Atomic Structure and Binding of Carbon Atoms

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Abstract – Many studies discuss carbon-based materials because of the versatility of its element. They include different opinions for scientific problems and discuss fairly at convincing and compelling 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 in the gas-state carbon atom is responsible to convert it into various states, namely, graphite, nanotube, fullerene, diamond, lonsdaleite and graphene. The shape of 'energy trajectory' enables transferring electrons from the left- and right-sides of an atom is like a parabola. That 'energy trajectory' is linked to states (filled state and suitable nearby unfilled state) where force-exertion along the poles of transferring electrons is remained balance. 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 for atoms executing confined inter-state electron-dynamics as the force is involved first. Graphite-, nanotube- and fullerene-state atoms 'partially evolve 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 balance force exerting along the poles. The graphite structure under only attained-dynamics of atoms can also be formed but in two-dimension. Here, binding energy between graphite-state carbon atoms is for a small difference of exerting forces along their opposite poles. Structural formation in diamond, lonsdaleite and graphene atoms involve energy to gain required infinitesimal displacements of electrons through which they maintain orientationally-controlled exerting forces along dedicated poles. In this study, the growth of diamond is found to be south to east-west (ground) where atoms bound ground to south. Thus, diamond atoms merge for a tetra-electron ground to south topological structure. Lonsdaleite atoms merge for a bi-electron ground to just-south topological

structure. The growth of graphene is found to be north to ground where atoms bound ground to north. Thus, graphene atoms merge for 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-energy behaviors of different state carbon atoms. Here, structure evolution in each carbon state atom explores its own science.

Keywords: Carbon; Atomic structure; Electron-dynamics; Potential energy; Force-exertion; Atomic binding

1.0 Introduction

Developing materials of selective size and shape, and investigating their characteristics for various applications, solicit new sort of approaches and observations. The forces appearing at electron-levels should perform the process of structural transitions through engaging the energy and vice versa. The engagement of balance and non-conservative forces for electrons should be responsible to execute partially non-confined and fully non-confined inter-state dynamics of their atoms, respectively. So, energy should involve first to control the forces in their engaging fashions. The atoms of various carbon allotropes are appeared to be the candidates to deal such forces as the available filled and unfilled states are just near to their centers. The force and energy of the atoms are to be considered in partially conserved mode in the former case (force-exertions to electrons are in balance mode) and in the non-conserved (frictional) mode entirely in the latter case (force-exertions to electrons are in non-conservative mode).

Carbon atoms having different states are known as allotropes, i.e., starting from the gas-state carbon atom to graphite-state, then, diamond, lonsdaleite carbon, fullerene followed by nanotube-state, glass carbon, and recently, 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 format solid-natured 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 first rather than the force is expected. In each carbon atom, electrons of outer ring should be considered to execute dynamics where they are close enough to electrons belonging to zeroth ring. A zeroth ring is related to center of an atom, which constitutes four electrons. So, electrons of zeroth ring don’t permit force to appear along their side-to-side poles. They should not undertake their transferring mechanism as for the case of electrons of outer ring. An outer ring is a first ring in the case of a carbon atom.

In different state carbon atoms, electrons of the outer ring obey 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 should 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 same numbers of filled and unfilled states are available for their outer ring. But the distance of each electron of the outer ring from the center in carbon atom is different as compared to silicon atom [2]. So, 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 don’t ionize [4]. Understanding the mechanism of forming structure based on the different carbon states rely on same chemistry at the input end. Various spectroscopic analyses of a ‘tiny grains carbon film’ give peaks at different positions indicating different nature of carbon atoms in their formed tiny grains [5]. Depending on the conditions and the techniques involved a source of gas carbon atoms works for the development of different morphology and structure of grains and crystallites [6]. Moreover, different morphology of grains and particles is observed at different chamber pressure identifying the role of arresting energies near to/at substrate with different rate for each resident chamber pressure [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].

So, an approach based on the multidisciplinary point of view may originate understandings of a different atomic structure which could be very different from that 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 them as materials for tomorrow [10]. Developing 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 followed by the development of their large-shaped particles where role of the required atomic nature was also in focus [13]. Different tiny particles followed by large-sized particles were 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 monolayer 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 into work as either effective or defective nanomedicine [17]. Gold particles of unprecedented shapes have been developed under tailored conditions of processing solution [18]. Hard coating of certain gas- and solid-natured atoms developed because of their established transitional force-energy behaviors [19].

Atoms of different elements along with their structures should be 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 same element but indicate a very different behavior while performing [5-8]. This indicates that the transition of electrons within designated states to nearby unfilled state (within the same ring) change the chemical nature of atom resulting into a new state of physical phenomenon. In gas- and solid-natured atoms of suitable elements, transitions of electrons can’t 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

to ground surface (south-pole) is different as compared to force at/near 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 at 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 namely, 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 as 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 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-leveled ground surface, as in atoms of semi-solids, the dominating force is considered because of surface-format. A detail study is presented discussing the evolution of structures in different formats for atoms involved 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 at their surfaces and they deal uncertainty in the measurements of their temperature [34]. This led to the removal of the 'uncertainty in temperature measurement' of levitated nanodiamond, which is paving the way forward to consider valuable applications [35]. However, different emerged and emerging applications of carbon-based materials lack the basic understanding of structures.

Bindings of atoms in different state show that their mechanism to form structures remains challenging since the discovery. Only partial information on the formation of graphite structure is available. 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, in a successive manner, 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 formations of their structures.

2.0 Results and discussion

The lattice of a carbon atom; Figure 1 (a) shows 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 wavelength of current when inter-crossed by keeping their common-centre, 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 resulting into freeze (jam) the element of force. A photon constitutes both the element of force and energy [1]. Along north-south axes, those two pairs of photons having characteristic of current when inter-crossed at the same centre, they compress two states (energy knots) of their opposite sides by means of already inter-crossed double-pair of overt-photons along east-west poles. This results into 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-centre. Among these twelve states, central four are related to zeroth ring while the outer ring of eight sites form

the first ring. In the outer ring, four states are remained fill 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), a 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].

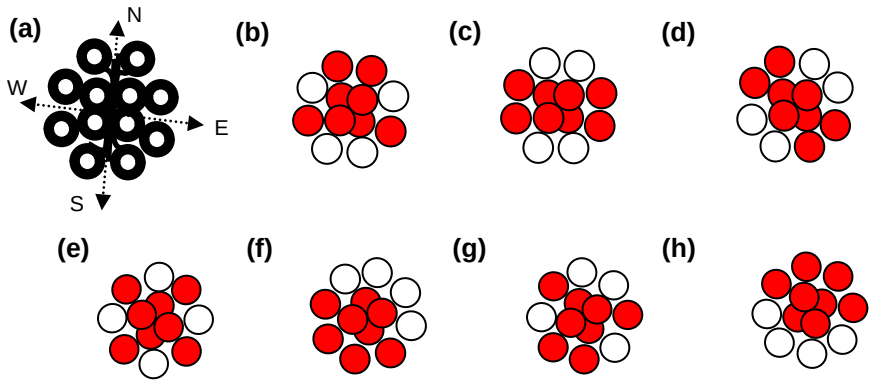

Figure 1: (a) lattice of a carbon atom, atomic structure of carbon atom when in (b) gas-state, (c) graphite-state, (d) nanotube-state, (e) fullerene-state, (f) diamond-state, (g) lonsdaleite-state and (h) graphene-state; red colored circles indicate filled states, white colored circles indicate unfilled states and black colored rings indicate clamping energy knots to states; drawn 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 relevant poles of electrons are remained in balance. Thus, a transferring electron obeys 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 to east-west poles (central line) in gas-state carbon atom, three pairs of energy plot have shape-like parabola involved, which results to convert it into a diamond-state carbon atom. The applied forces to relevant poles of electrons for transfer to dedicated states of an atom remain in balance.

When gas-state carbon atom converts into graphite, it is under the availability of energy shape-like parabola where certain electron of left-side and right-side are transferred by the balance behaviors of forces applied for 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. So, an energy plot having parabola like shape along west to south and an energy curve-like parabola along east to south are involved. Here, the exerting forces for those electrons remained under the balance behavior. But, exerted forces for transferring of electrons are related to surface-format and grounded-format. In 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 becomes further below to ground surface as compared to 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 into ground point of the carbon atom to become fully grounded. This gives the diamond-state carbon atom. Thus, the transferred electron undertakes the maximum potential energy where clamped energy knots to electrons possess the maximum expansion also.

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, for transferring a filled state electron to nearby unfilled state, in each case, becomes almost equal. Thus, energy shape-like parabola regulates it for the entire trajectory forming between filled to nearby unfilled state. So, the relevant forces influence under the balance behavior while transferring 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 converts it into fullerene-state carbon atom. A gas-state carbon atom converts into nanotube-state carbon atom. But, a fullerene-state atom can be converted directly into nanotube-state under the supply of two unit-energy shape-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 shape-like a parabola trajectory having a different number. Here, the exerting forces to electrons do not experience unbalances for them while obeying 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 electron state. Depending on the electrons-attained positions in their carbon 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 transfer of an electron where it obeys the trajectory of that energy having shape-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 shape-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 balance behavior of applied forces as its shape and connection between states are not affected. The applied balance behavior of forces in binding atoms in graphite remain along the same axis as shown in Figure 2 (a), thus, developing 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 to convert them into structures of smooth elements [5].

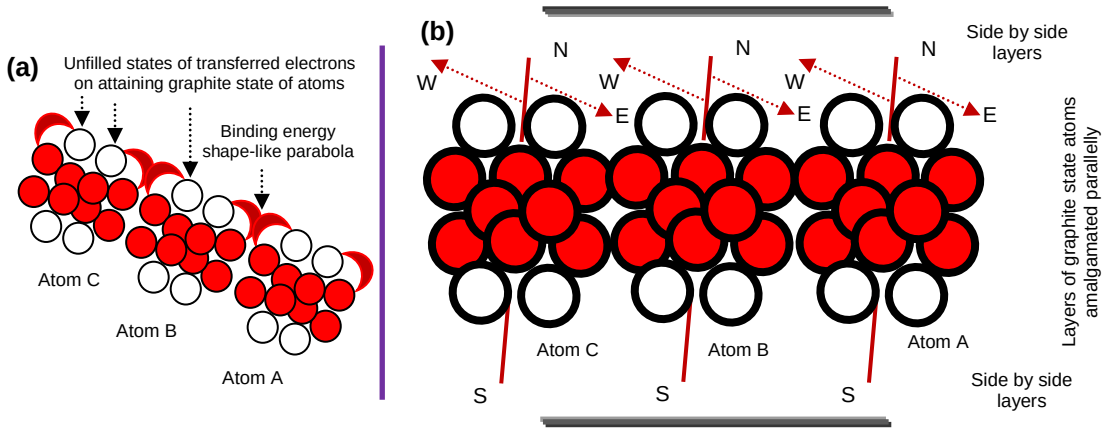

Figure 2: Structure formation in graphite-state atoms (a) when executing electron-dynamics under suitable amalgamation, they form a one-dimensional structure and where (b) amalgamated atoms engaged forces only under the attained dynamics, they form a two-dimensional structure

When atoms amalgamated 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 like energy curve remains no more involved in binding graphite-state carbon atoms. Based on the slight difference in exerting east-west forces at point of amalgamated two graphite-state atoms to central one, they remain bound only under attained-dynamics, Figure 2 (b). When identical layers of graphite-state atoms are 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 don't work for an appreciable difference to allow binding of graphite-state carbon atoms, they also don't allow atoms to go away from each other. Under the opposite poles' forces of east-west, graphite-state carbon atoms adjust along both directions of X-axis where they amalgamate adjacently.

A nanotube-state carbon atom, converted from the fullerene-state carbon atom prior for assembling, is under the balance forces while transferring electrons. Therefore, transferring electrons for each unfilled state is also under the involved energy shape-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 balance 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, 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 balance behavior of exerting forces to electron in surface-format and space-format for one quadrant. The balance behavior of exerting forces to electron in surface-format and grounded-format is for the opposite quadrant. The energy shape-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 at both sides, 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 shape-like parabola for all four quadrants, where transferring electron of each quadrant engages a balance behavior of exerting forces along relevant poles. Here, a contribution of applied balance force in space-format along with surface-format for two quadrants is to be considered. And a contribution of applied balance force in grounded-format along with surface-format for two quadrants is also to be considered. A characteristic energy shape-like parabola while binding of 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 to form fullerene structure for all four quadrants of nearly plane surface forming angle either at nearly mid of each quadrant or at nearly along north-south poles and east-west poles. A fullerene-state carbon atom converts from the nanotube-state carbon atom before assembling, where exerting forces along relevant poles of electrons, at the time of transferring, remain in balance. In the fullerene-state carbon atom, upper-sided transferred electrons engage the balance exertion of forces in space-format and surface-format, while lower-sided transferred electrons engage the balance exertion of forces in grounded-format and surface-format. Here, a balance force is a force neither fully conservative nor fully non-conservative.

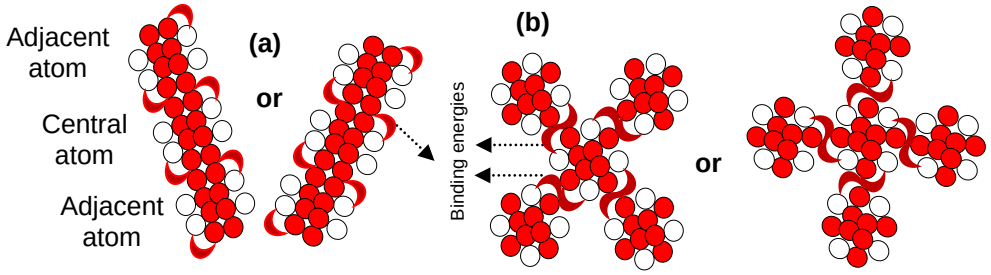

Figure 3: (a) nanotube structure – a two-dimensional structure where the involved energy shape-like parabola in opposite quadrants of targeted atom binds amalgamated atoms at left-side and right-side and (b) fullerene (buckyballs) – a four-dimensional structure where the energy shape-like parabola involved in each quadrant of targeted atom binds four amalgamated atoms

A lonsdaleite-state carbon atom having ground point just below ground surface is shown in Figure 4 (a). It approaches to bind to the diamond-state atom once it is converted into a diamond-state atom. A diamond-state atom, which has already attained ground point at 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 shown in Figure 4 (a). In the nucleation of synthetic diamond, a deposited atom is at highly-heated scratched-seeded surface of solid which doesn't allow it further to attempt gravitation behavior of electrons. This is because of having their maximum potential energy under orientationally-controlled exerting forces of fixed poles. Therefore, no more expansion of their clamped-energy-knots takes place. So, those electrons don't intrude further their resting surface even to the extent of size (mass) of an electron, resulting to maintain the diamond-state of their atom. Thus, the diamond-state carbon atom shows solid behavior at maximum extent. Therefore, the ground point of diamond-state carbon atom is at sufficiently below ground point of lonsdaleite-state carbon atom, which is a bit below to 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 expansion of clamped energy knots also comes to the maximum extent. The resulting energy against the work done 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 centre, resulting in lower amount of potential energy. Hence, the clamping energy knots are in lesser expansion.

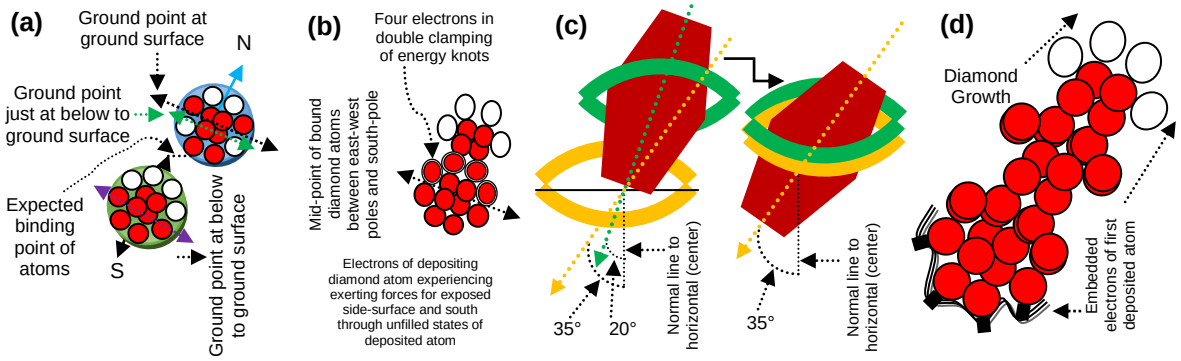

Figure 4: (a) ground points of lonsdaleite- and diamond-state carbon atoms along with the expected binding point of two diamond-state carbon atoms, (b) depositing diamond-state carbon atom when four electrons of outer ring undertake double clamping of energy knots under experiencing the forces of side-surfaces (east-west poles) and south-poles where they 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

On the transfer of left two electrons to downward-side unfilled states, lonsdaleite-state carbon atom is converted to 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 should be anticipated as experiencing orientationally-controlled exerting forces (in surface-format and grounded-format) along the relevant poles. This results in undertaking of 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 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. So, 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 centre (270°+20° = 290°). Hence, 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 relevant poles in lonsdaleite-state carbon atom and diamond-state carbon atom from their normal line drawn at the center are shown in Figure 4 (c). When electron of diamond-atom undertakes double clamping of energy knot to bind another diamond-atom is also shown, separately at 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 on converting from 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 of depositing (binding) a new diamond-atom to already deposited diamond-atom. 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 being detained by the unfilled states of first deposited atom. A double clamping to electrons becomes apprehend on adjusting the expansion-contraction of the ‘energy knot nets’ of two atoms. This came into force prior to bind with third diamond-state carbon atom. This can be

referred as the nucleation stage of diamond. Depositing the third diamond-state carbon atom, by locating a new point of binding with respect to already bound two deposited diamond-state carbon atoms, starts 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 force-exertion along the outer-sided pole (left-side electron west-pole and right-side electron east-pole) equal to the force-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. So, the mechanism of undertaking double clamp of energy knot by each electron is by the inner two electrons, following by 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 instant of clamping another energy knot. The clamping of (another) energy knot is for the half-length to that electron when reached inside to hollow region by undertaking the frictional (non-conservative) forces of various sections of infinitesimal displacements. Only the force exerts along one-pole having surface-format (exposed side-surface) and, similarly, only the force exerts along south-pole having grounded-format to undertake double clamping of energy knot. Both energy knots clamped by each electron expanded under disappeared exertion of one-pole force in surface-format and north-pole force in space-format are shown in Figure 5.

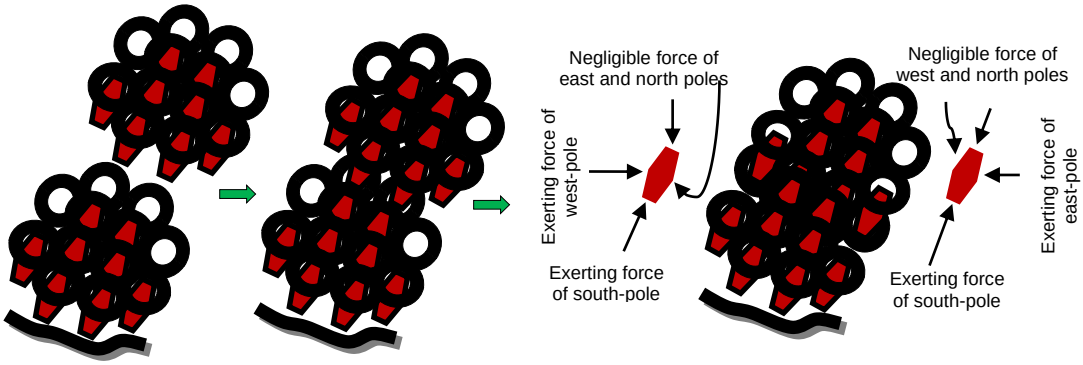

Figure 5: Binding of depositing diamond-state carbon atom to the rooted diamond-state carbon atom along with exertion of forces to the exposed sides of left-side electron and right-side electron

The mechanism of binding lonsdaleite-state atoms is identical to that of the case 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 just-south, but growth behavior is just-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 south-pole, left- and right-sides.

The ground point of graphene-state atom doesn't lie at ground surface but lies just above ground surface. Therefore, carbon atoms when in graphene-state undertake contraction of clamping energy knots while exerting force to electrons. Here, the levitation 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 just-north. So, the growth of graphene is north to ground. This is the reason why graphene structure is based to only 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 as for diamond.

One more physical behavior of the carbon atom is resulted 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. Force-exertions to electrons along their relevant poles in the atoms are being orientated (engaged) through the involved energies. So, coordination between energy and force of dedicated electrons and unfilled states bind their atoms of layers to form structure 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 paired unfilled states belonging to graphite-atoms (from the rear-side). Gas-state carbon atoms attempt forcefully the gravitation 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 paired unfilled states belonging to graphite-atoms (from the front-side). Lonsdaleite-state carbon atoms attempt forcefully levitation 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-contraction of bound layers of atoms as shown in Figure 6.

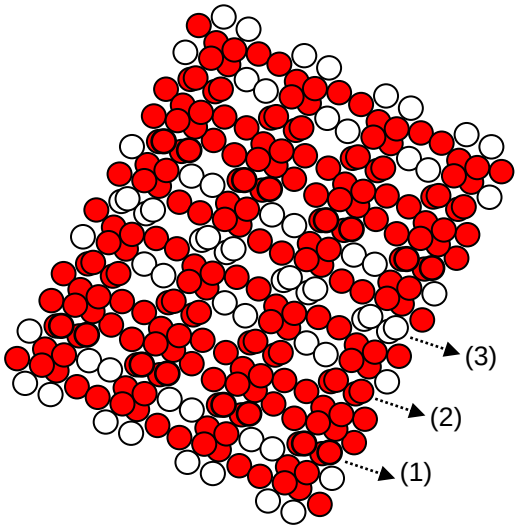

Figure 6: Structure formation of glassy carbon where tri-layers of gas-, graphite- and lonsdaleite-state carbon atoms respectively bind in the successive manner; (1) paired electrons of each atom (belonging to gas-state carbon atoms layer) undertake double clamping of paired energy knots of each atom (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

To originate the different physical behavior of each state carbon atom, non-conserved energies involve engaging non-conservative forces. A carbon atom where two electrons of outer ring occupy states at left- and right-sides of north-pole and remaining two electrons of outer ring occupy states at just below the line of east-west poles, it is related to gas state. In the carbon atom, when two electrons of outer ring retain positions in the states available at just above the line of east-west poles and two electrons of outer ring retain positions in the states available at just below to that line, it is related to graphite state. The involved energies to form structures (in surface-format) are in their non-conservation. They are the sub-parts (fractions) of conserved (discrete) force-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 involves engaging 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 electrons of atoms of above lonsdaleite layer and below gas layer enter from the front-side and rear-side, respectively, to orientationally-controlled pairs of unfilled states of atoms of intermediate graphite layer to 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 engage. However, wherever the conservative forces involve addressing the dynamics of electrons in certain-natured atoms, they engage the conserved energy as well. As in the case of neutral-state silicon atom where, a filled state electron is transferred to nearby unfilled state under the exertion of conservative forces where 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 force-energy behavior is being considered for that atom.

Different state carbon atoms develop amorphous structures when binding for frustrating and miscellaneous amalgamations. They and their tiny buds mix to 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-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-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 can’t 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 states 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 evolution of 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].

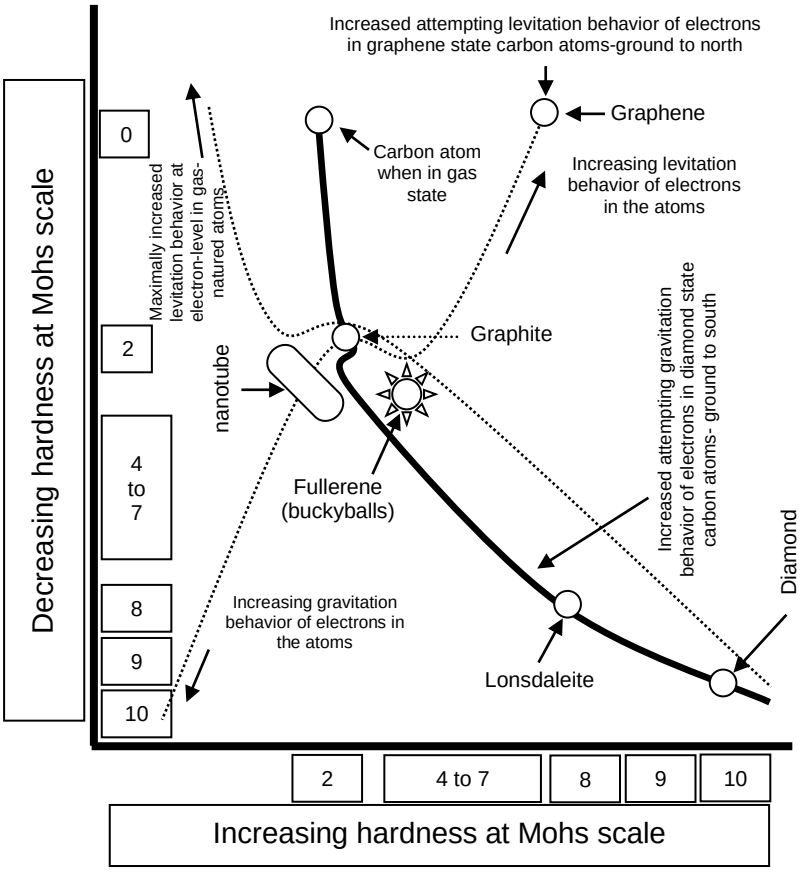

Figure 7: A sketch of approximately estimated hardness (at Mohs scale) of nanoscale structure in different states carbon atoms versus exerting levitational-gravitational force at electron-levels

3.0 Conclusions

An energy shape-like a parabola trajectory, which is also in the shape of built-in gauge of electron-dynamics of a carbon atom, enables transferring of an electron to suitable nearby unfilled state. At once transfer of electrons (suitable) of left-side and right-side of atom to occupy nearby unfilled states (suitable), that atom maintains the equilibrium of attained 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 centre of atom. A carbon atom where electrons of the outer ring retain positions in the states at below the line of east-west poles, it is related to diamond state.

When structure of graphite-state carbon atoms in two-dimension, it is under the significant attained-dynamics only where difference in opposite pole forces between suitably amalgamated atoms form the structure. Forces, if they do not restrict them to bind under the harvested energies, at least, they also do not keep them from separating. Amalgamated atoms remain bound under attained dynamics only.

There is an exertion of balance forces along the poles of electrons in structural formation of one-dimensional graphite, two-dimensional nanotube and four-dimensional fullerene. The exertion of balance forces is mainly taken 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 are ground to south, but growth is south to ground. So, it is a tetra-electron ground to south topological structure. Bindings of lonsdaleite atoms are ground to just-south, so it is a bi-electron ground to just-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 relevant poles while occupying space- and surface-formats instead of occupying surface- and grounded-formats as for lonsdaleite-and diamond atoms. So, 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 are entered from the rear-side (bottom) in the case of layer of gas-state carbon atoms and from the front-side (top)

in the case of layer of lonsdaleite-state carbon atoms. Binding atoms of each layer of lonsdaleite-state to atoms of each layer of graphite-state is under attempting forcefully levitation behavior of electrons. This is because of decreased (lost) potential energy of electrons in each lonsdaleite-state carbon atom. So, 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 atoms of each layer of graphite-state is because of the forcefully gravitation behavior of electrons where, because of their increased (gained) potential energy, they result into undertake 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 fully 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 for structure formation in atoms of glassy carbon where the level of frictional forces for electrons is exceeded.

Force and energy work by 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 internal (inner) source is force, for example, different kind of photons where force is attempting to leave the covered energy at the point of their generated end. When force is the external (outer) source, then, internal (inner) source is energy, for example, in all sorts of electron-dynamics (conserved, partially conserved and non-conserved). In either way, these coordinate each other under the established nature to function properly. The matter remains as the intermediate component identifying the functioning of force and energy.

Each state carbon atom elaborates its own science and, so, in binding of different states 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 force-energy behaviors of atoms of different elements, designing of new materials and light-matter interactions.

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