Atomic Structure and Binding of Carbon Atoms

Mubarak Ali
Department of Physics, COMSATS University Islamabad, Park Road, Islamabad-45550, Pakistan, E-mail: mubarak74@mail.com, mubarak74@comsats.edu.pk

Abstract: Many studies discuss carbon-based materials because of the versatility of their element. They include different opinions for scientific problems and discuss convincingly various levels within the scope and application. A gas state carbon atom converts into various states depending on its conditions of processing. The electron transfer mechanism is responsible for converting the gas state carbon atom into various states, such as graphite, nanotube, fullerene, diamond, lonsdaleite and graphene. The parabola shaped of ‘energy trajectory’ enables transfer of electrons from the left and right sides of an atom. That ‘energy trajectory’ is linked to states (filled state and suitable unfilled state), where forced exertion along the poles of transferring electrons remained balanced. So, the mechanism of originating different states of a gas state carbon atom is under the involvement of energy first. This is not the case with atoms executing confined inter-state electron dynamics as the force (conservative) is involved first. Graphite, nanotube and fullerene state atoms ‘partially evolve and partially develop’ (form) their structures. These possess one-dimensional, two-dimensional and four-dimensional ordering of atoms respectively. Their structural formation also comprises ‘energy curve’ having a shape like parabola. Transferring suitable filled state electron to suitable nearby unfilled state is under a balanced force, exerting along the poles. The graphite structure under attained dynamics of atoms only can also be formed but in a two-dimensional order. Here, binding energy between graphite state carbon atoms is due to a small difference of exerting forces along their opposite poles. Structural formation in diamond, lonsdaleite and graphene atoms involves energy to gain required infinitesimal displacements of electrons through which they maintain orientationally-controlled exerting forces along the dedicated poles. In this study, the growth of diamond is found to be south to east-west (ground), where atoms bind ground to south. Thus, diamond atoms merge from a tetra-electron ground to south topological structure. Lonsdaleite atoms merge from a bi-electron ground to a bit south
topological structure. The growth of graphene is found to be from north to ground, where atoms bind from ground to north. Thus, graphene atoms merge from a tetra-electron ground to north topological structure. Glassy carbon exhibits layered-topological structure, where tri-layers of gas, graphite and lonsdaleite state atoms successively bind in repetitive order. Nanoscale hardness is also sketched based on different force and energy behaviors of different state carbon atoms. Here, the structure evolution in each carbon state atom explores its own science.

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

1.0 Introduction

Developing materials of selective size and shape, and investigating their characteristics for various applications, solicit new approaches and observations. The forces appearing at electron levels process the structural transitions engaging the energy and vice versa. The engagement of balance and non-conservative forces for electrons is responsible for executing partially non-confined and fully non-confined inter-state dynamics of their atoms respectively. First, energy controls the forces in their engaging fashions. The atoms of various carbon allotropes appear to be the candidates for dealing with such forces as the available filled and unfilled states are just near their centers. The force and energy of the atoms are considered to be in partially conserved mode in the former case (forced exertions to electrons are in balanced mode) and in the non-conserved (frictional) mode entirely in the latter case (forced exertions to electrons are in non-conservative mode).

Carbon atoms have different states known as allotropes, i.e., starting from the gas state carbon atom to graphite state, and then, diamond, lonsdaleite carbon, fullerene followed by nanotube state, glass carbon, and finally the graphene. Several studies on carbon-based materials are available in the literature explaining the conditions of deposition and their effects in the form of morphology, growth rate, quality and application, etc.

Engaging (or involving) energy to involve (or engage) force for forming structure of different formats such as solid atoms is to be considered as per their built-in gauge of electron dynamics. Here, the word “involve” refers to an action of energy or force for “instant time”, whereas the word “engage” refers to an action of energy or force for “eternal period”. When carbon atoms of gas state are converted into certain
state eligible to form structure, the involvement of energy rather than the force is expected. In each carbon atom, electrons of outer ring are considered to execute dynamics, where they are close enough to electrons belonging to zeroth ring. A zeroth ring is related to the center of an atom, which constitutes four electrons. Hence, electrons of zeroth ring do not undertake their dynamics. The force along their east-west poles does not get exerted. They do not undertake their transferring mechanism as in the case of electrons of outer ring. An outer ring is the first ring in the case of a carbon atom.

In different state carbon atoms, electrons of the outer ring follow transfer mechanism because of the uncovered sides of filled states and unfilled states. Due to their limitation to be too close to the center of their atom, they involve the energy first for transferring to suitable nearby unfilled states. When forces in conservative mode are exerted to electron of a neutral state silicon atom, an uninterrupted execution of electron dynamics generates a photon of immeasurable length [1]. This indicates that the built-in gauge of electron dynamics in the case of carbon atom is different as compared to silicon atom, despite the fact that the same numbers of filled and unfilled states are available for their outer ring. However, the distance of each electron of the outer ring from the center in carbon atom is different as compared to silicon atom [2]. This way, silicon atom executes confined inter-state electron dynamics instead of non-confined (or partially confined) inter-state electron dynamics. Atoms belonging to suitable elements evolve structures in different formats by involving the conservative forces to execute confined inter-state electron dynamics [3].

It is pertinent that atoms belonging to any element do not ionize [4]. Understanding the mechanism of forming structure based on the different carbon states relies on the same chemistry at the input end. Various spectroscopic analyses of a ‘tiny grain carbon film’ give peaks at different positions indicating different nature of carbon atoms in the form of tiny grains [5]. Depending on the conditions and the techniques involving a source of gas carbon atoms, they deposit for the development of different morphology and structure of grains and crystallites [6], different morphology of grains and particles are observed at different chamber pressures identifying the role of arresting energies near substrate with different rates [7]. The deposition of graphite and diamond in distinctive manner at a single substrate is due to the different set inter-wire distance of dissociating gases [8].
This way, an approach based on the multidisciplinary point of view may originate understandings of a different atomic structure, which could be very different from the one(s) available in the existing literature.

It is necessary to understand the dynamics of development of tiny particles prior to assembling them into large-sized particles [9]. Agglomerations of colloidal matter envisage atoms and molecules to deal with them as materials for tomorrow [10]. Development of tiny particles of different features has been discussed elsewhere [11]. The developing mechanism of tiny-shaped particles under certain concentration of gold precursor has been discussed [12]. Under identical process parameters, the nature of precursor directs tiny-shaped particles following the development of their large-shaped particles, where the role of the required atomic nature was also in focus [13]. Different tiny particles following large-sized particles developed under the application of nano-energy supplied by varied pulses ON/OFF times [14]. Developing large-sized particles showed very high development rate [15]; origin of their physics and chemistry was also discussed. Developing mono layer tiny-shaped particles under the application of nano-energy was discussed, where atoms of one-dimensional arrays are converted into structures of smooth elements [16]. Certain nature atoms of tiny-sized particles undertake different behaviors resulting in work as either effective or defective nanomedicine [17]. Gold particles of unprecedented shapes developed under tailored conditions of processing the solution [18]. Hard coating of suitable gas and solid atoms developed because of their established transitional energy and force behaviors [19].

Atoms of different elements along with their structures are recognized by their physical behavior. A carbon atom shows several physical states even though it exhibits a distinctive chemical nature. Different carbon-based materials possess atoms of the same element but indicate a very different behavior during the process [5-8]. This specifies that the transition of electrons within designated states to nearby unfilled state (within the same ring) changes the chemical nature of atom resulting in a new state of physical phenomenon. In gas and solid atoms of suitable elements, transitions of electrons cannot cross the north-pole or south-pole of their atom, but they do cross their own projected north-south poles to develop liquid transition state [2]. It is also observed that the force entering (north-pole) and leaving the ground surface (south-pole) is different as compared to force on the ground surface (east-west poles) [20]. Thus, the available option for transferring electron of filled state to
unfilled state in all suitable atoms is left on the left-side or right-side of their atoms. So, the available option for transition of electrons in gas or solid atoms is only within the clamped energy knots, where they undergo established transition states, such as recovery, neutral, re-crystallization and liquid states depending on the rate of their infinitesimal displacements. The center of atoms is related to zero-force axis as it is declared the common point of inter-crossed overt photons forming their lattice [2]. When the ground point of an atom is above the ground surface, as in the gas state, the dominating force is considered to be based on the space format. When the ground point of an atom is below the ground surface, as in solid state, the dominating force is considered to be based on the grounded format. When the ground point of an atom is at average level ground surface, as in atoms of semi-solids, the dominating force is considered because of surface format. A detailed study is presented discussing the evolution of structures in different formats for atoms involving conservative forces to execute confined inter-state electron dynamics [3].

From the point of view of different studies conducted on carbon-based materials, a recent study shows transformation of graphene film into a diamond like film, where the elastic deformations and chemical natures were changed [21]. Wu et al. [22] also 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 the catalyst [23]. Different applications related to graphene hybrids were reviewed recently in a study [24]. Nitrogen incorporated carbon dots were used to modify a glassy carbon electrode [25]. A novel energy dissipation system was investigated by combining the carbon nanotube and buckyballs [26]. Different carbon allotropes were studied for the dehydrogenation temperature in their comparison [27]. A precise positioning of the vacancies within the diamond crystal was studied by Chen et al. [28]. Liu et al. [29] 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 optimized conditions of microwave-based vapor deposition system [30]. Cheng and Zong [31] observed structural evolution of damaged carbon atoms for deeper surface layer. Maruyama and Okada [32] investigated geometric, electronic and magnetic structures of a two-dimensional network of carbon atoms. Narjabadifam et al. [33] 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 measurements of their temperature [34]. This leads to the removal of the ‘uncertainty in temperature measurement’ of levitated nanodiamond, which is paves the way for considering valuable applications [35]. However, already emerged and emerging different applications of carbon-based materials lack the basic understanding of structures.

Bindings of atoms in different states show that their mechanism to form structures remains challenging since their discovery. The cause of structural formation in different state carbon atoms has remained elusive. Additionally, the formation of layer-based structure comprising a different state of atoms of each layer remains challenging. Here, atomic structure of different state carbon atoms along with their structural formation is pinpointed. This study describes the science of originating different carbon states and formation of their structures.

2.0 Results and discussion

The lattice of a carbon atom in Figure 1 (a) displays four unfilled states (energy knots) at the center which are related to the zeroth ring, whereas eight unfilled states (energy knots) around the zeroth ring are related to outer ring (first ring). Each energy knot is formed by the precise inter-crossing of the overt photons having length of filled and unfilled states. Two pairs of overt photons having characteristic of current inter-cross by keeping their common centre and eight states of electrons are formed which are related to the eight hollow regions. In crossing over photons, the trough of one is in front of the crest of other that results in freezing (jam) the element of force. A photon constitutes both the element of force and energy [1]. Along the north and south axes, those two pairs of photons having characteristic of current inter-crossed at the same centre and compress two states (energy knots) of their opposite sides by means of already inter-crossed double pair of overt photons along the east and west poles. This results in the hollow regions for only four states of electrons as shown in Figure 1 (a). Pairs of certain length overt photons inter-crossed to form the states of clamping energy knots of twelve electrons under their common center. Among these twelve states, central four are related to zeroth ring while the outer ring of eight sites forms the first ring. In the outer ring, four states
remained filled and four vacant. This order provides the option to originate six different state behaviors of a carbon atom in addition to the gas state. In Figure 1 (b), the gas state carbon atom is shown, while other different states are shown in Figure 1 (c-h). The positions of electrons belonging to the outer ring are changed accordingly in their atoms; in (c) graphite state, (d) nanotube state, (e) fullerene state, (f) diamond state, (g) lonsdaleite state and (h) graphene state carbon atoms are shown. For each carbon atom, the central four electrons form the zeroth ring. Zeroth ring is termed as nucleus, which is also related to a helium atom [2].

![Diagram of carbon atom states](image)

**Figure 1**: (a) lattice of a carbon atom, atomic structure of carbon atom when in (b) gas state, (c) graphite state, (d) nanotube state, (e) fullerene state, (f) diamond state, (g) lonsdaleite state and (h) graphene state; red colored circles indicate filled states, white colored circles indicate unfilled states and black colored rings indicate clamping energy knots to states; drawing is shown in estimation.

A gas state carbon atom is processed to transfer two electrons of filled state to nearby unfilled state: one from the right-side and one from the left-side for one state migration. As a result, energy having shape of built-in gauge of the electron dynamics is involved, where exerting forces along the relevant poles of electrons remain in balance. Moreover, a transferring electron follows the exact trajectory of bound energy to energy knots of filled and unfilled states. Each binding energy plot will have electron for transfer, one from the east-side and one from the west-side of the atom, enabling conversion of gas state carbon atom into graphite state. In transferring all four electrons of outer ring to unfilled states available below the east-west poles (central line) in gas state carbon atom, three pairs of energy plot have shape like parabola. It helps convert it into a diamond state carbon atom. The applied forces to relevant poles of electrons for transferring them to dedicated states of an atom remain in balance.

When gas state carbon atom converts into graphite, it is under the availability of energy shaped like parabola, where certain electron of left-side and right-side are
transferred by the balanced behaviors of forces applied to them. The exerted forces are related to space format and surface format, which are kept in balance at the instant of transferring electrons. However, transferring requires electrons of graphite state carbon atom for lonsdaleite state carbon atom. Thus, parabola-shaped energy plot along the west to south and an energy plot with the same shape along the east to south are involved. Here, the exerting forces for those electrons remain under the balanced behavior. On the other hand, exerted forces for transferring of electrons are related to surface format and grounded format. During the conversion of lonsdaleite state atom from graphite state, only two electrons are transferred to dedicated states. On conversion of diamond state atom from lonsdaleite, two electrons are transferred further to dedicated states. At that instant, ground point of the diamond state atom goes further below the ground surface as compared to the lonsdaleite state atom. Transfer of all (four) electrons of outer ring towards south-pole in a carbon atom (two from the left-side of south-pole and two from the right-side of the south-pole) results in the ground point of the carbon atom to become fully grounded giving the diamond state carbon atom. Thus, the transferred electron undertakes the maximum potential energy, where clamped energy knots to electrons possess the maximum expansion, too.

Due to the very small distance of outer ring from the center of carbon atom, exerting forces of east and south poles, east and north poles, west and south poles and west and north poles, in transferring a filled state electron to nearby unfilled state, in each case, becomes almost equal. Thus, energy shaped like parabola regulates it for the entire trajectory forming between filled to nearby unfilled state. This way, the relevant forces influence, under the balanced behavior, the transfer of electrons of opposite sides in carbon atom and under the involved set of typical energies. Therefore, the carbon atom originates a new state behavior under the maintenance of equilibrium. Under the maintenance of equilibrium, transferring electrons of outer ring in graphite state carbon atom convert it into fullerene state carbon atom. A gas state carbon atom converts into nanotube state carbon atom. On the other hand, a fullerene state atom can be converted directly into nanotube state under the supply of two-unit energy shaped like parabola trajectory. A graphite state carbon atom is converted into diamond state, lonsdaleite state and graphene state carbon atom one by one under the supply of energy shaped like a parabola trajectory having a different number. Here, the exerting forces to electrons do not
experience imbalances, while following the trajectory as they are balanced for their experiencing poles. Energy knots forming the unfilled and filled states of the carbon lattice expand or contract to different extent depending on the position of electrons belonging to the outer ring.

An occupied or unoccupied position of electron in the atom is termed as ‘state’. Based on newly occupied state of the electron, a new allotrope of its carbon atom is also termed as ‘state’, but in this case, it is the atomic state instead of electronic state. Depending on the electrons and their attained positions in their atom, the contraction and expansion of clamped energy knots are adjusted accordingly and then relatively to the neighboring ones.

In Figure 2 (a), binding of graphite state carbon atoms is shown, where one amalgamated atom is already in the graphite state (atom A) and the other (atom B) is in the transition to attain the graphite state. Energy involved to transfer suitable electrons of filled states to the suitable nearby unfilled states is utilized for binding. Thus, graphite state carbon atoms are bound adjacently along the same axis. However, the energy is absorbed (or linked between states) prior to the transfer of an electron, where it follows the trajectory of that energy shaped like parabola to attain the graphite state. Here, the role of the engaged forces (in both space format and surface format) remained in balance. Thus, the atom B is bound to atom A while converting to graphite state. Binding of atom B to atom A involves typical energies having plot shaped like parabola and results in the graphite structure by the repetition of the same scheme. In the binding of carbon atoms in graphite state carbon atoms, the energy involved is protected by a balanced behavior of applied forces as its shape and connection between states are not affected. The applied balance behaviors of forces in binding atoms of graphite remain along the same axis as shown in Figure 2 (a). Thus, they develop graphite structure in one dimension. In developing graphite structure under the execution of electron dynamics of atoms, their binding remains along the single direction of X-axis. Under the execution of electron dynamics, this one-dimensional structure formation in graphite state carbon atoms can be in the single direction of opposite side of X-axis. Atoms of such one-dimensional arrays while forming tiny grains elongate under the exertion of forces in surface format convert them into the structures of smooth elements [5].
Figure 2: Structure formation in graphite state atoms (a) when executing electron dynamics under suitable amalgamation, the graphite state atoms form one-dimensional structure and where (b) amalgamated atoms engaged forces only under the attained dynamics, the graphite state atoms formed a two-dimensional structure; drawing is shown in estimation.

When atoms amalgamate under preserving their state of graphite, they only bind under the attained dynamics to form structure without the execution of electron dynamics. At this stage, the evolving graphite structure becomes two-dimensional. The typical parabola shaped energy curve remains no more involved in binding graphite state carbon atoms. Based on the slight difference in exerting east and west forces at the point of amalgamation of two graphite state atoms to central one, they remain bound only under attained dynamics as shown in Figure 2 (b). When identical layers of graphite state atoms developed side by side (parallelly) to that layer, upward-side and downward-side (or only for one side), it undertakes two dimensions as the force differs along the opposite poles of atoms while forming their layers. Even though existing forces of opposite poles do not work for an appreciable difference to allow binding of graphite state carbon atoms, they also do not allow atoms to go away from each other. Under the opposite forces of east and west poles, graphite state carbon atoms adjust along both directions of X-axis, where they amalgamate adjacent.

A nanotube state carbon atom, converted from the fullerene state carbon atom prior to assembling, is under the balanced forces while transferring electrons. Therefore, the transfer of electrons for each unfilled state is also under the involved energy shaped like parabola. Here, the execution of dynamics of electron is neither under non-conservative force, nor under conservative force, but rather under partial conservative force (exertion of a balanced force). Carbon atom of nanotube state forms structure based on the involvement of binding energy for atoms attaining the
identical state at the instance of amalgamating as shown in Figure 3 (a). Here, a fullerene state carbon atom converts into a nanotube state carbon atom on transferring electron to nearby unfilled state for each opposite quadrant. Atoms of such carbon state bind under the balanced behavior of exerting forces to electron in surface format and space format for one quadrant. The balanced behavior of exerting forces to electron in surface format and grounded format is for the opposite quadrant. The energy shaped like parabola is involved to transfer electron of a particular state from south-side and north-side in the opposite quadrants of atom resulting in binding amalgamating atoms on both sides as displayed in Figure 3 (a).

The binding of atoms in nanotube structure has two opposite quadrants. In either way, the formation of the structure is related to two dimensions, but the overall shape of nanotube appears in one-dimensional shape, which is shown for two options in Figure 3 (a).

A carbon atom attains fullerene state by the transfer of electron at each dedicated state of pole while engaging the energy shaped like parabola for all four quadrants, where transferring electron of each quadrant engages a balanced behavior of exerting forces along the relevant poles. Here, a contribution of applied balanced force in space format along with surface format for two quadrants is considered. Furthermore, the contribution of applied balanced force in grounded format along with surface format for two quadrants is also considered. A characteristic energy shaped like parabola while binding identical state atoms at point of executing electron dynamics is shown in Figure 3 (b), where the formation of fullerene structure in two different ways is shown. This indicates that the structural formation in fullerene state carbon atoms is four-dimensional. Binding of fullerene state carbon atoms form fullerene structure for all four quadrants of nearly plane surface forming angle either nearly at mid of each quadrant or nearly along the north- and south-poles, and east-and west-poles. A fullerene state carbon atom converts into the nanotube state carbon atom before assembling, where exerting forces along the relevant poles of electrons at the time of transferring remain in balance. In the fullerene state carbon atom, upper-sided transferred electrons engage the balanced exertion of forces in space format and surface format, while lower-sided transferred electrons engage the balanced exertion of forces in grounded format and surface format. Here, a balanced force is a force neither fully conservative nor fully non-conservative.
Figure 3: (a) nanotube structure – a two-dimensional structure where the involved energy shaped like parabola in opposite quadrants of targeted atom binds amalgamated atoms on left-side and right-side and (b) fullerene (buckyballs) – a four-dimensional structure, where the energy shaped like parabola involved in each quadrant of targeted atom binds four amalgamated atoms.

A lonsdaleite state carbon atom having ground point just below the ground surface is shown in Figure 4 (a). It approaches to bind the diamond state atom once it is converted into a diamond state atom. A diamond state atom, which has already attained ground point sufficiently below surface, is also shown in Figure 4 (a). The expected binding point of atoms, when both are binding in diamond state, is also exhibited in Figure 4 (a). In the nucleation of synthetic diamond, a deposited atom is at highly-heated scratched seeded surface of solid which does not allow it further to attempt gravitational behavior of electrons. This is due to their maximum potential energy under orientationally controlled exerting forces of fixed poles. Therefore, no more expansion of their clamped energy knots takes place. This way, electrons do not intrude their resting surface even to the extent of size (mass) of an electron, resulting in maintaining the diamond state of their atom. Thus, the diamond state carbon atom shows solid behavior at maximum extent. Moreover, the ground point of diamond state carbon atom is sufficiently below the ground point of lonsdaleite state carbon atom, which is a bit below the ground surface. In this context, lonsdaleite state carbon atom is in less expansion of clamped energy knots to filled and unfilled states forming its lattice as compared to ones in diamond state carbon atom. In Figure 4, sketches of different entities are drawn in estimation to show less and more expansion of clamped energy knots to filled and unfilled states of carbon state atoms.

The ground point of lonsdaleite state carbon atom is just below the ground surface because it is underneath the ground point of graphite state carbon atom. In diamond state carbon atom, electrons are in their maximum gravitational behavior in the region, where maximum expansion of clamped energy knots takes place. As mentioned earlier, the resulting energy of electrons in diamond state carbon atom
dissipates, enabling the expansion of clamped energy knots to the maximum extent. Electrons of lonsdaleite state carbon atom exert orientational force at lower degree angle from the normal line of their center, resulting in lower amount of potential energy. Hence, the clamping energy knots are in lesser expansion.

**Figure 4:** (a) ground points of lonsdaleite and diamond state carbon atoms along with expected binding point of two diamond state carbon atoms, (b) depositing diamond state carbon atom when four electrons of outer ring undertake double clamping of energy knots under experiencing the forces of side surfaces (east and west poles) and south poles where they are rightly located above the four unfilled states of deposited diamond state carbon atom, (c) orientation of certain electron of lonsdaleite state carbon atom, prior to conversion and orientation, when it undertakes conversion into diamond state carbon atom where clamping another energy knot belonging to certain unfilled state of deposited diamond state carbon atom and (d) growth of diamond is south to ground; red colored circles indicate filled states, white colored circles indicate unfilled states and red colored double circles indicate electrons of double clamping of energy knots; drawing is shown in estimation

On the transfer of two electrons from left to downward side unfilled states, lonsdaleite state carbon atom is converted into the diamond state carbon atom. Now electrons of that converted diamond state carbon atom also undertake the same level of expansion in terms of clamped energy knots as in the case of targeted (deposited) diamond state carbon atom. On the other hand, depositing diamond atom on deposited diamond atom, a controlled expansion in clamped energy knots to their electrons is expected while experiencing orientationally controlled exerting forces (in surface format and grounded format) along the relevant poles. This results in undertaking the targeted electrons (of depositing diamond state carbon atom) for another clamping of energy knot through targeted unfilled states (of deposited diamond state carbon atom), where they experienced the exerting force along the relevant poles while arriving rightly over them (targeted unfilled states). Each electron of filled states belonging to outer ring of depositing diamond state carbon atom undertakes another clamp of energy knot of unfilled states belonging to outer
ring of deposited diamond state carbon atom, resulting in their binding as shown in Figure 4 (b). Binding diamond atoms adjust and compensate expansion and contraction of their lattices. This way, they construct a new binding point for the following depositing diamond atom.

Lonsdaleite state carbon atom undertakes less expansion of energy knots clamping electrons and vacant sites as compared to the diamond state carbon atom. Therefore, a lonsdaleite state carbon atom is more related to the recovery state of an atom, where orientation of exerting force to each electron clamped by energy knot becomes ~20° angle from the normal line drawn from its center (270°+20° =290°). Further, in diamond state carbon atom, expansion of clamped energy knot to electron takes place under the exertion of forces along the relevant poles at ~35° angle from the normal line drawn from its center (270°+35° =305°). The angles of exerting forces to electrons along the relevant poles in lonsdaleite state carbon atom and diamond state carbon atom from their normal line drawn at the center are displayed in Figure 4 (c). The electron of diamond atom undertakes double clamping of energy knot to bind another diamond atom and it is also shown separately on the right side.

Overall growth behavior of diamond state carbon atoms is shown in Figure 4 (d). The binding of diamond state carbon atoms remained in progress under the same mechanism for the conversion of gas state carbon atoms. Here, diamond state carbon atoms adjust and compensate contraction and expansion of their ‘energy knot nets’ (and clamping energy knots to their electrons). This adjustment of nets (lattices) takes place each time the depositing (binding) of a new diamond atom to already deposited diamond atom takes place. Therefore, in diamond binding, growth behavior is from south to ground where binding point of the atoms remains between surface format and grounded format. Electrons embedded under their suitable mechanism in the first deposited diamond state carbon atom are also shown in Figure 4 (d). They direct themselves ground to south under the maximum expansion of clamped energy knots. At that instant, electrons of depositing diamond atom remain detained in their clamped energy knots. When the binding of third diamond state carbon atom is in process, electrons of second deposited atom are detained by the unfilled states of first deposited atom. A double clamping to electrons is apprehended, adjusting the expansion contraction of the ‘energy knot nets’ of the two atoms. This came into force prior to binding third diamond state carbon atom.
This can be referred to as the nucleation stage of diamond. Depositing the third diamond state carbon atom and locating a new point of binding with respect to already bound two deposited diamond state carbon atoms initiate the growth process of diamond as shown in Figure 4 (d).

When the depositing diamond state carbon atom is precisely over the deposited diamond state carbon atom, two electrons of outer ring undertake forced exertion along the outer side pole (left-side electron west-pole and right-side electron east-pole) equal to the forced exertion along the south-pole. Here, exertion of the force along the north-pole becomes negligible. On undertaking another clamp of energy knot by those two electrons (belonging to depositing atom), their left two outer side electrons also come into the precision to undertake another clamp of left two energy knots of outer sides as shown in Figure 5. This way, the mechanism of undertaking double clamp of energy knot by each electron is by the inner two electrons, following the left two electrons for both quadrants of the south-pole to bind a diamond atom. Therefore, exertion of one pole force to outer side of the electron and one pole force to tip side remains diligent to control position at an instant of clamping another energy knot. The clamping of (another) energy knot is for the half-length to that electron when it reaches inside the hollow region by undertaking the frictional (non-conservative) forces of various sections of infinitesimal displacements. Only the force that exerts along the one pole has surface format (exposed side surface) and, similarly, only the force that exerts along the south-pole has grounded format to undertake double clamping of energy knot. Both energy knots clamped by each electron expanded under disappearing exertion of one pole force in surface format and north-pole force in space format are shown in Figure 5.

**Figure 5:** Binding of depositing diamond state carbon atom to the rooted diamond state carbon atom along with exertion of forces to the exposed sides of left-side electron and right-side electron; drawing is shown in estimation.
The mechanism of binding lonsdaleite state atoms is identical to that of binding diamond state carbon atoms. However, only two oriented (~290°) electrons of lonsdaleite state atom clamp another clamping of energy knot belonging to deposited lonsdaleite state carbon atom. In this manner, one atom experiences the force in grounded format, while the other atom in surface format locating a new joint ground point. Therefore, binding in lonsdaleite state carbon atoms is ground to a bit south, but growth behavior is a bit south to ground. The involved characteristic energy to convert gas state carbon atom into lonsdaleite state carbon atom is in the same shape as for the diamond state carbon atom, but in fewer amounts. This is because of transferring of only two electrons along the south-pole, left and right sides.

The ground point of graphene state atom does not lie on the ground surface but lies just above the ground surface. Therefore, carbon atoms in graphene state undertake contraction of clamping energy knots while exerting force to electrons. Here, the levitational behavior of force is at pronounced level. Binding of graphene state carbon atoms bears exerting forces in surface format and space format. Thus, binding of graphene state atoms is ground to north. So, the growth of graphene is north to ground. This is the reason why graphene structure is based on a few layers as it is challenging to maintain exerting forces for further elevation. Therefore, in formation of graphene structure, the binding mechanism of atoms is opposite to the one required for diamond.

One more physical behavior of the carbon atom is visible when successive layers of three different states carbon atoms bind in repetitive manner, i.e., gas, graphite and lonsdaleite state carbon atoms in successive manner. Forced exertions to electrons along relevant poles in the atoms are engaged through the involved energies. Thus, coordination between energy and force of dedicated electrons and unfilled states bind their atoms of layers to form a structure, i.e., a structure of glassy carbon. Layers of gas and graphite state atoms bind under the joint application of exerting forces in grounded format and surface format. Here, orientationally-controlled paired electrons of gas atoms undertake double clamping of energy knots of unfilled paired states belonging to graphite atoms (from the rear side). Gas state carbon atoms attempt forcefully the gravitational behavior under increased potential energy of their electrons. Layers of lonsdaleite state carbon atoms and graphite state carbon atoms bind under the joint application of exerting forces in space format and surface format. Here, orientationally-controlled paired electrons of lonsdaleite atoms
undertake double clamping of energy knots of unfilled paired states belonging to graphite atoms (from the front side). Lonsdaleite state carbon atoms attempt forcefully levitational behavior under decreased potential energy of their electrons. Layers of lonsdaleite state carbon atoms and gas state carbon atoms provide compensation in terms of expansion and contraction of bound layers of atoms as shown in Figure 6.

![Figure 6: Structure formation of glassy carbon, where tri-layers of gas, graphite and lonsdaleite state carbon atoms respectively bind in the successive manner; (1) paired electrons of each atom (belonging to gas state carbon atoms layer) undertake double clamping of paired energy knots of each atom (belonging to graphite state carbon atoms layer) by entering from the rear sides, (2) paired electrons of each atom (belonging to lonsdaleite state carbon atoms layer) undertake double clamping of paired energy knots (belonging to graphite state carbon atoms layer) by entering from the front sides and (3) layers of gas and lonsdaleite state carbon atoms compensate in binding their layers to the layer of graphite state carbon atoms; drawing is shown in estimation](image)

To originate the different physical behavior of each state carbon atom, non-conserved energies help manipulate non-conservative forces. A carbon atom is related to gas state when two electrons of outer ring occupy states on left and right sides of north-pole and remaining two electrons of outer ring occupy states just below the line of east and west poles. The carbon atom is related to graphite state when two electrons of outer ring retain positions in the states available just above the line of east and west poles and two electrons of outer ring retain positions in the states available just below to that line. The involved energies form structures (in surface format) and are in non-conservation. They are the sub-parts (fractions) of conserved (discrete) forced energy of unit photons. A unit photon has shape like a ‘Gaussian distribution of both ends turned’ [1]. However, for structural formations of
diamond, lonsdaleite, graphene and glassy carbon, a transitional potential energy of electrons engages orientationally-controlled exerting forces. On suitable coincide of carbon atoms belonging to a state, these engaged orientationally-controlled exerting forces enable their suitable electrons to undertake another clamping of suitable energy knots. However, in the formation of glassy carbon structure, orientationally-controlled pairs of electron atoms of lonsdaleite layer above and gas layer below enter from the front side and rear side respectively to orientationally-controlled pairs of unfilled state atoms of intermediate graphite layer undertake their one more clamping of energy knot.

Transferring electrons of filled states to the unfilled ones in the carbon atom involves the non-conserved energy through which non-conservative forces get engaged. However, wherever the conservative forces involve addressing the dynamics of electrons in certain atoms, they engage the conserved energy as well. As in the case of neutral state silicon atom, a filled state electron is transferred to nearby unfilled state under the exertion of conservative forces, and this way engaging the conserved energy also [1]. This indicates that atomic radius in different elements along with electronic structure of the atom is the core to elucidate what sort of the energy and force behavior is considered for that atom.

Different state carbon atoms develop amorphous structures when binding for frustrating and miscellaneous amalgamations. Their tiny buds mix with each other. Hence, they are not promising for an affirmative structure of specialized applications. When the surface of evolving graphite structure is not flat at electron level, the influences of exerting north and south forces are also included, where developing structure of graphite state carbon atoms is related to amorphous graphite structure. The formation of amorphous structures may be considered in the case of other states of carbon atoms, where atoms can distort forming structure of a certain state carbon atom. Uneven surfaces for developing the first layer utilize the forces of north and south poles under non-uniform distribution, resulting in maintaining developed amorphous graphite structure.

Hardness at Mohs scale for different structures of different states carbon atoms at nanoscale is sketched in Figure 7. The value of hardness cannot be counted when considering the gas state carbon atoms as they do not form structure having hardness of any scale. The hardness scale is related to the binding of different state carbon atoms, where involved non-conserved energies due to electron dynamics
engage their non-conservative forces, which is different for each established state of structure evolving carbon atoms as discussed above. In Raman spectroscopy, different values of wave number printed against energy signals of graphite structure and other structures of carbon (at nanoscale) reveal different nature of propagating photons through different inter-state electron gaps (in their different state carbon atoms), which is also validated by the energy loss spectroscopy [5].

**Figure 7:** A sketch of approximately estimated hardness (at Mohs scale) of nanoscale structure in different states carbon atoms versus exerting levitational and gravitational forces at electron levels; drawing is shown in estimation

### 3.0 Conclusion

Energy shaped like a parabola trajectory, which is also in the shape of built-in gauge of electron dynamics of a carbon atom, enables the transfer of an electron to suitable nearby unfilled state. The transfer of electrons (suitable) of left-side and right-side of atom to occupy nearby unfilled states (suitable) maintains the attained equilibrium of that state of carbon. For the transfer of electrons to attain another state of atom in each respective format, the exertion of forces along their relevant poles remains in
balance. The nearby states become a bit slanted, so they overlay accordingly while handing over and taking over the electron. These are through the control of the center of atom. A carbon atom is related to the diamond state when electrons of the outer ring retain positions in the states below the line of east and west poles.

When structure of graphite state carbon atoms is in two dimensions, it is under the significantly attained dynamics only, where difference in the opposite pole forces within the suitably amalgamated atoms forms the structure. Forces do not restrict them to bind under the harvested energies and at least they also do not keep them separated. Amalgamated atoms remain bound under attained dynamics only.

There is an exertion of balanced forces along the poles of electrons in structural formation of one-dimensional graphite, two-dimensional nanotube and four-dimensional fullerene. The exertions of balanced forces mainly take place in the surface format. In the case, where binding of graphite state carbon atoms is under the execution of electron dynamics, the formation of structure is one dimensional. Carbon atoms in nanotube state form structure under the involvement of energy for electrons of opposite quadrants of their atoms. Carbon atoms in fullerene state form structure under the involvement of energy for electrons of all quadrants of atoms.

There is exertion of forces in non-conservation along the dedicated poles of electrons in the case of topological structural formation of diamond, lonsdaleite and graphene. The gained non-conserved energy for electrons in diamond, lonsdaleite and graphene state carbon atoms is triggered to maintain orientationally-controlled exerting forces along their relevant poles.

Bindings of diamond atoms is from ground to south, but growth is from south to ground. So, it is a tetra-electron ground to south topological structure. Bindings of lonsdaleite atoms are ground to a bit south, so it is a bi-electron ground to a bit south topological structure. Bindings of graphene atoms follow opposite mechanism to that of the diamond. Here, energies of the electrons engage the controlled behavior of exerting forces along the relevant poles while occupying space and surface formats instead of occupying surface and grounded formats as for lonsdaleite and diamond atoms. Thus, it is a tetra-electron ground to north topological structure.

Repeated sequence of tri-layers (gas, graphite and lonsdaleite atoms) forms a structure of glassy carbon. In the structure formation of glassy carbon, the electrons undertaking double clamping of the energy knots enter from the rear side (bottom) in the case of the layer of gas state carbon atoms and from the front side (top) in the
case of the layer of lonsdaleite state carbon atoms. Binding atoms of each layer of lonsdaleite state to atoms of each layer of graphite state is attempting forcefully levitational behavior of electrons. This is because of decreased (lost) potential energy of electrons in each lonsdaleite state carbon atom. This way, the engagement of orientationally-controlled exerting forces of relevant poles of paired electrons is from the front side to undertake another clamping of energy knot. Binding atoms of each layer of gas state to the atoms of each layer of graphite state is because of the forcefully gravitational behavior of electrons where, because of their increased (gained) potential energy, they result in undertaking another clamping of energy knot for each case. Here, the engagement of orientationally-controlled exerting forces of relevant poles of paired electrons is from the rear side.

The structure formation in graphite, nanotube and fullerene state carbon atoms is partially under the conserved behavior of energy first and then force, whereas in diamond, lonsdaleite and graphene state carbon atoms, it is under the full non-conserved behavior of energy first and then force. In the first case, atoms execute partially confined inter-state electron dynamics to form their structures, whereas in the latter case, atoms execute fully non-confined inter-state electron dynamics to form their structures. The same is the case with structural formation in atoms of glassy carbon, where the level of frictional forces for electrons exceeds.

Force and energy work through coordination; when force is involved, energy is engaged, and vice versa. In the structural formation of carbon atoms related to different states, the energy is involved first to engage the force. When energy is the external (outer) source, the internal (inner) source is force, and for example, different kinds of photons’ force attempt to leave the covered energy at the point of their generated end. When force is the external (outer) source, the internal (inner) source is energy in all sorts of electron dynamics such as conserved, partially conserved and non-conserved. In either way, these coordinate with each other under the established nature to function properly. The matter remains the intermediate component identifying the functioning of force and energy.

Each state carbon atom elaborates its own science in binding different state carbon atoms. The carbon atom enables us to understand the nature of electron dynamics in atoms of different class of elements along with those originating new physical behaviors of atoms. These investigations open new areas of research on different lines as compared to the existing ones. These investigations enable one to
understand different phenomena related to optics and photonics, certain energy and force behaviors of atoms of different elements and the design of new materials and light-matter interactions.

References:


Author’s biography:

Mubarak Ali graduated from University of the Punjab with BSc (Phys & Maths) in 1996 and MSc Materials Science with distinction from Bahauddin Zakariya University, Multan, Pakistan (1998); his thesis work completed at Quaid-i-Azam University Islamabad. He gained PhD in Mechanical Engineering from the Universiti Teknologi Malaysia under the award of Malaysian Technical Cooperation Programme (MTCP;2004-07) and postdoc in advanced surface technologies at Istanbul Technical University under the foreign fellowship of The Scientific and Technological Research Council of Turkey (TÜBİTAK, 2010). He completed another postdoc in the field of nanotechnology at the Tamkang University Taipei (2013-2014) sponsored by National Science Council now M/o Science and Technology, Taiwan (R.O.C.). Presently, he is working as Assistant Professor on tenure track at COMSATS University Islamabad (previously known as COMSATS Institute of Information Technology), Islamabad, Pakistan (since May 2008) and prior to that worked as assistant director/deputy director at M/o Science & Technology (Pakistan Council of Renewable Energy Technologies, Islamabad, 2000-2008). He was invited by Institute for Materials Research, Tohoku University, Japan to deliver scientific talk. He gave several scientific talks in various countries. His core area of research includes materials science, physics & nanotechnology. He was also offered the merit scholarship for the PhD study by the Government of Pakistan, but he did not avail himself of the opportunity. He also earned Diploma (in English language) and Certificate (in Japanese language) in 2000 and 2001 respectively, in part-time from the National University of Modern Languages, Islamabad. He is the author of several articles available at following links; https://scholar.google.com.pk/citations?hl=en&user=UYjvhDwAAAAJ, https://www.researchgate.net/profile/Mubarak_Ali5, https://www.mendeley.com/profiles/mubarak-ali7/, & https://publons.com/researcher/2885742/mubarak-ali/publications/