]. The high sensitivity of CdSe thin film is affected by the deposition conditions and the method used. Therefore, the theoretical and experimental study of CdSe properties is a matter of high reputation [6]. The CdSe thin film has been prepared using a variety of chemical and physical methods [7]. The growth and quality of the thin film depend on the essential parameters including a substrate, substrate temperature, and relative kinetic energies [8]. II-VI compound semiconductors have the band gap between 1-3 eV in the visible region, and these semiconducting materials are used worldwide in optoelectronic devices [9]. The CdSe exists in two structures, cubic, and wurtzite. The wurtzite is more abundant than cubic [10]. The characteristic of CdSe quantum dots is dependents on the size of the particle, as shown in Fig. 1 [10]. This makes them an excessive material for use in chemical and biological sensors [11]. The CdSe has been also the first example of self-assembled semiconductor nanocrystal superlattices with a direct band gap equal to 1.8 eV [11]. The present review concerned on some of recent experimental results of CdSe nanoparticles. Fig. 2 illustrated different structure of CdSe nanomaterials.

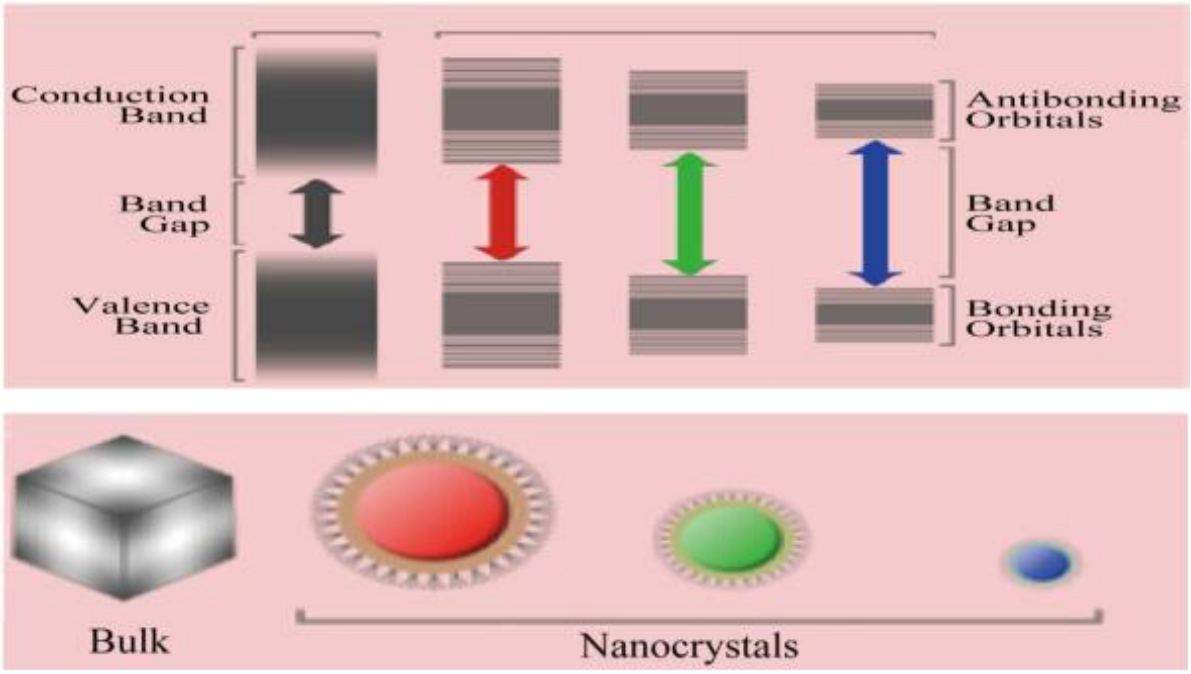

Fig. 1 *Schematic energy band diagram of nanocrystal-line CdSe and bulk materials [10]*

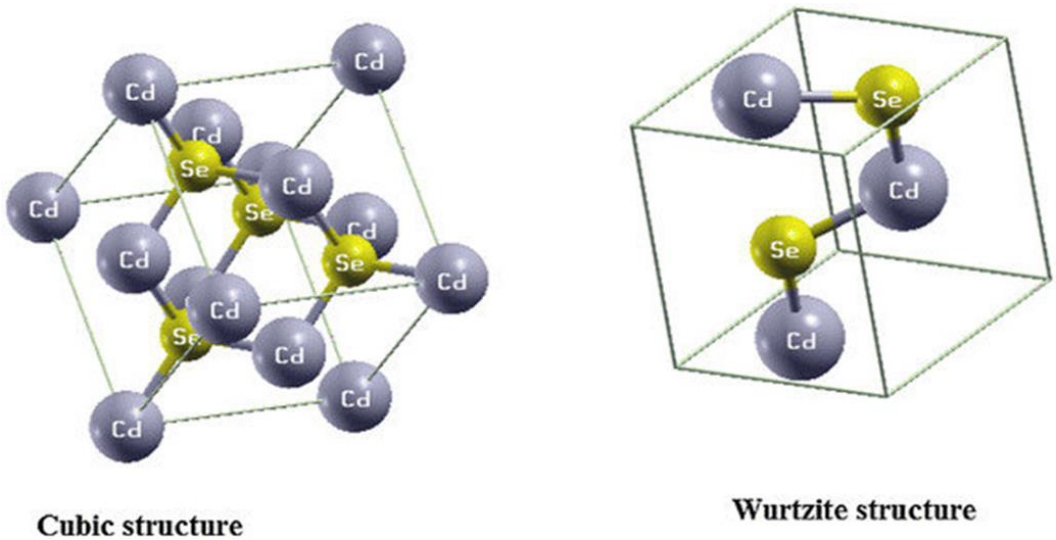

Fig. 2 *Geometrical structure for CdSe nanomaterials for different phases Cubic and Wurtzite structures [12]*

Graphene implies to a monolayer of graphite, encompassing carbon atoms in sp2 hybridization and arranged in a honeycomb lattice structure. It consists of two interpenetrating triangular sub-lattices and serves as a fundamental constituent for various carbon allotropes, such as fullerenes and carbon nanotubes [13]. Graphene, a two-dimensional carbon sheet with an interconnected structure, exhibits remarkable qualities like a high surface-to-volume ratio, minimal electrical noise, and great transport characteristics. Graphene exhibits exceptional efficiency owing to its distinctive two-dimensional structure and its distinctive chemical attributes, which encompass remarkable electrical, optical, and mechanical qualities [14].

Graphene, owing to its exceptional characteristics, has found widespread application in various domains, including energy generation, spintronics, and field effect transistors (FETs) [15]. Graphene has been demonstrated to possess potential applications in the detection of molecules, encompassing both experimental and theoretical domains. Graphene exhibits potential as a promising material for adsorption and desorption processes owing to its reduced dimensions and expansive surface area. Graphene, a semiconductor with a zero band gap, has valence and conduction bands that intersect at the Dirac points located at the corners of the Brillouin zone [16]. The advancement of graphene-based electronics is contingent upon the capability to create a modifiable band gap. Numerous methods have been devised to construct high-performance graphene devices by manipulating their band gaps, hence enhancing their semiconducting characteristics [17].

One of the most notable aspects is that graphene is a crucial derivative of carbon and is derived from a diverse group of fullerene nanomaterials. Graphene plays a vital role in various dimensionalities of allotropes, which are extensively utilised as electrode materials [18]. At the higher level of structural arrangement, graphene is commonly acknowledged as the progenitor of various graphitic configurations, as illustrated in Fig. 3. In addition to its planar form, a single sheet of graphene can adopt a zero-dimensional spherical structure known as a C60 Bucky ball. Furthermore, it can also manifest as one-dimensional carbon nanotubes, which can be further categorised as single-walled carbon nanotubes (SWCNTs) or multi-walled carbon nanotubes (MWCNTs) depending on the number of graphene layers present. Lastly, several layers of graphene can be stacked jointly to form a three-dimensional structure known as graphite [19].

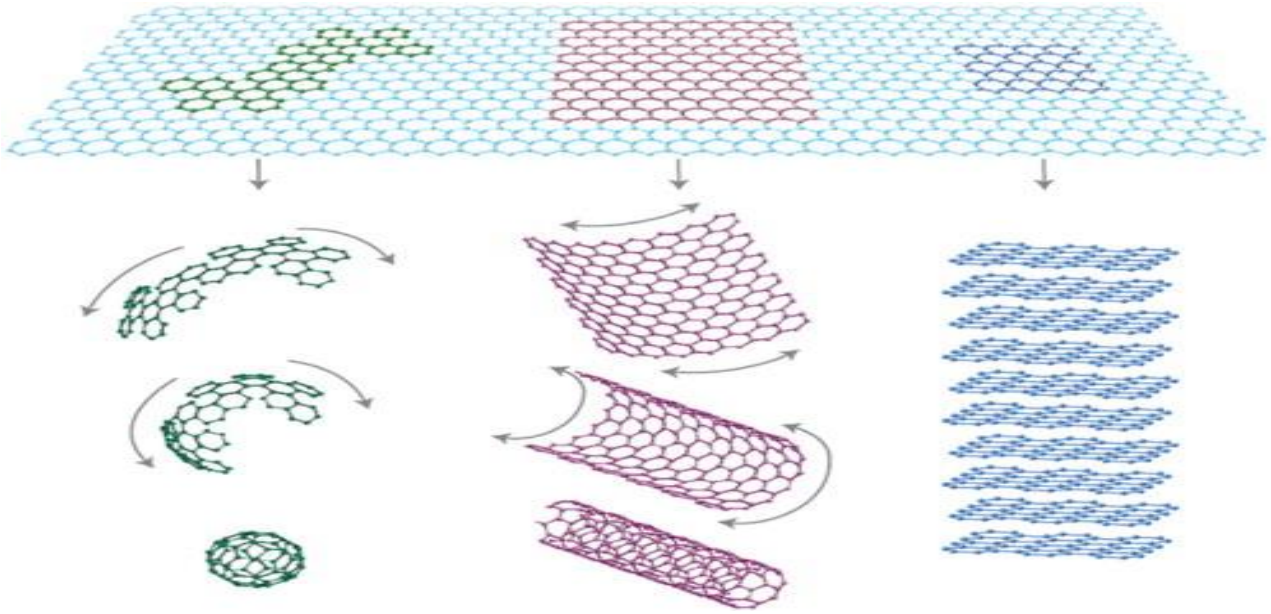

Fig. 3 *Mother of graphene form (fullerene, carbon nanotubes and graphite) [19]*

2. Adsorption Process

In order to comprehend the process by which gas sensing occurs on the surface of nano materials, it is important to establish a clear understanding of the adsorption mechanism that occurs place among gas molecules and the surface of the nanomaterial.

In recent years, there has been a demonstration of a new generation of gas sensors utilising carbon nanotubes (CNTs) and semiconductor nanowires, owing to their high sensitivity, broad applicability, and cost-effectiveness [20]. Carbon nanotubes (CNTs) exhibit promising potential as highly effective nanoscale sensors due to their rapid response time and exceptional sensitivity when operating at ambient temperatures [21]. Graphene is regarded as a highly effective material for sensing applications, much like carbon nanotubes (CNTs), owing to its notable characteristics. These include its two-dimensional structure, which facilitates enhanced

interaction between adsorbates and the graphene layer, as well as its low Johnson noise and minimal crystal defects [22].

The utilization of graphene samples as very sensitive gas sensors, capable of detecting nitrogen dioxide (NO2) molecules, has been documented. This development has prompted the theoretical investigation of graphene's sensing capabilities [23]. The DFT method was employed to illustrate the substantial impact of donor or acceptor molecules on the electronic characteristics of graphene [24]. In addition to the adsorption of gas molecules on a graphene sheet, there are observable alterations in resistivity. This phenomenon enables graphene to function as a solid-state sensor for the detection of gas molecules. The adsorption capacity and high surface-to-volume ratio of graphene render it a very suitable material for gas sensing applications. In recent times, there has been a surge in the investigation of the adsorption phenomenon involving various atmospheric gases on graphene, which serves as an active surface. This exploration has been carried out through both experimental and theoretical approaches [25]. The adsorption process in pure graphene has limited variability.

Hence, with the exception of certain cases, employing pure graphene as an adsorption mechanism for gas molecules may not be the optimal choice. In order to address the issue of insensitivity of molecules on pure graphene, the implementation of doped graphene is deemed advantageous due to its ability to build a three-dimensional structure. Previous research has demonstrated that doping graphene with metals can significantly enhance its sensitivity towards various compounds [26]. Fig. 4 listed the adsorption process between different gases molecules and surface of different nano materials.

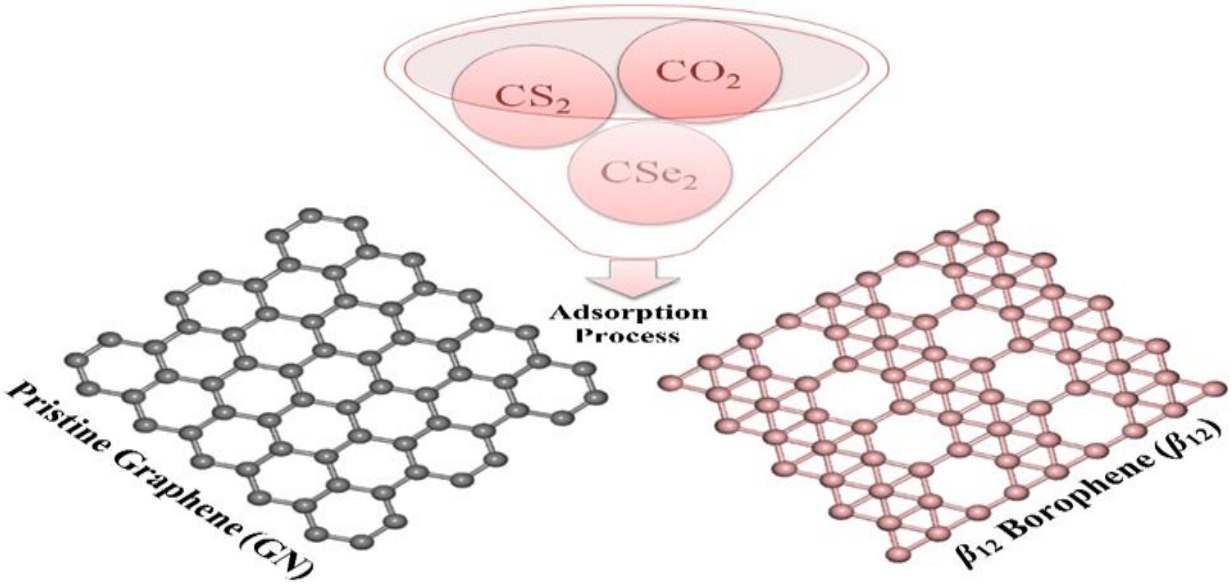

Fig. 4 *Adsorption process between different types of toxic gases and surface of pure graphene and borophene [12]*

3. Literature

3.1 Theoretical and Experimental

A decade before Graphene was produced by exfoliation from the parent graphite crystal, Takeda and Shiraishi [27] examined for the first time the atomic and electrical structure of the materials that are now known as silicene and germanene. They have demonstrated using density functional theory (DFT) that it is energetically advantageous for silicene and Germanene to buckle rather than remain planar, as carbon atoms do in the case of Graphene. The silicene band structure was also reported, but the Dirac cone, which is the straight crossing at the Fermi level, was not given much attention. For two key reasons, this forward-thinking study was disregarded for almost a decade. The idea that these two-dimensional (2D) materials cannot exist in nature was widely held.

The electrical and mechanical characteristics of graphene sheets were examined by Bunch [28], and gated, quasi-2D graphite quantum dots were used to monitor low temperature electrical transport. By employing longitudinal and Hall resistances to extract a carrier density of (2–6) *1011 holes per sheet and a mobility of (200–1900) cm^2/V.s. in devices with low contact resistances. He studies the mass and elastic constants of Graphene membranes, and establish that atomic layers of \sGraphene exhibit stiffness similar to bulk graphite (E ~ 1 TPa). They achieved that a new class of atomic size membrane-based devices can be produced by combining single atomic sheets with microfabricated components.

AlZahrani and Srivastava investigated density-Graphene, bilayer Graphene, multilayer Graphene, and graphite using the first principles pseudo potential plane-wave approach [29]. A warped triangle shape is used

for examination of the electronic band structure and structure close to the Fermi level, which quantified the gradual shift in the Fermi surface topology from graphite using a functional theory to examine the electronic characteristics of a point-like structure for Graphene. discussed how the effective masses and velocities of the electrons and holes gradually change when the system transitions from graphene to graphite.

The subject of whether silicon could adopt a sp2-like hybridization to create a stable free-standing 2D structure was addressed by Cahangirov *et al.* [30]. For both buckled and planar silicene, phonon dispersions have been estimated. In contrast to the buckled silicene, which exhibited all positive phonon modes, the planar silicene had imaginary frequencies that were obviously indicative of structural instability. This meant that whereas flat silicene was unstable, buckling silicene had restoring forces to any potential deformation. They also underlined that, despite the fact that buckling reduced the system's symmetry, the lattice's remaining hexagonal symmetry was sufficient to maintain the linearly crossing bands at the Fermi level. Beyond graphene, this work stimulated numerous theoretical and practical investigations on silicene.

Sahin *et al.* [31] examined the two-dimensional (2D) honeycomb structure of group-IV elements and their binary compounds as well as the compounds of group III-V elements using first-principles plane-wave computations. They discovered that 22 distinct honeycomb materials are stable and correlate to local minima on the BornOppenheimer surface using structural optimization and phonon-mode computations. Additionally, they discover that all binary compounds containing B, C, or N, one of the first row elements, have stable planar structures. The GW09 simulations software is used to repair the band gaps that were determined using the local density approximation inside density functional theory. According to preliminary findings, these compounds' almost lattice matched heterostructures can provide options for nanoscale electrical devices.

Saffarzadeh investigated utilizing DFT calculations to describe a gas molecule in a graphene nano-ribbon [32]. Results indicate that the length of the ribbon and the orientation of the gas molecule influence the amount of charge transfer. On the C atom of the CO molecule sits the highest occupied molecular orbital.

Thierfelder *et al.* [33] investigated the interaction of a methane CH4 gas molecule with a graphene nanoribbon. For interacting systems, adsorption energy was calculated using DFT simulation. The interaction system's vertical adsorption distances are 3.25 and 3.18, and the indicated adsorption energies are 0.14 and 0.15 eV, respectively. Physical adsorption was quite weak, according to binding energy.

Using first-principles calculations based on density functional theory, Houssa *et al.* examined the electrical characteristics of hydrogenated silicene and germanene, also known as silicane and germanane, respectively [34]. It is discovered that two distinct atomic configurations are energetically degenerate and stable. In germanene and silicene, an energy gap develops upon hydrogen adsorption. The atomic arrangement of silicane determines the kind of gap (direct or indirect). Independent of its atomic configuration, germanane is projected to be a direct-gap material with an average energy gap of roughly 3.2 eV, making it potentially intriguing for optoelectronic applications in the blue/violet spectral range.

Ding *et al.* [35] examined how protein tyrosine nitration (PTN) adsorption behaved on graphene that was both pure and doped. The results demonstrate that PTN physically adsorbs across pure graphene while also producing a little amount of energy. Between two reactors, charge transmission was almost nonexistent. Doping graphene with gold, corium, and nickel metal atoms modifies the adsorption behavior. Increased binding energy and charge transmission between them. Lastly, calculations show that graphene doped with metal can be employed as a chemical sensor for dangerous gases.

Alpernce [36] used the traditional empirical molecular dynamics simulation technique to examine the structural and mechanical properties of SiNR. SiNR sheets have been shown to not have a fully flat honeycomb shape. Also, it has been discovered that at room temperature, finite length models are more likely to generate tubular structures that resemble warped silicon nanotubes. At 5% and 10% uniaxial strain, the mechanical characteristics of silicene nanoribbons of various widths have been studied. Under stress, it has been discovered that SiNRs exhibit the following material characteristics: they are quite ductile, they have significant toughness, and while having low elasticity, they have a very extended plastic range before fragmenting.

Zhou [37] research centered on comprehending the structural and electrical characteristics of a few atomic layers of silicon and carbon (graphene) (silicene). On the basis of density functional theory, the atomic structures of the 2D materials, associated band structures, and transport parameters were estimated. With the appropriate layer spacing, a band gap was seen in AB forwardly stacked bilayer silicene. A further expansion of the band gaps up to 0.19 eV was seen when an external electric field was applied. I-V curves and the transmission spectrum were determined in addition. A novel structure of a thin silicon layer on a substrate of graphene is proposed, displaying distinct transport properties from 2D silicene.

In 2013, Rastegar and colleagues [38] looked at the sensitivity of HCN-towering graphene doped with silicon and aluminum atoms. The researchers computed the energic and geometrical properties using the DFT approach. For a pure graphene nanoribbon, the HCN gas molecule physically adsorbed. The geometric structure of pure graphene was altered by the addition of metal atoms, resulting in bond lengths on its surface shortening at the locations of doped atoms. Aluminum-graphene (AlG) had higher HCN adsorption energy than silicon-graphene (SiG). They demonstrated that AlG structure is more suitable than SiG for detecting HCN.

First-principles density functional theory (DFT) computations were used by Bohayra *et al.* [39] to examine and contrast the interaction of Na or Li ions on the Silicene, germanene, and stanine sheets. For a single Na or Li adatom on the membranes under consideration, we first determined the most stable binding sites and their related binding energies. Then, they steadily raised the ions concentration until the surfaces were completely saturated. The investigation's findings may be helpful for silicene, germanene, and stanene applications in Na or Li ion batteries.

Vessally *et al.* [40] investigated the adsorption energy of the boron-nitride drug used to make aspirin in both its pure and doped forms. The interaction of the aspirin medication molecule over the surface of the born-nitride nano cage was studied using the DFT approach. Adsorption energy for the pure state ranged from -10.2 to -32.6 kcal/mol. The adsorption energy increased as aluminum atoms were added to the structure, and it ranged from -42.9 to -75.5. It is evident that aluminum atom modification of boron-nitride doping affects the material's thermal and adsorption properties. Moreover, because to the doping process, UV spectra shifted from blue shifting in reference to pure boron-nitride nano cage to red shifting.

Aghaei *et al.* [41] investigated how gas molecule adsorption energy behaves (CO, NO, NO2 and NH3). The most stable adsorption configurations, adsorption energies, binding lengths, charge transfers, and electronic band topologies were calculated from first principles. The results indicated that the BC3-based sensor had a low to moderate sensitivity to CO, with the adsorption energy for the CO gas molecule being less than -1 eV.

First-principles calculations were used by Pang *et al*. [42] to examine the structural, kinetic, and electronic characteristics of germanene adsorbed with tiny nitrogen-based molecules, including N2, NH3, NO2, and NO. The findings demonstrate that because to the hybridized bonding of Ge atoms, all nitrogen-based compounds taken into account attach to germanene far more strongly than to graphene. While the NH3 molecule donates electrons to germanene, the N2, NO, and NO2 molecules all function as acceptors. Moreover, the NO2 molecule exhibits a strong p-type doping feature that gives germanene a metallic appearance. Overall, the various ways that tiny nitrogen-based gas molecules adsorb on germanene offer a workable technique to utilize chemically modified germanene for a variety of real-world uses, including field-effect transistors and gas sensors.

Lu *et al.* [43] used DFT calculations to study the adsorption of certain gas molecules in BNNT. The results show that the interaction between gas molecules affected HOMO and LUMO. When the gas molecule adsorption distance increased, the energy gap shrank. The boron nitride nanotube (BNNT) was a highly sensitive gas sensor for N-based small molecules, and sensitivity was best between 1 and 1.5Å.

Bhuvaneswari *et al.* examined the adsorption of an HCN gas molecule in an arsenene nano-ribbon using the SIESTA software [44]. Formations, adsorption energy, and band gap were computed. The results show that the energy gap changed very little and that HCN gas molecules interacted chemically. Band structure show that arsenene nano-ribbon was chemical sensor.

Ni *et al.* [45] investigated the adsorption energy of tiny gas molecules on both graphene that was undoped with transition metals and graphene that was doped. Using the DFT approach, the adsorption energy for (CO2, NO, NO2 and SO2). Calculations using pure graphene indicate that these gases are physically adsorbable. Energy modification and charge transfer between gas molecules and graphene occur after doping it with a transition metal such as copper (Cu) adsorption. With transition metal doping, adsorption energy changed from a physical to a chemical interaction, and covalent bonds also manifested as a clear indication of a strong binding energy. NO2 gas molecules are highly selectable by transition metals doped with graphene.

3.2 Application

Benjamin [14]write brief of some important applications of chalcogenide materials in industry field like thermal glasses, optical device and sensors. He is focused on the II-IV groups of periodic elements table such as cadmium-selenium (CdSe), Zinc-Tellurium (ZnTe) and cadmium-sulfide (CdS). In the present time the chalcoganied materials has have wide application in the renewable energy field because novel non-liner and midinfared optical properties. CdSe materials has wide applicate in the gas sensor field, Cd-Te use in optical device and ZnS in the solar cell field.

Tong *et al.* [46] investigate the thermal conductivity of chalcogenide materials Cd-Se as an example. The molecular dynamic technique was used to explain the thermal conductivity as function of layer substrate, also the quanta of vibration energy (phonon) was computed. The result show that's thermal conductivity was decreased when substrate layer was increase, in addition the phonon effect was been vanished. Raman spectroscopy also indicate that's, the light scattering was been decreased when layer of Cd-Se increased[15].

Al-Seady *et al.* [47] investigated the adsorption energy for CH4 gas on the surface of pure and Cu-Doped graphene nano structure utilize DFT method. Adsorption energy calculation shows that CH4 has have a low adsorption energy when interacted on the surface of pure graphene nano structure compared with Cu-Doped structure. In other hand the Cu atom increasing the adsorption strength between gas molecule and the surface of nano structure. They were concluding that ability to design gas sensor device from Cu-graphene doped materials to detect the CH4 gas molecule.

Rani *et al.* [48] study the non-liner optical properties for arsenide-sulfide (As-S) semiconductors chalcogenides materials utilize Z-scan method. Two pulse laser was used in the study are 553 (Nd:YAG) and 1064 (Nd:YVO_4) nm. Non-liner refractive index and absorption coefficient was most response for wavelength 1064 nm compared to 553. The Z-scan technique shows that As-S has two fundamental absorption band. In addition, results show that a thin film of As-S has high optical limitation compared with volumetric As-S semiconductor chalcogenide materials[16].

Timo [49] used the tight-binding approach in conjunction with computations of the Green's function to study the electronic structure of silicene. The band gap and how the electric field affects it have received much of the attention in relation to bulk silicene. We have also investigated nanoribbons, where they searched for edge-localized effects. The results show that the band gap of silicene may be externally controlled using an electric field. Moreover, an artificial interface has been established in the middle of the ribbon by applying opposing electric fields to the distinct portions of the nanoribbon. By expanding the field, the gap gradually closes until it is totally closed. Following this, it resumes growing. The gap's ease of manipulation points to a wide range of potential electronic uses.

Suhtar *et al.* [50] explain an ability of design photonic crystal from chalcogenide material such as Cd-Se and Cd-S. the optical non-liner properties of material under study were estimate by Z-scan method. The band gap property was being enhance by cavity-point defect, in another hand increase or decrease the size, by remove or addition impurities. Reduce the size of chalcogenide material was used in the wave guide field. The final results show that, there are an ability to development photonic crystal from semiconductor chalcogenide materials.

Choi *et al.* [51] investigate the ability of utilize the Cd-Se nanomaterial in the renewable energy" dye sanitizers solar cell for example. The Cd-Se nanomaterial was been synthesis by chemical bath technique and covered by selenium di-oxide (SnO2). The perhaps of covering the Cd-Se by SnO2 is enhance the efficiency of light conservation. Increasing the ration of Cd-Se nano material led to increase to light conservation efficiency process. In addition, simulation study was utilized to compute the light harvesting efficiency. The simulation study was being done by the Wien2K software, based on density function theory (DFT) tool. DFT calculation shows that Cd-Se materials was had high ability of light harvesting in the rang 450-610 nm. Final result shows that Cd-Se was more suitable use in the renewable energy site.

By using first-principles computer simulations, Osborn created and analyzed novel silicene-based nanomaterials [52] to evaluate the impact of defects and adsorptions on stability, electrical, and thermal properties. As a result of lithium atoms adhering to the atom-down sites on both sides of the silicene sheet, the results indicate that entirely lithiated silicene sheets (silicel) will remain stable. Using the molecular adsorption of CO, CO2, O2, N, and H2O on nanoribbons for possible gas sensor applications, he further investigates the electrical tunability of silicene. Investigations also look into the effects of atmospheric gases like nitrogen, oxygen, and carbon dioxide. The findings point to pure silicene nanoribbons as a potentially useful novel sensing substance with single molecule resolution.

Chizhov *et al.* [53] study the ability of design NO2 gas sensor based on Cd-Se, Zn-O, Sn-O and In2-O3 activation by visible light. The crystal matrix formed from Cd-Se and Zn-O in the term of synthesis metal oxide semiconductor. The luminance method gives clearly explain to transfer electron to conduction band of Cd-Se quantum dot. From the results of band gap energy conclude that Cd-Se have high electrical conductivity compared with Zn-O, In2-O3 and Sn-O. XRD calculations show that all semiconductors system under study have multi-crystalline phase[19].

A summary of recent theoretical and experimental studies on silicene, a novel two-dimensional material, was published by Houssa *et al.* [54]. First, they talked about free-standing silicene's structural, electrical, and vibrational characteristics as anticipated by first-principles computations. They then evaluated theoretical research on silicene's interactions with various substrates. The next section discusses the growth and experimental characterization of silicene on Ag surface (111), offering information on the many phases or atomic configurations of silicene seen on this metallic surface as well as on its electrical structure. Furthermore, discussed are recent experimental findings about the potential production of hexagonal Si nanosheets on MoS2.

Abdulsatar [55] investigate ability of chalcogenide material Zn-O for example to sense the chlorine (Cl2) gas using density function theory. The researcher uses the Zn-O cluster in some different orientation between gas molecule and the chalcogenide system, the important factor in the study is the temperature. The adsorption energy shows that Cl gas molecule interaction chemically with Zn-O cluster. Results show that the optimum temperature of reaction varies between 950 to 1150 °C.

Al-Hilli study the responsibility of cadmium selenium for carbon mono-oxide gas as a function of film thickness. The Cd-Se was been deposed on the glass slide by DC plasms sputtering method at room temperature and different deposed time. The DC conductivity was being increasing when a thickness of CdSe film increasing, in another hand a liner formula was appeared between thickness and conductivity. Because of the reverse relationship between the band gap and conductivity, the energy gap decreased when conductivity increasing, and this process let high number of valance electron transport through band energy. the recovery and response time was being increasing when thickness of Cd-Se increasing[21].

Al-Seady *et al.* [56], studied the adsorption energy for CO gas molecule in the different nano system by DFT principle. Firstly, they were selected the pure graphene and boron-nitride nano system, in addition doped with Al atom. The calculation of interaction energy between CO gas molecule and the surface of pure structure was little bit energy raised. Adding the Al atom to the surface of graphene and boron-nitride nano-systems improved the interaction energy and it was clear in Al-graphene nano system. In addition, Al atoms enhanced the conductivity of the nano system, because of caused by decreased the energy gap of graphene and boron-nitride nano system.

Al-Seady *et al.* [57], investigated the adsorption energy strength for NO2 gas molecule at the different distance from graphene surface used DFT principle. They studied the molecular orbital energy and band gap of isolated graphene structure, and concluded that graphene has have semiconductor behavior. After that they placed the NO2 at different distance started from 1 to 3 Å, and checked the interaction energy at each distance. Interaction energy showed that when gas molecule near the surface it reached higher value and decreased rapidly when gas molecule goes far from the surface. Meanwhile, the energy gap reduced during chemical interaction and allow a high possible number of valance electron transfer to conduction band. Finally, they were concluding has have ability to design graphene based sensor for detect NO2 gas molecule.

Abed *et al.* [58] investigated ability of design graphene/natural dyes nano composites utilize in the field of DSSCs by first principle calculations. They chose two natural dyes were curcumin and pathalocaynine, after that joined with graphene nano structure. The graphene/pathalocaynine has have high ability to harvesting light compared with graphene/curcumin composite. The graphene/pathalocaynine composite has have high ability to inject an electron in the minimum conduction band of titanium di-oxide $(CBM)_{TiO2}$. In addition, it absorbed light in the red region of electromagnetic radiation. Final result they were conclude that an ability to design nano composite from graphene and patholacaynine that can be used in renewable energy field.

4. Conclusion

In this review of theoretical and experimental applications for graphene and cadmium selenide, many properties of these materials were investigated such as graphene has zero band gap energy and cadmium selenide have semi-conductor behavior. One of the most important applications of graphene materials was gas sensor application. Result shows that graphene has a good response for nitrogen dioxide gas molecule, and this property was improved by added the metal atom. In addition, this review shows studies of improved sensitive graphene materials for carbon mono-oxide by added aluminum atom or nickel atom. Many researchers investigate the optical properties of cadmium selenide materials because of its wide optical band gap. Furthermore, many have reported on application of Cd-Se in the field of solar cell applications due to high optical efficiency.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***A Review on the Potential Applications for Cadmium Selenide and Graphene Materials****: Saif M. Alghazaly and Rusul Mohammed Neamah;* ***data collection****: Ahmed Abbood Funkher;* ***analysis and interpretation of results****: Mohammed A. Al-Seady and Saif M. Alghazaly;* ***draft manuscript preparation****: Mohammed A. Al-Seady and All authors reviewed the results and approved the final version of the manuscript.*

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