Atomic Structure and Binding of Carbon Atoms

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Abstract: Many studies discuss carbon-based materials because of the versatility of carbon element. These studies deal with different ideas and discuss them within the scientific scope and application. Depending on the processing conditions of carbon precursor, carbon exists in its various allotropic forms. The electron transfer mechanism is responsible for converting the gaseous carbon atom into various states, i.e., graphite, nanotube, fullerene, diamond, lonsdaleite and graphene. In the conversion of carbon atom from existing state to new state, two typical energies of dash shapes involve transferring filled state electrons to nearby unfilled states. In the electron transfer mechanism, a carbon atom preserves its equilibrium state. Through the involved typical energies, filled state electrons instantaneously and simultaneously transfer to unfilled states. The involved typical energy has its conserved behavior that is partial. The force exerted to the transferring electron also behaves conservatively in a partial way. Carbon atoms in graphite, nanotube and fullerene evolve and develop the structures partially. The structures of one dimension, two dimensions and four dimensions are formed respectively. In the formation of such structures, atoms bind by the same involved dash-shaped typical energies. (The graphite structure under attained dynamics of atoms only is also formed though in the order of two dimensions and amorphous carbon.) The structural formations in diamond, lonsdaleite and graphene atoms involve a different shaped typical energy controlling the orientation of electron while undertaking one additional clamp of energy knot. The involved typical energy has a form like golf-stick. To undertake double clamping of energy knot, all four electrons (of the outer ring) in depositing diamond atom get aligned along the south pole and all four unfilled energy knots (of the outer ring) in deposited diamond atom get positioned along the east-west poles. In this way, a depositing diamond atom binds to deposited diamond atom from ground to south. Thus, the growth of diamond should be south to...
ground. Thus, diamond atoms form the tetra-electron topological structure. Binding of lonsdaleite atoms can be from ground to a bit south. To nucleate the structure of glassy carbon, carbon atoms deal with different states of each layer to bind in successive manner, i.e., gaseous, graphite and lonsdaleite atoms. Mohs hardness of nanostructured and microstructured carbon-based materials is also sketched.

**Keywords:** Carbon; Atomic structure; Electron dynamics; Potential energy; Forced exertion; Atomic binding

1. **Introduction**

To develop materials of selective size and to investigate their characteristics for suitable applications solicit new approaches. The exertion of force at the electron level should also detail energy at the electron level. In the structural formation of carbon atoms, the involvement of partial conservative energy should also engage the partial conservative force. In the structural formation of carbon atoms, the involvement of non-conservative energy should also engage the non-conservative force. In this context, the involved energy at the electron level should direct the engaged force at the electron level.

To form the structure among suitable carbon atoms, a partial conservative energy engages a partial conservative force at the electron level. This can be the case in carbon atoms having graphite, nanotube and fullerene states. To form the structure among suitable carbon atoms, a non-conservative energy engages a non-conservative force at the electron level. This can be the case in carbon atoms having diamond, lonsdaleite and graphene states.

Due to the presence of filled and unfilled states very close to the center of carbon atom, electrons of the outer rings do not deal with the conservative force. The relation of energy and force in such atoms can be anticipated either in partially conserved mode or in non-conserved mode. This can depend on the carbon state.

Carbon has different states, which are known in the allotropes, i.e., starting from the gaseous state to graphite state, and then diamond state, lonsdaleite state, fullerene state followed by the nanotube state, graphene state, and finally glassy carbon. In the literature, several studies explain depositions of carbon materials.

When forces in the conservative mode are exerted to the electron of a silicon atom, an uninterrupted execution of electron dynamics generates a photon of continued length [1]. This indicates that the built-in interstate gap of electron
dynamics in case of carbon atom is different as compared to silicon atom. Both carbon atom and silicon atom have the same numbers of filled and unfilled states in the outer rings. However, the distance of electrons of the outer ring from the centre of carbon atom is different as compared to silicon atom. (A silicon atom has zeroth ring, first ring and outer ring, but a carbon atom has only zeroth ring and outer ring.) Therefore, in the conversion of carbon atom to the different carbon state, a different electron transfer mechanism can be introduced. Different gaseous and solid atoms deal with different distances of outer rings from the centers [2]. In the atoms of those elements executing confined interstate electron dynamics, they evolve structures in the relevant formats of exerting forces rather than form or develop structures [3]. Atoms belonging to all elements do not ionize [4].

Different spectroscopic analyses of carbon film show peaks at different positions, which indicate that carbon atoms amalgamated to develop tiny grains [5]. Depending on the conditions of the process, carbon atoms deposit in different morphology and structure of grains and crystallites [6]. A different morphology of grains and particles resulted at different chamber pressures identifying the role of typical energy binding the atoms [7]. The deposition of graphite and diamond in separate regions of the single substrate is due to different fixed inter-wire distance of dissociating gases [8]. Different carbon-based materials contain atoms of the same element, i.e., carbon, but specify different behaviors in the analysis [5-8]. Thus, the electron transfer mechanism can change the chemical nature of an atom.

The force entering from the north pole and leaving the ground surface for the south pole behaves differently as compared to the force at the ground surface, i.e., along the east-west poles [9]. Transitions of gaseous and solid atoms take place to undertake the liquid states where electrons deal with infinitesimal displacements by remaining within the occupied energy knots [2]. But, atoms of gaseous, semisolid and solid deal with different ground points [3].

A recent study shows the transformation of graphene film into a diamond like carbon film, where the elastic deformations and chemical natures were changed [10]. Wu et al. [11] reviewed the developments in Raman spectroscopy of graphene-based materials from both fundamental research and practical perspectives. Uniform carbon nanofibers were grown by vapor deposition method without involving catalyst [12]. Different applications related to graphene hybrids were reviewed recently in the study [13]. Nitrogen incorporated carbon dots were used to modify a glassy carbon
electrode [14]. A novel energy dissipation system was investigated by combining the carbon nanotube and buckyballs [15]. Different carbon allotropes were studied for the dehydrogenation of temperature in their comparison [16]. A precise positioning of the vacancies within the diamond crystal was studied by Chen et al. [17]. Liu et al. [18] presented an efficient strategy of electrochemical activation to fabricate the graphite-graphene Janus architecture. Repeated large-area doped nano-crystalline diamond layers were prepared under the optimized conditions of microwave-based vapor deposition system [19].

Cheng and Zong [20] observed a structural evolution of damaged carbon atoms for deeper surface layer. Maruyama and Okada [21] investigated geometric, electronic and magnetic structures of a two-dimensional network of carbon atoms. Narjabadifam et al. [22] studied both elastic and failure properties of carbon nanocones through the application of molecular dynamics simulation. Levitated nanodiamonds burn in the air because of the presence of amorphous carbon on their surfaces, and they deal with uncertainty in the measurement of their temperature [23]. This leads to the removal of uncertainty in temperature measurement of levitated nanodiamond, which paves the way for considerable applications [24].

A layout of atomic structure in different states carbon atoms is not clear along with the binding mechanism in identical state carbon atoms. The formation mechanism of glassy carbon is also not clear. Here, atomic structures of various carbon allotropes along with their structural formations are studied.

2. Experimental Details
This work does not include the experimental details on the processes dealing with the formation of structures related to different carbon-based materials. However, a preliminary knowledge on the process dealing with the synthesis of different allotropic forms of carbon can be found in the studies cited above. However, the processes utilized to synthesize various carbon-based materials require optimization to single out the particular form of a carbon material. In this context, this study purely deals with the science of originating different carbon allotropic forms along with structural formation in each state of carbon atom.

3. Results and Discussion
3.1. Structures of different states carbon atoms
Understanding the formation mechanism of electronic structure in different states, carbon atoms relies on the same number of electrons. A carbon atom in any of the state has fixed numbers of filled and unfilled states. A change in the position of filled and unfilled state gives birth to new chemistry of the atom.

In the formation of carbon lattice, overt photons having a suitable length and number intercross to construct twelve states. In the intercrossing, overt photons keep the centres of their lengths at a common point. Energy knots related to filled and unfilled states are constructed by precisely intercrossing of overt photons. Overt photons are equal in lengths. The lengths of overt photons are in such a manner that their schedule crossing construct filled and unfilled states required to form energy-knot-net of a carbon atom. Two pairs of overt photons (having characteristics of photonic current) intercross along the east and west sides. Two pairs of photons (having characteristics of photonic current) also intercross along the north and south lines. All intercrossed overt photons keep the position of mid-lengths at the same point.

In the formation of carbon lattice, two energy knots from each side of the centre remained compressed. The compression is due to the presence of adjacent filled and unfilled states. In this way, a total number of eight states are constructed forming the outer ring of carbon atom as shown in Figure 1 (a). Four states are related to the filled states and four states are related to the unfilled states. Four energy knots of the central ring are related to the zeroth ring, which are also shown in Figure 1 (a).

![Figure 1](image)

**Figure 1:** (a) Lattice or energy-knot-net of carbon atom. Atomic structure of carbon atom when it is in the (b) gaseous state, (c) graphite state, (d) nanotube state, (e) fullerene state, (f) diamond state, (g) lonsdaleite state, (h) graphene state and (i) electron transferring to the downward state and
electron transferring to the upward state; red colored circles indicate filled states and white colored circles indicate unfilled states (sketches are drawn in estimation)

The lattice of a carbon atom is related to the energy-knot-net as shown in Figure 1 (a). On intercrossing the overt photons, the trough of one is in front of the crest of other, so overt photons freeze the element of force wrapped by the energy [2].

In the gaseous carbon atom, required four energy knots of the outer ring are filled by the electrons. The states belonging to the zeroth ring are also filled by the electrons. In the outer ring, four states remained filled and four vacant. This order of the states provides the option to originate six different states of the carbon atom in addition to the one in gaseous state. In Figure 1 (b), a gaseous carbon atom is shown. Other different states of the carbon atom are shown in Figure 1 (c-h); positions of the electrons belonging to the outer ring inter-changed in the carbon atom to form (c) graphite state, (d) nanotube state, (e) fullerene state, (f) diamond state, (g) lonsdaleite state and (h) graphene state. In each state of the carbon atom, four centered electrons form the zeroth ring. The zeroth ring is related to helium atom [2]. In Figure 1, the atomic structure of carbon having different states are shown, where electrons and energy knots are symbolized.

A gaseous carbon atom is processed for transferring two electrons of filled states to nearby unfilled states. One electron from the east side and one from the west side transferred to originate the new state of carbon atom. To migrate electrons from left and right sides of the atom, the involved typical energies having the shapes like dash provide the route to transfer filled state electrons, where the engaged force remains in its partial conservative behavior. The typical energy shaped like dash keeps the electron arrested till occupying the nearby unfilled state. Moreover, the engaged force facilitates the filled state electron in transferring to the nearby unfilled state safely. To convert the carbon atom for each state, one electron from the east side and one from the west side transfer to their nearby unfilled states.

When the gaseous carbon atom converts into the graphite state, the engaged forces are mainly related to the surface and space formats. The transferring electrons of graphite atom convert it into the lonsdaleite atom, dash-shaped typical energy along the west to south and an energy with the same shape along the east to south get involved. The exerting forces to electrons remain partially conserved, which are related to the surface format and a bit grounded format. During the conversion of graphite atom into lonsdaleite atom, only two electrons are transferred
to the nearby positioned unfilled states. To convert lonsdaleite atom into diamond atom, two electrons are further transferred to the nearby positioned unfilled states. The ground point in the diamond atom goes further below the ground surface as compared to the ground point in the lonsdaleite atom. On transferring all four electrons of the outer ring to the energy knots available below the east-west line, the ground point in the diamond atom becomes fully grounded. A partial conservative energy gets involved as well as a partial conservative force gets engaged. Electrons are in the maximum potential energy, where the occupied energy knots also keep the maximum stretching.

Involved typical energy and engaged force to transfer electrons for another state of the carbon atom are due to the originally built-in distance of the outer ring from the centre of atom. Thus, involved energy shaped like dash provides the path for the transferring electron to originate a new state of the carbon atom. In this way, the engaged forces only influence in a partial conservative manner, where the involved typical energy to transfer electron from the side of atom also behaves in a partial conservative manner. Thus, a carbon atom originates a new state.

A graphite atom is converted into diamond, lonsdaleite and graphene atom by involving the typical energy shaped like dash and engaging the partially conserved force for each electron. A gaseous carbon atom converts into nanotube and fullerene atoms, where the involved typical energy and engaged force for transferring electrons to the positioned unfilled states behave in the same manner as for the case of other states. Energy knots, forming the unfilled and filled states, stretch or contract depending on the state of carbon atom.

In Figure 1 (i), an electron of filled state transferring to the nearby unfilled state is shown. A dash-shaped typical energy is like a pipe, through which force can see. At one side, dash-shaped typical energy connects with the tip of transferring electron. From the opposite side, it connects with the nearby unfilled state. In this way, electron safely transfers to the unfilled state. In Figure 1 (i), downward arrow indicates an increasing potential electron and upward arrow indicates a decreasing potential electron.

An occupied or unoccupied position of the electron in atom is termed as “state”. Based on newly occupied positions, transferred electrons originate a new allotropic form of the carbon atom, which is also termed as “state”, but it is related to the atomic state instead of electronic state in this case. Therefore, expansion and
compression of carbon atoms under different states depend on the potential energy and orientation of the electrons.

3.2. Formation of graphite structure

3.2.1 Formation of graphite structure under electron dynamics of carbon atoms

Binding carbon atoms while attaining the graphite state is shown in Figure 2 (a). The Atom A has attained the graphite state, whereas the Atom B and Atom C are in the transition to attain graphite state. Typical energies shaped like dash involve to transfer suitable filled state electrons into nearby suitable unfilled states. Thus, the Atom B and Atom C bind to the both sides of Atom A. The binding of atoms is through the involved typical energies shaped like dash. Thus, in the transferring electrons, the forces exerted to them remain in the partial conservative mode. This is the nucleation stage of graphite structure and on binding the graphite atoms, the structure starts to grow. In the execution of electron dynamics of graphite atoms amalgamating under the attained dynamics, a graphite structure nucleates along the same axis as shown in Figure 2 (a). The bound layer formed from the rearward side is also shown in Figure 2 (a).

![Figure 2](image)

**Figure 2:** (a) Formation of graphite structure when inter-state electron dynamics executed in graphite atoms; (1) unfilled state of transferred electron and (2) binding typical energy shaped like dash. (b) Formation of graphite structure when weak energy contributed under uniformly attained dynamics of graphite atoms. (c) Formation of amorphous graphite structure when weak energy contributed under non-uniformly attained dynamics of graphite atoms

Graphite structure grows in one dimension, which is mainly along the line of east and west poles. The binding graphite atoms can be from the both sides of X-axis, but all the electrons of bound atoms orientate along the same axis, where the exerting
forces of north-south poles to the electrons remain less effective. Hence, the structure compels to be termed as one-dimensional structure. In tiny grain carbon film, atoms of arrays elongate by the exertion of forces, so they convert into the structures of smooth elements [5].

In Figure 2 (a), the involved typical energy shaped like “dash” is used to bind the atoms. Typical energy shaped like “dash” is required in transferring the filled state electron to nearby suitable unfilled state. In transferring electrons from left and right sides of gaseous carbon atom to attain the graphitic state, the potential of the sides transferring electrons from upper states to lower states increases. While converting gaseous carbon atom into the graphite state, the potential of an atom remains equalizing. Thus, atom maintains its equilibrium state.

3.2.2 Formation of graphite structure under only attained dynamics of graphite atoms
When carbon atoms amalgamate under the preservation of graphite state, they only bind through the attained dynamics. In this case, atoms do not execute interstate electron dynamics. The structure of graphite having two dimensions is formed. A dash-shaped typical energy is no more involved in the binding of graphite atoms. Based on the slight difference of forces exerting along the east and west poles of amalgamating graphite atoms, they bind only under attained dynamics to form the arrays as labeled by (1), (2) and (3) in Figure 2 (b); the existed weak energy among graphite atoms keeps them bind. Thus, carbon atoms of graphite state naturally come into the order. Under the force and energy available among them, graphite atoms bind from their east-west sides or west-east sides. Forces at the atomic level introduce weak application to preserve the structure of graphite. Though existing forces of opposite poles of atoms do not work for a greater difference, they do not separate the amalgamated atoms. Amalgamated atoms bind under the even (force and) energy due to the uniformly attained dynamics.

Forces involved at atomic level (to attain uniform dynamics) also engage the energy at atomic level. The force at atomic level becomes weaker than the force at electronic level. The same is the case for energy behavior at atomic and electronic levels. Therefore, when graphite atoms get bound under only attained dynamics, the involved (weak) force for them also engages the weak energy. Due to orderly amalgamation of graphite atoms, they involve force and engage energy in even manners.
3.2.3 Formation of amorphous graphite structure or amorphous carbon structure

The formation of the amorphous graphite structure can be anticipated when binding graphite atoms are under a bit inconsistent manner. Atoms do not position exactly from the east-west sides or west-east sides. An amorphous graphite structure is more likely a “developed structure” rather than a “formed structure” as graphite atoms do not obey the consistency in attained dynamics. In amorphous graphite structure, the amalgamation of graphite atoms is under the non-uniformly attained dynamics. As shown in Figure 2 (c), amalgamated atoms bind under the non-uniformly attaining dynamics where weak energy and force contribute in uneven manners. (A word ‘develop’ is also appropriate for the synthesis of different carbon films.) When the ground surface is not flat at the electron level, a developed structure of graphite atoms can be related to the amorphous carbon structure.

Forces involved at atomic level (to attain non-uniform dynamics) also engage the energy at atomic level. When graphite atoms get bound under only non-uniform attained dynamics, the involved (weak) force for them also engages the weak energy for them. Due to disorderly amalgamation of graphite atoms, they involve force and engage energy in uneven manners. Further studies can be conducted to understand the mechanism of binding graphite atoms.

3.3. Formation of nanotube and fullerene structures

On converting carbon atoms into the nanotube state, the nanotube structure forms. Prior to binding, a nanotube atom can be converted from fullerene atom. A fullerene atom converts into a nanotube atom on transferring electron to nearby unfilled state of one quadrant and transferring electron to nearby unfilled state of other quadrant located oppositely. The transferring electrons to suitable unfilled states are under the involved typical energies shaped like dash. A partial conservative force is engaged in the transfer of electron. Thus, nanotube atoms form a structure based on the involvement of partial conservative energy and engagement of partial conservative force. Forces exerted to the electron of one quadrant are engaged in the space and surface formats. Forces exerted to the electron of oppositely sided quadrant are engaged in the surface and grounded formats. In this manner, carbon atom keeps equilibrium state.

A typical energy shaped like dash is involved to transfer an electron. So, carbon atoms having nanotube state can bind to the centered atom having nanotube state,
too. Binding of nanotube atoms to the centered nanotube atom from both sides is displayed in Figure 3 (a). This is called a nucleation stage of nanotube structure. The nucleation of nanotube structure can be under two options, which is also shown in Figure 3 (a). In either way, the formation of the structure is two-dimensional. The binding of atoms is not along the same axis, i.e., X-axis. (However, in the electron dynamics of graphite atoms, the binding of atoms is completely along the X-axis. Thus, the formation of structure in graphite atoms is considered one-dimensional.)

In the formation of nanotube structure, exertion of forces related to the space and surface formats remained engaged for one electron of suitable quadrant, whereas exertion of forces related to the surface and grounded formats remained engaged for other electron of the oppositely-sided quadrant. In each case, the electron dealing with the exertion of forces depends on the manner of linked typical energy for the relevant quadrant, so the behavior of both energy and force in the formation of nanotube structure is partially conserved. The surface format constitutes force of two poles, i.e., force from the east pole and force from the west pole, so in each case of the formation of nanotube structure, two forces behave for the exposed sides of the electron, whereas forces of two poles do not behave due to facing the sides of covered typical energy. However, further work is required to understand the mechanisms of formation of different nanotube structures.

Figure 3: (a) nanotube structure – a two-dimensional structure where the involved typical energy for electrons (of opposite quadrants) of targeted atom binds with the involved typical energy for electrons (of opposite quadrants) of amalgamating atom and (b) fullerene (buckyballs) – a four-dimensional structure where the involved typical energy for four electrons of centered atom binds with the involved typical energy for electrons of four amalgamating atoms

On transfer of electron for each positioned state, a carbon atom converts into fullerene atom. Electrons of the outer ring (belonging to all four quadrants) involve typical energy shaped like dash. So, transferring electron of each quadrant engages
the partial conservative force along the relevant poles. The engagement of forces can be in the space and surface formats for electrons of two quadrants. The engagement of forces can be in the surface and grounded formats for electrons of remaining two quadrants. An involved typical energy (at the electron level) shaped like dash binds fullerene atoms for each quadrant as shown in Figure 3 (b); the fullerene structure is formed in two different ways. Binding of fullerene atoms to all four quadrants of (first) centered fullerene atom nucleate a fullerene structure. Hence, the structural formation in fullerene atoms is four-dimensional. The exerting forces along the relevant poles of transferring electrons remain partially conserved.

In the formation of fullerene structure, exertion of forces related to the space and surface formats remained engaged for two electrons of oppositely sided quadrants, whereas exertion of forces related to the surface and grounded formats remained engaged for remaining two electrons of the quadrants. In each case, two electrons dealing with the exertion of partial conservative forces depends on the manner of covered typical energy. A force in surface format is based on two poles. Therefore, two forces of poles behave for the electron of each quadrant. Due to covering with the typical energy, two forces of poles do not behave for electron of each quadrant. Thus, both energy and force behave partially conserved in the formation of fullerene structure. However, more work is required to understand the binding mechanism.

3.4. Formation of diamond structure

A lonsdaleite atom having ground point just below the ground surface is shown in Figure 4 (a). It reaches to bind the diamond atom once converted into the diamond state. A carbon atom having diamond state is also shown in Figure 4 (a). The expected binding point of diamond atoms, when lonsdaleite atom will convert into the diamond state, is also shown in Figure 4 (a). A diamond atom deals with the maximum solid state. So, the ground point of diamond atom remains below the ground point of lonsdaleite atom. In the nucleation of synthetic diamond, a highly-heated seeded solid surface deals with the deposited atom. Thus, the electrons of a deposited diamond atom do not further gravitate. Again, due to the maximum achieved potential energy of the electrons, there is no more stretching of their occupied energy knots. Further, electrons do not encroach on the resting surface even to the extent of length of an electron.
A lonsdaleite atom is converted into the diamond atom when electrons from the left and right sides transfer to the downward unfilled states. Energy knots clamped electrons in the converted diamond atom also undertake the same level of stretch as in the case of deposited diamond atom. On depositing diamond atom to already deposited diamond atom, a controlled stretching of energy knots clamped electrons took place. So, the orientationally controlled electrons of depositing atom also in the exertion of forces exert in the surface and grounded formats. All electrons of filled states (in the outer ring) of depositing diamond atom are in position to undertake one additional clamp of energy knot belonging to all unfilled states (in the outer ring) of deposited diamond atom as shown in Figure 4 (b).

**Figure 4:** (a) Lonsdaleite atom converting into diamond atom for binding: (1) east-west poles at ground surface and north pole; (2) ground point of lonsdaleite atom a bit below the ground surface; (3) expected binding point of the atoms when lonsdaleite state converted into the diamond state; (4) ground point of diamond atom below the ground surface and south pole. (b) Binding of depositing diamond atom to deposited diamond atom: (1) zeroth ring; (2) outer ring; (3) substrate; (4) positioned energy knot; (5) typical energy shaped like golf-stick; (6) targeted electrons. (c) South to ground growth of diamond: (1) diamond growth; (2) embedded electrons of first deposited atom. (Red colored circles indicate filled states, white colored circles indicate unfilled states, targeted electrons and positioned energy knots are donated by red dotted line arrows in Figure 4b and overlapped red colored circles indicate double clamping to electrons)

To undertake another clamp of energy knot by each electron of the outer ring in depositing diamond atom, left-positioned electron orientates along the left side to line drawn normal to the center and right-positioned electron orientates along the right side to line drawn normal to the center. Thus, the orientation of an electron approximately becomes 20° along the south side to the line drawn normal to its center. All four electrons of the outer ring in diamond atom, west (left) sided two
electrons and east (right) sided two electrons obey nearly the same orientation as shown in Figure 4(b). (Orientation of electrons of the zeroth ring in diamond atom got adjusted accordingly.) Atoms of gaseous and solid states when in the original states keep the orientation of the electrons approximately 40° along the north pole and 40° along the south pole, respectively [2]. In this way, the degree of orientation in electrons of diamond atom becomes half to the degree of orientation in positioned electrons of gaseous atoms or solid atoms. A typical energy shaped like golf-stick enables the electron of outer ring in depositing diamond atom to undertake additional clamp of the positioned unfilled energy knot of outer ring in deposited diamond atom as shown in Figure 4(b). In the structural formation of diamond, exerting force to each electron also becomes non-conserved.

A growth behaviour of diamond is shown in Figure 4 (c). An adjustment in the stretching of energy-knot-nets takes place at each time of depositing (binding) diamond atom to deposited (bound) diamond atom. Therefore, expansion and compression of the lattice is adjusted in the growth process of diamond. Electrons embedded to substrate surface in first deposited diamond atom are also shown in Figure 4 (c). On bearing the maximum stretching of occupied energy knots, electrons aligned ground to south under the non-conservative force. Thus, two diamond atoms bind from ground to south. This is the nucleation stage of diamond. On binding two diamond atoms, the third diamond atom comes into position to bind. On depositing the third diamond atom, a new point of binding is located under the reference of already adhered two diamond atoms. In this way, a process of growth in diamond is initiated as shown in Figure 4 (c). Therefore, the growth of diamond is south to ground. (But, the binding of diamond atoms is ground to south.) A binding point in diamond atoms remains between surface format and grounded format (or ground to south). Thus, the structural formation in diamond atoms is related to the topological structure. The orientation of growing diamond crystal can approximately become 18° to the normal axis as shown in Figure 4 (c), and it can grow with several faces.

3.5. Formation of lonsdaleite and graphene structures
The ground point of lonsdaleite atom is a bit below the ground surface as it is below the ground point of graphite atom. Electrons of lonsdaleite atom deal with the lower amount of potential energy as compared to electrons of diamond atom. Hence, the energy knots are in the lesser stretch, so lonsdaleite atom is in less expansion as
compared to the diamond atom. A lonsdaleite atom is mainly in a bit solid behavior. In structural formation, a lonsdaleite atom also experiences the non-conservative force for two electrons under the involvement of non-conserved energy. It is mainly in the surface format and a bit in the grounded format. Thus, lonsdaleite atoms bind from ground to a bit south, but the growth behaviour is a bit south to ground. However, further studies to investigate the lonsdaleite structure in different carbon-based materials are required.

The ground point of graphene atom exists just above the ground surface. Electrons of graphene atoms largely deal with levitational force. However, the levitational behaviour of force is in non-conserved manner. Binding of graphene atoms experiences forces mainly in surface and space formats. So, the growth of graphene atoms is opposite to diamond. And the growth of graphene should be ground to north. Principally, graphene atoms should grow a topological structure. However, due to limitation of existing force in surface format and existing force in space format, adherence of only a few layers in graphene structure is possible. Thus, the topological feature in graphene structure is not observed. In this context, further investigations are required to study not only the binding mechanism in graphene atoms but the viability of associated forces also.

3.6. **Formation of glassy carbon structure**

In the structural formation of glassy carbon, three layers of carbon atoms having different state for each layer bind in successive manner. Layers of gaseous carbon atoms, graphite atoms and lonsdaleite atoms nucleate the structure of glassy carbon. For growth of glassy carbon, layers of gaseous carbon atoms, graphite atoms and lonsdaleite atoms bind in the repeated manner. The pieces of typical energy having a shape like golf-stick (half of parabola) are involved to bind the atoms between the layers.

Layers of gaseous carbon atoms and graphite atoms bind under the joint application of exerting forces in the grounded format and surface format. The orientationally controlled pair of targeted electrons (of each gaseous carbon atom) undertakes clamping of positionally controlled pair of energy knots (of each graphite atom) from the rear side as shown in Figure 5. Thus, gaseous carbon atoms attempt a forceful gravitational behavior under increased potential energy of electrons. Layers of lonsdaleite atoms and graphite atoms bind under the joint application of
exerting forces in the space format and surface format. The orientationally controlled pair of targeted electrons (of each lonsdaleite atom) undertakes clamping of positionally controlled pair of energy knots (of each graphite atom) from the front side as shown in Figure 5. So, lonsdaleite atoms attempt a forceful levitational behavior under decreased potential energy of electrons.

![Diagram of carbon structure](image)

**Figure 5**: Formation of glassy carbon structure where layers of gaseous carbon, graphite and lonsdaleite atoms bind in the successive manner; (1) two electrons of each gaseous carbon atom (of the layer) undertake clamping of energy knots of two unfilled states of each graphite atom (of the layer) by entering from the rear sides, where typical energy having a shape like golf-stick is involved, (2) two electrons of each lonsdaleite atom (of the layer) undertake clamping of energy knots of two unfilled states of each graphite atom (of the layer) by entering from the front sides, where typical energy having a shape like golf-stick is involved and (3) layers of gaseous and lonsdaleite atoms compensate expansion and compression in binding layers to intermediate layers of graphite atoms; double clamping of energy knot to electron is through the involvement of typical energy shaped like golf-stick.

Binding gaseous carbon atoms (arranged in each layer) to the graphite atoms (arranged in each layer) involves an oppositely J-shaped typical energy (also called golf-stick shaped typical energy), where each pair of electron (belonging to each gaseous carbon atom) undertakes another clamping of each pair of unfilled energy knot (belonging to each graphite atom). The clamping of each pair of unfilled energy knot upto the half-length of each pair of electron is from the rear side. This sort of
binding between gaseous carbon atoms and graphite atoms is shown in (1) of Figure 5. Binding lonsdaleite atoms (arranged in each layer) to the graphite atoms (arranged in each layer) involves a J-shaped typical energy (also called golf-stick shaped typical energy), where each pair of electron (belonging to each lonsdaleite atom) undertakes another clamping of each pair of unfilled energy knot (belonging to each graphite atom). The clamping of each pair of unfilled energy knot upto the half-length of each pair of electron is from the front side. This sort of binding between lonsdaleite atoms and graphite atoms is shown in (2) of Figure 5. Further studies to form various topological structures in glassy carbon can be conducted. Accordingly, underlying science of various topological structures can be explored.

3.7. General discussion

A carbon atom exists in gaseous state when one electron of the outer ring occupies the state on left side to the north pole and one electron of the outer ring occupies the state on right side to the north pole: the remaining two electrons of the outer ring occupy the states just below the line of east and west poles. A carbon atom is related to graphite state when two electrons of the outer ring retain positions at the states occurring just above the line of east and west poles and two electrons of the outer ring retain positions at the states occurring just below that line.

A typical energy shaped like dash involves in transferring filled state electron to unfilled state, where contributing force remains in partial conservative mode. In the conversion of suitable carbon atom to graphite state, nanotube state or fullerene state, two dash-shaped typical energies involve in transferring the electron from both sides of the atom. The length of a dash-shaped typical energy is equal to the distance between nearby states. The same involved typical energy shaped like dash contributes in the structural formation of graphite, nanotube and fullerene. In the formation of graphite, nanotube and fullerene structures, the engaged forces are under the involvement of partially conserved energy.

In the conversion of suitable carbon atom to diamond state, lonsdaleite state or graphene state, again a dash-shaped typical energy involves for each side of transferring electron. The engaged forces along the poles of electrons also get partially conserved. However, in the structural formation of diamond, lonsdaleite and graphene, the newly involved typical energy largely controls the potential energy of an electron. In this way, the structural formations in diamond, lonsdaleite and
Graphene atoms engage the non-conservative forces. In the structural formation of glassy carbon, a non-conservative force is also engaged by the involved non-conservative energy.

In Figure 6, Mohs hardness of different nanostructured and microstructured carbon materials is sketched in estimation. The value of hardness cannot be registered when gaseous carbon atoms are considered. Gaseous carbon atoms do not even form a soft structure, so gaseous carbon atoms keep the hardness zero at Mohs scale. However, in the nanostructures and microstructures of graphite, nanotube and fullerene, involvement of partial conservative energy and engagement of partial conservative forces do not measure the hardness at high scale. However, in the nanostructures and microstructures of lonsdaleite, graphene and glassy carbon, the involvement of non-conservative energy and engagement of non-conservative forces measure the hardness at high scale. The maximum value of Mohs hardness is in the case of diamond as registered in the published literature. In the Raman spectroscopy, different values of the wave number vs. energy signals indicate different characteristics of carbon materials [5]; energy loss spectroscopy of carbon nanostructures also validates different characteristics.

**Figure 6:** Mohs hardness of nanostructured and microstructured carbon-based materials vs. engaged forces at the electron level; (1) levitational force of electrons in graphene atoms (ground to north), (2) graphene carbon, (3) increasing levitational force at the electron level, (4) gaseous carbon atoms, (5) graphitic carbon, (6) increasing gravitational force at the electron level, (7) gravitational force of electrons in diamond atoms (ground to south), (8) lonsdaleite carbon, (9) fullerene carbon, (10) maximally increased gravitational force at the electron level, (11) nanotube carbon, (12) maximally increased levitational force at electron level.

The high hardness and very high hardness of nanostructured/microstructured lonsdaleite, graphene and diamond are due to the involved typical energies having
shapes like golf-sticks. In the structural formation of hard carbon materials, the typical energy shaped like golf-stick is involved to control the process of undertaking double clamping (of energy knot) by each targeted electron of diamond, lonsdaleite and graphene atoms. Hence, targeted electrons undertaking double clamping of energy knots engage a non-conservative force in the process. The same is the case in structural formation of glassy carbon, where layers of gaseous, graphite and lonsdaleite atoms bind successively.

In the conversion of gaseous carbon to different states, the involved typical energy engages the force. Here, the word “involve” refers to an action of energy for “instant time”, whereas the word “engage” refers to an action of force for “eternal period”. The “grounded format” implies that the force exerts along the south pole of an electron, whereas the “ground” signifies east-west poles, i.e., surface format, where force exerts along the east-west poles of an electron. When carbon atoms of gaseous state are converted into another state, the involvement of typical energy at the first stage is there rather than the partial conservative force. In each carbon atom, electrons of the outer ring execute dynamics. This indicates that atomic radii in different elements along with electronic structure of an atom is the core to elucidate the sort of energy and force which is anticipated for that atom.

4. Conclusion
Carbon atom in its any state does not deal with an impartial or a neutral force for an electron. In the conversion of carbon atom from one state to another, energy partially treats the force by involving, and force partially treats the energy by engaging. In electron transfer mechanism of carbon atom, typical energy shaped like dash transfers filled state electron (of outer ring) to nearby unfilled state. A carbon atom instantaneously and simultaneously transfers electrons of east and west sides occupying suitable unfilled states. To attain a new state, a carbon atom maintains equilibrium state by engaging partial conservative force for the transferring electrons.

A structure of one-dimensional forms when the graphite atoms execute attained dynamics as well as interstate electron dynamics. When the graphite atoms form two-dimensional structure, it is only through the attained dynamics. Due to a minute difference of forces along the east-west poles, amalgamating graphite atoms engage the weak energy to form structure. The force involves in an even manner. In amorphous graphite structure, atoms of graphitic carbon amalgamate under non-
uniformly attained dynamics. The force involves in an uneven manner. Force and energy are weak in nature because of having atomic level contributions.

In the structural formation of graphite, nanotube and fullerene atoms, a partially conserved energy gets involved. Hence, a partially conserved force engages in the formation of one-dimensional, two-dimensional and four dimensional structures, respectively. To nucleate the structure of carbon nanotube, involved energy for the electron of one quadrant and involved energy for the electron of opposite quadrant in targeted atom bind with the involved energy for electrons of amalgamating nanotube atoms from both sides. To nucleate the structure of carbon fullerene, involved energy for the all four electrons of outer ring in targeted atom bind with the involved energy for electrons of amalgamating fullerene atoms from all four sides.

Involved typical energy in the diamond, lonsdaleite and graphene atoms is in non-conservative manner. Each electron of the outer ring of depositing diamond atom takes another clamp of energy knot belonging to the outer ring of deposited diamond atom. A typical energy shaped like golf-stick involves in the process of transferring electron upto the half-length. The portion of electron above the clamped energy knot is fully under the exposure of force. Thus, the nature of engaged force in bound atoms of topological structures remains non-conservative.

Binding of diamond atoms is from ground to south, but growth is from south to ground, so diamond forms a tetra-electron topological structure. Binding of lonsdaleite atoms can be from ground to a bit south, but growth can be from south to a bit ground, so lonsdaleite forms a bi-electron topological structure. Binding of graphene atoms can follow opposite mechanism to that of the diamond where engaged force at the electron level should function in surface and space formats. Binding graphene atoms upto the few layers do not form the topology of structure.

Repeated layers of gaseous, graphite and lonsdaleite atoms nucleate a structure of glassy carbon. Under the forceful gravitational behavior of electrons, atoms of gaseous layer bind to atoms of graphite layer. Due to increased potential energy, electron pair in each gaseous atom undertakes additional clamp of energy knot pair in each graphite atom, where golf-stick shaped typical energy involves from the rear side. Under the forceful levitational behavior of electrons, atoms of each lonsdaleite layer bind to atoms of each graphite layer. Due to decreased potential energy, electron pair in each lonsdaleite atom undertakes additional clamp of energy knot
pair in each graphite atom, where golf-stick shaped typical energy involves from the front side.

The structural formation in graphite, nanotube and fullerene atoms is through the partially conserved energy first, and then partially conserved force. In such structural formations, suitable electrons of atoms execute interstate dynamics by remaining partially confined. On the other hand, in diamond, lonsdaleite and graphene atoms, structural formation is through the non-conserved energy first, and then non-conserved force. A same is the case in the structural formation of glassy carbon. A property of hardness in a nanostructured carbon material or a microstructured carbon material should relate to the introduced energy and force at electron level.

In the structural formation of carbon atoms having different states, energy is involved first to engage the force exploring their own science. Carbon atoms enable one to understand the nature of electron dynamics in atoms of different elements. The study of different carbon allotropes opens new areas of investigations, which can enable the understanding of different phenomena of nature.

Acknowledgement and Dedication:
Author acknowledges the support from whoever he learnt at any stage of his career along with all the offices and countries provided the financial supports. He dedicates this work to his family for supporting throughout his professional career.

References


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