

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 carbon element. These studies include different opinions for scientific problems and discuss various levels within the scope and application. Originally, a carbon atom converts for various states depending on the conditions of processing its precursors or compounds. The electron transfer mechanism is responsible for converting the gas 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 (suitable filled and unfilled states), where forcing exertion along the poles of transferring electrons is remained balance or impartial. 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 in conserved manner is involved first. Graphite, nanotube and fullerene state atoms partially evolve partially develop (form) structures. These possess one-dimensional, two-dimensional and four-dimensional ordering of atoms respectively. Atoms of their structural formation involves 'energy curve' having a shape like parabola while transferring of suitable filled state electron to suitable nearby unfilled state. Their structural formation deal with a balanced exertion of force engaged for the poles of relevant electrons. The graphite structure under attained dynamics of atoms only can also be formed but in a two-dimensional order. Here, binding energy between graphite atoms is due to a small difference of exerting forces to their opposite poles. Structural formation in diamond, lonsdaleite and graphene atoms involves energy to gain required infinitesimal displacements of electrons. Through the involved energy, orientationally exerting forces along the dedicated poles of relevant electrons in their atoms are engaged. 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. Structure of each state carbon atom explores own science. Based on the carbon structure, hardness (at Mohs scale) of nanoscale components is also sketched.

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

1. Introduction

Developing materials of selective size and shape, and investigating their characteristics for various applications, solicit new approaches and observations. Exertion of forces when involved at electron level should engage the energy at electron level as well. Engaging partially conservative (balanced) forces or non-conservative forces should be considered responsible to execute partially confined inter-state electron dynamics or non-confined inter-state electron dynamics of atoms respectively. Here, such atoms should not execute confined inter-state electron dynamics as their electrons do not address conservative forces. In such atoms, 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. Such atoms appear not providing room to electrons of outer rings to deal with conservative forces. The relation of energy and force for such atoms should be anticipated either in partially conserved or in non-conserved 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 in grounded format 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. 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 should be the first ring in the case of a carbon atom.

In different state carbon atoms, electrons of the outer ring should follow transfer mechanism because of the uncovered sides of filled 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 unfilled states are available for their outer ring. However, the distance of each electron of the outer ring from the centre 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 execute confined inter-state electron dynamics to evolve structures in different formats [3].

It is pertinent that atoms belonging to any element do not ionize [4]. Understanding the mechanism of forming structure in 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].

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 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 forced behavior [19].

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.

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 their 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 through inter-state dynamics 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 centre of atoms is related to zero-force axis as it is declared the common point of inter-crossed overt photons forming their energy knot nets [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 of 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 measurement of their temperature [34]. This leads to the removal of the 'uncertainty in temperature measurement' of levitated nanodiamond, which paves the way for considering valuable applications [35]. However, already emerged and emerging different applications of carbon-based materials seriously lack the basic understanding of their science.

The cause of structural formation in different state carbon atoms has remained elusive. Bindings of atoms in different states show that their mechanism to form structures remains challenging since their discovery. Additionally, the formation of layer-based structure comprising a different state of atoms (for each layer) remains challenging. Here, atomic structure of different state carbon atoms along with their structural formation is studied. This study describes the science of originating different carbon states and formation of their structures. Although, a structure of glassy carbon 'forms' under the availability of extreme frictional forces but these engaged in highly ordered manner, are also discussed here.

2. Results and Discussion

The lattice (energy knot net) of a carbon atom in Figure 1 (a) displays four unfilled states (energy knots) at the centre which are related to the zeroth ring, whereas eight unfilled states (energy knots) around the zeroth ring are related to outer ring (first ring). Energy knots of filled and unfilled states are designed on precise inter-crossing of the overt photons. They are equal in lengths. The lengths of overt photons are in such a manner, on schedule crossing, design filled and unfilled states required for the energy knot net of a carbon atom. Two pairs of overt photons having characteristic of current inter-cross by keeping their common centre and eight states of electrons are designed which are related to the eight hollow regions. In crossing overt photons, the trough of one is in front of the crest of other that results in freezing 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 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 design 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 designs the first ring. In the outer ring, four states remained filled and four vacant. This order provides the option to originate six different state behavior 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 in carbon atom; in (c) graphite state, (d) nanotube state, (e) fullerene state, (f) diamond state, (g) lonsdaleite state and (h) graphene state are shown. In each state carbon atom, the central four electrons form the zeroth ring. It is termed as nucleus, which is related to helium atom [2].

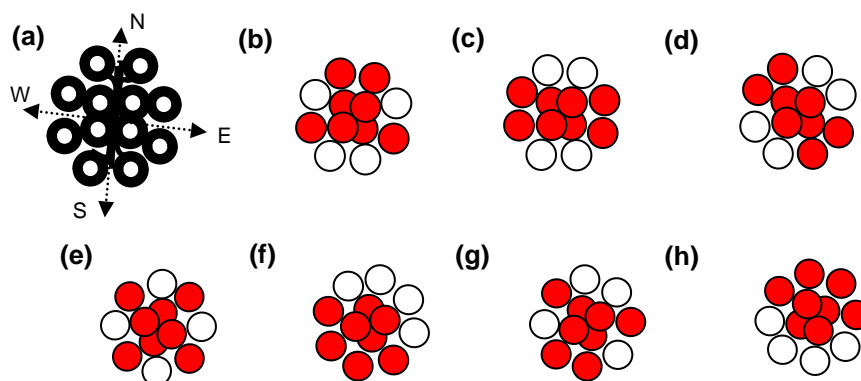


Figure 1: (a) lattice (energy knot net) of a carbon atom, atomic structure of carbon atom when in (b) gas state, (c) graphite state, (d) nanotube state, (e) fullerene state, (f) diamond state, (g) lonsdaleite state and (h) graphene state; red colored circles indicate filled states, white colored circles 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 to originate a new state of carbon atom. As a result, energy having shape like built-in gauge of inter-state electron dynamics is involved, where engaged forces along the poles of electrons remain in balance. Here, a balanced force infers that exerting forces to electron of transferring does not let it allow dropping. It keeps bound to the electron to follow the trajectory of linked energy knot between filled and unfilled states till occupying unfilled state. An involved typical energy provides clear path to electron to

transfer from energy knot of filled state to energy knot of unfilled state. 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 carbon atom into graphite state. On transferring all four electrons of outer ring to unfilled states available below the east-west poles (central line), a gas carbon atom converts into diamond state. To originate a new state, each time the role of engaged force along the poles of transferring dedicated electrons is remained balance.

When a gas carbon atom converts into graphite state, it is by the involved energy shaped like parabola, where engaged forces for relevant electrons are remained balance in exertion. The engaged forces are mainly related to surface format and space format. These forces are remained balance in exertion at the instant of transferring the relevant electrons through the path provided by the linked energy shaped like parabola. Transferring required electrons in graphite atom to convert into lonsdaleite atom, parabola shaped energy plot along the west to south and an energy plot with the same shape along the east to south are involved. Exerting forces for those electrons remain in their balanced behavior. Here, exerted forces for transferring of electrons are related to surface format and grounded format. During the conversion of graphite atom into lonsdaleite atom, only two electrons are transferred to dedicated states. For conversion of lonsdaleite atom into diamond atom, two electrons are further transferred to dedicated states. At that instant, ground point of the diamond atom goes further below the ground surface as compared to the lonsdaleite atom. Transfer of all four electrons of outer ring towards south-pole (two from the left side and two from the right side of atom) results in the ground point of the carbon atom to become fully grounded originating the diamond atom. Thus, the transferred electrons are in the maximum potential energy, where clamped energy knots to them possess the maximum expansion, too.

The cause of engaged forces exerting along the relevant poles of electrons to originate any state of carbon atom is due to the very small distance of outer ring from the centre of carbon atom. Thus, involved energy shaped like parabola enables electron to migrate for a new state in the atom. 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 energy. Therefore, the carbon atom originates a new behavior under the attained state of equilibrium. A gas carbon atom converts into nanotube and fullerene atoms, where involved energy and

engaged force for transferring electrons to their dedicated states behave in the same manner as for the case of originating other states. A graphite atom is converted into diamond, lonsdaleite and graphene atom by involving the energy shaped like a parabola trajectory and engaging the balanced exertion of force for each transferring electron. Energy knots designing the unfilled and filled states of the carbon atom expand or contract to different extent depending on the position of electrons belonging to the outer ring in each state atom.

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 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 atoms are bound adjacently along the same axis. However, the energy 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 impartial. 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. The engaged 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 inter-state electron dynamics of atoms, their binding remains along the single direction of X-axis. So, under the execution of electron dynamics, graphite atoms form one-dimensional structure which is in the single direction of opposite side of X-axis. In tiny grain carbon film, atoms of arrays elongate by the exertion of forces, where they convert them into the structures of smooth elements [5].

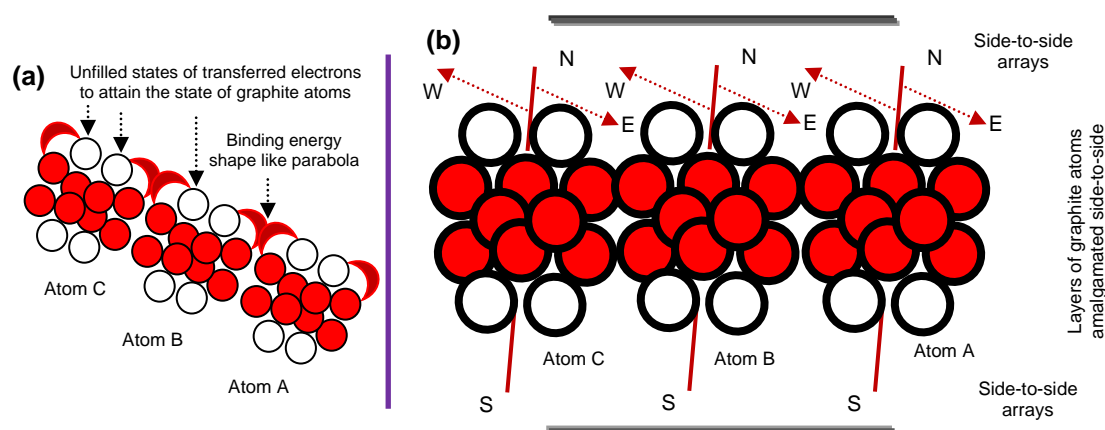


Figure 2: Structure formation in graphite when amalgamated atoms (a) executed inter-state electron dynamics and (b) engaged weak forces by attained dynamics; drawing is shown in estimation

When atoms amalgamate under preserving the behavior of graphite state, they only bind under the attained dynamics to form structure. They do not execute partially confined inter-state electron dynamics and graphite structure of two-dimensional is formed. The typical parabola shaped energy curve remains no more involved in binding graphite atoms. Based on the slight difference in exerting east and west forces at the point of amalgamation of two graphite atoms to central one, they remain bound only under attained dynamics as shown in Figure 2 (b). When identical layers of side-to-side adhered (by weak forces) graphite atoms formed in repeated manner, they translate the geometry of two-dimensional structure. Even though existing forces of opposite poles of atoms do not work for an appreciable difference to allow binding of graphite atoms, they also do not allow atoms to go away from each other. Under the forces of east-west poles, graphite atoms adjust unidirectionally, where they amalgamate only under attained dynamics.

A nanotube atom converted from the fullerene atom prior to assembling. 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. Nanotube atoms form structure based on the involvement of binding energy attaining their state along with engagement of balanced exertion at the instance of amalgamating as shown in Figure 3 (a). Here, a fullerene atom converts into a nanotube 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 engaged balanced force in space format along with surface format for two quadrants is considered. Furthermore, the contribution of 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 atoms is four-dimensional. Binding of fullerene 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 atom converts into the nanotube atom before assembling, where exerting forces along the relevant poles of electrons at the time of transferring remain in balance. In the fullerene 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.

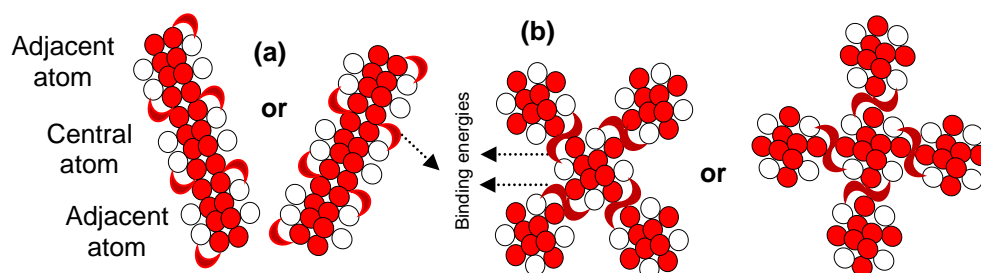


Figure 3: (a) nanotube structure – a two-dimensional structure, where the involved energy in opposite quadrants of targeted atom binds amalgamated atoms on left side and right side and (b)

fullerene (buckyballs) – a four-dimensional structure, where the energy involved in each quadrant of targeted atom binds four amalgamated atoms; drawing is shown in estimation

A lonsdaleite atom having ground point just below the typical level of ground surface is shown in Figure 4 (a). It approaches to bind the diamond atom once it is converted into a diamond 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 attaining the diamond state of their atom. Thus, the diamond atom shows solid behavior at maximum extent. Moreover, the ground point of diamond atom is sufficiently below the typical level ground point of lonsdaleite atom, which is a bit below the typical level of ground surface. In this context, lonsdaleite atom is in less expansion of clamped energy knots to filled and unfilled states designing energy knot net as compared to ones in diamond 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.

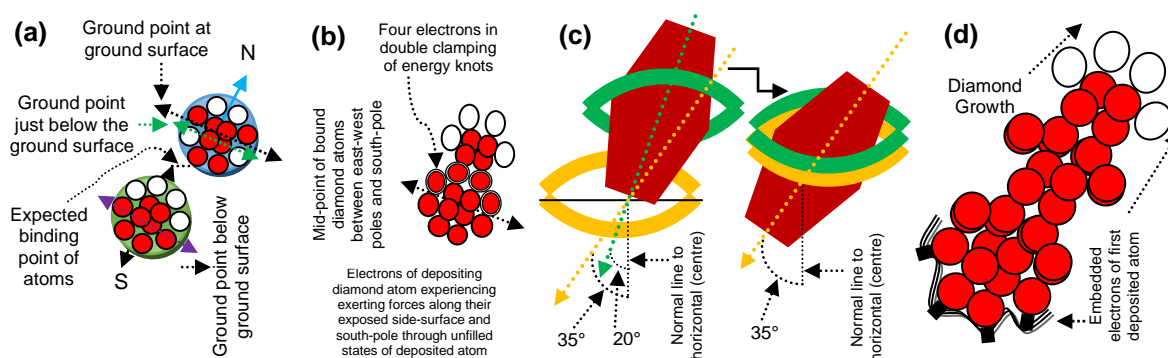


Figure 4: (a) ground points of lonsdaleite and diamond atoms, (b) depositing diamond atom (to deposited diamond atom) when four electrons of outer ring experiencing the forces of side surfaces (east and west poles) and south poles, (c) orientation of an electron in lonsdaleite atom before converting into diamond atom and orientation of an electron in diamond 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

The ground point of lonsdaleite atom is just below the typical level of ground surface because it is underneath the ground point of graphite atom. In diamond 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 atom dissipates, enabling the expansion of clamped energy knots to the maximum extent. Electrons of lonsdaleite 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.

On the transfer of two electrons from left to downward side unfilled states, lonsdaleite atom is converted into the diamond atom. Clamped energy knots to electrons of that converted diamond atom also undertake the same level of expansion as in the case of targeted (deposited) diamond atom. On depositing diamond atom to deposited diamond atom, a controlled expansion in energy knots clamped electrons is occurred. So, the electrons (of depositing atom) also experience orientationally controlled exerting forces (in surface format and grounded format) along the relevant poles. Here, each filled state electron (of outer ring of depositing diamond atom) undertakes another clamping of energy knot of each unfilled state (of outer ring of deposited diamond atom). At this node, electrons of depositing atom experienced the required orientationally controlled exerting forces along their relevant poles as rightly orientated for the unfilled states of deposited diamond atom. Electrons of filled states in outer ring of depositing diamond atom undertook one additional clamp of energy knot belonging to unfilled states of outer ring in deposited diamond atom, resulting in their binding as shown in Figure 4 (b). Binding diamond atoms adjust and compensate expansion/contraction of their energy knot nets. This way, they construct a new binding point for the following depositing diamond atom.

Lonsdaleite atom undertakes less expansion of energy knots clamping electrons and vacant sites as compared to the diamond atom. Therefore, a lonsdaleite atom is more related to the recovery state of an atom, where orientation of exerting force to each electron clamped by energy knot becomes $\sim 20^\circ$ angle from the normal line drawn from its centre ($270^\circ + 20^\circ = 290^\circ$). Further, in diamond atom, expansion of

clamped energy knot to electron takes place under the exertion of forces along the relevant poles at $\sim 35^\circ$ angle from the normal line drawn from its centre ($270^\circ + 35^\circ = 305^\circ$). The angles of exerting forces to electrons along the relevant poles in lonsdaleite atom and diamond atom from their normal line drawn at the centre 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 atoms is shown in Figure 4 (d). The binding of diamond atoms remained in progress under the same mechanism for the conversion of gas carbon atoms. Here, diamond atoms adjust and compensate contraction and expansion of their energy knot nets (and clamping energy knots to their electrons). This adjustment of energy knot nets 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 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 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 atom. This can be referred to as the nucleation stage of diamond. Depositing the third diamond atom and locating a new point of binding with respect to already bound two deposited diamond atoms initiate the growth process of diamond as shown in Figure 4 (d).

When the depositing diamond atom is precisely over the deposited diamond 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 due to 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.

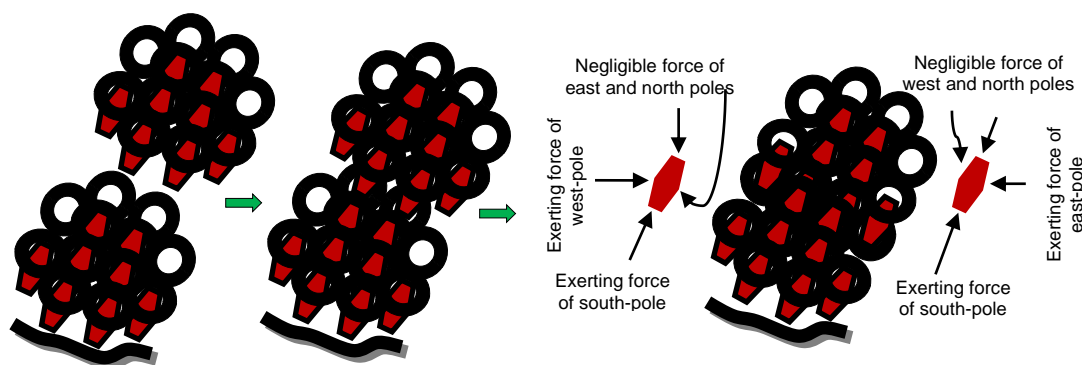


Figure 5: Binding of depositing diamond atom to the rooted diamond atom along with exertion of forces to the exposed sides of left-side and right-side electrons; drawing is shown in estimation

The mechanism of binding lonsdaleite atoms is identical to that of binding diamond atoms. However, only two oriented ($\sim 290^\circ$) electrons of lonsdaleite atom clamp another clamping of energy knot belonging to deposited lonsdaleite 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 atoms is ground to a bit south, but growth behavior is a bit south to ground. The involved characteristic energy to convert gas carbon atom into lonsdaleite atom is in the same shape as for the diamond 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 atom does not lie on the ground surface but lies just above the typical level of 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 atoms bears exerting forces in surface format and space format. Thus, binding of graphene 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 of the one required for diamond.

As shown in Figure 6, one more physical behavior of the carbon atom is available, where successive layers of three different states of carbon atoms bind in repetitive manner, i.e., gas, graphite and lonsdaleite atoms in successive manner. Forced exertions to electrons along relevant poles in their 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 atoms bind under the joint application of exerting forces in grounded format and surface format. Here, orientationally controlled paired electrons of gas carbon atoms undertake double clamping of energy knots of paired 'unfilled states', from the rear side, belonging to graphite atoms. Gas carbon atoms attempt forcefully the gravitational behavior under increased potential energy of their electrons. Layers of lonsdaleite atoms and graphite 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', from the front side, belonging to graphite atoms. Lonsdaleite atoms attempt forcefully levitational behavior under decreased potential energy of their electrons. Layers of lonsdaleite atoms and gas carbon atoms provide compensation in terms of expansion and contraction of atoms of bound layers as shown in Figure 6.

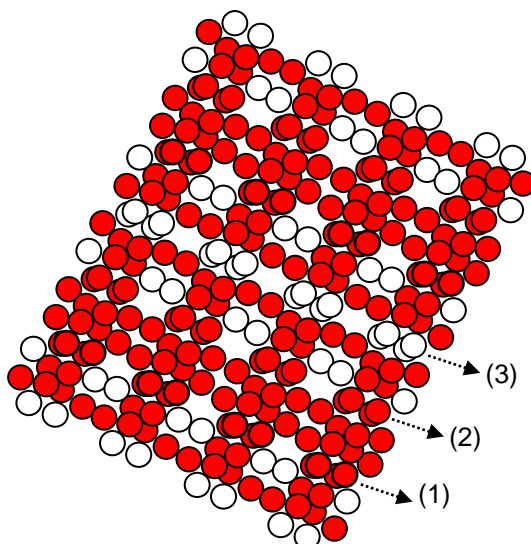


Figure 6: Structure formation of glassy carbon, where tri-layers of gas, graphite and lonsdaleite state carbon atoms respectively bind in the successive manner; (1) paired electrons of each atom (belonging to gas carbon atoms layer) undertake double clamping of paired energy knots of each atom (belonging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

To form structures of carbon atoms in graphite, nanotube and fullerene states, typical energy of non-conservation shaped like parabola trajectory engages forces of partially conservative behaviors. 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. Similarly, in the case of nanotube and fullerene atoms, they involved energies to form structures while engaging the forces for dedicated electrons mainly in the surface format. Both energy and force are under their partial conservation behaviors. An involved typical energy for the formation of graphite, nanotube and fullerene structures is a diligently cut-portion of unit photon, which is in the shape of parabola trajectory. A unit photon has shape like a 'Gaussian distribution of both ends turned' [1].

A gas carbon atom converts for diamond, lonsdaleite and graphene states also involves a typical energy shaped like a parabola trajectory, where behavior of the

engaged forces is also remained impartial. However, in the structural formations of carbon atoms in diamond, lonsdaleite and graphene states, involved transitional energy controls potential energy of their dedicated electrons. Here, orientational forces at electron level are engaged to control orientation of those dedicated electrons. So, structure formation in atoms of diamond, lonsdaleite and graphene states is under the engagement of fully non-conservative behaviors of forces. On suitable coincide of such state carbon atoms, each dedicated electron, which engages orientationally controlled exerting force according to involved transitional energy of atom, deals with another clamping of dedicated energy knot. However, in the structure formation of glassy carbon, a pair of electrons controlling orientation orientationally in atoms of lonsdaleite layer (above) and in atoms of gas layer (below) enter from the front side and rear side respectively to pairs of unfilled states available at above- and below-sides in atoms of graphite layer (intermediate) to deal with their one more clamping of energy knot.

Transferring electrons of filled states to the unfilled ones in the carbon atom involves the typical energy through which forces get engaged for impartial behavior. A transferring electron stays in occupied state till the adjustment of typical energy between (for two) states. Again, the exertion of force for that electron remains impartial while transferring from its occupied state to suitable nearby unfilled state. So, a balanced force remains in action at the instant of transferring electrons of occupied states at both left-right sides of their atom. This is the same case to originate a new state (graphite, nanotube, fullerene, diamond, lonsdaleite and graphene) of the carbon atom. 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.

However, different modes of exerting forces remain in action for their structure formation. A same mode of engaging force remains in action when structures of one-, two- and four-dimensional are formed. So, structure formation in graphite (1D), nanotube (2D) and fullerene (4D) is under the partially confined inter-state electron dynamics. However, a different is the case in structure formation of diamond,

lonsdaleite and graphene atoms, where they engage the non-conservative forces. The exerting forces at electron levels are under the involvement of non-conserved energies. In case of structure formation of glassy carbon, a highly non-conservative force is to be anticipated.

Carbon atoms of mixed states develop amorphous structures when binding under their unsuitable 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 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.

Hardness (at Mohs scale) of nanoscale components in different state carbon atoms is sketched in Figure 7. The value of hardness cannot be registered when considering the gas state carbon atoms as they do not form the structure, which signifies the hardness at any scale. In the formation of structure of nanoscale components, involving of not conserved energies and engaging either partially conservative or non-conservative forces for different electron dynamics of different state carbon atoms establish different level of hardness. In Raman spectroscopy, different values of wave number printed against energy signals indicate their different characteristics to the photons propagating through photonic band gap (or inter-state electron gap) of graphite structure or other suitable structures of carbon allotropes as also validated by the energy loss spectroscopy [5].

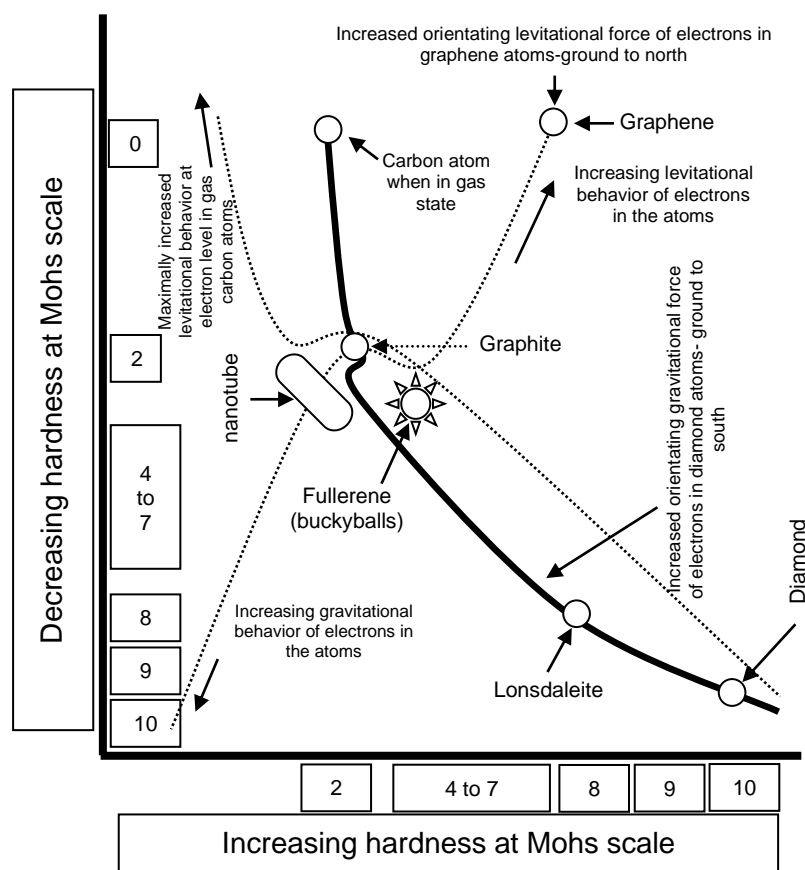


Figure 7: Sketch of estimated hardness (at Mohs scale) of nanoscale components in structure of different states carbon atoms versus engaged levitational and gravitational forces for dedicated electrons

3. Conclusion

Energy shaped like a parabola trajectory, which is also in the shape of arc-length of inter-state electron dynamics in a carbon atom, enables the transfer of an electron to suitable nearby unfilled state. The transfer of suitable electrons of left side and right side of atom to occupy nearby suitable unfilled states 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 as controlled at the centre of atom, so they overlay accordingly while handing over and taking over the electron. A carbon atom is related to the diamond state when all four electrons of the outer ring retain positions in the states below the line of east and west poles.

When structure of graphite 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. However, in case, where binding of graphite state carbon atoms is under the execution of electron dynamics, the formation of structure is one dimensional.

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 when structure evolution is in the surface format. 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 case of topological structural formation of diamond, lonsdaleite and graphene. The gained non-conserved energy for electrons in diamond, lonsdaleite and graphene atoms is triggered to orientationally controlled exerting forces along their relevant poles.

A binding of diamond atoms is from 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 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 case of the layer of gas carbon atoms and from the front side (top) in the case of the layer of lonsdaleite 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 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 atoms is partially under the conserved behavior of energy first and then force, whereas in diamond, lonsdaleite and graphene 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 non-confined inter-state electron dynamics to form their structures. The same is the case with structural formation in atoms of glassy carbon. But layered atoms engage frictional forces for their relevant electrons under the involvement of energy are in the highly ordered manner.

Force and energy work through coordination; when energy is involved, force 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. In either way, these coordinate with each other under the established nature to function properly. So, each originated state carbon atom elaborates own science in the form of conversion and binding.

The carbon atom enables one 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:

- [1] M. Ali, Heat and Photon Energy Phenomena: Dealing with Matter at Atomic and Electronic Levels. (2017)<https://www.preprints.org/manuscript/201701.0028/v10>
- [2] M. Ali, Atoms in Gaseous and Solid States. (2019)
<https://www.researchgate.net/publication/323723379>.

- [3] M. Ali, Structure Evolution in Atoms of Those Elements Executing Confined Inter-State Electron Dynamics. (2019), <http://arxiv.org/abs/1611.01255>.
- [4] M. Ali, Atoms of None of the Elements Ionize While Atoms of Inert Behavior Split by Photonic Current. (2019), <http://arxiv.org/abs/1611.05392>.
- [5] M. Ali, I –N. Lin, Phase transitions and critical phenomena of tiny grains carbon films synthesized in microwave-based vapor deposition system. Surf. Interface Anal. 51 (2019) 389-399.
- [6] M. Ali, M. Ürgen, Switching dynamics of morphology-structure in chemically deposited carbon films -A new insight, Carbon 122 (2017) 653-663.
- [7] M. Ali, M. Ürgen, Deposition of Different Morphology-Structure of Carbon Films under Varying Chamber Pressures. (2019), <https://arxiv.org/abs/1802.00730>.
- [8] M. Ali, M. Ürgen, Simultaneous growth of diamond and nanostructured graphite thin films by hot filament chemical vapor deposition, Solid State Sci. 14 (2012) 150-154.
- [9] S. Link, M. A. El-Sayed, Shape and size dependence of radiative, nonradiative and photothermal properties of gold nanocrystals, Int. Rev. Phys. Chem. 19 (2000) 409- 453.
- [10] S. C. Glotzer, M. J. Solomon, Anisotropy of building blocks and their assembly into complex structures, Nature Mater. 6 (2007) 557-562.
- [11] M. Ali, I –N. Lin, Effects of the Electronic Structure, Phase Transition and Localized Dynamics of Atoms in the Formation of Tiny Particles of Gold, (2019) <http://arXiv.org/abs/1604.07144>.
- [12] M. Ali, I –N. Lin, Development of Gold Tiny Particles and Particles in Different Sizes at Varying Precursor Concentration. (2019), <http://arxiv.org/abs/1604.07508>.
- [13] M. Ali, I –N. Lin, C. -J. Yeh, Tapping Opportunity of Tiny-Shaped Particles and Role of Precursor in Developing Shaped Particles, NANO 13 (7) (2018) 1850073 (16 pages).
- [14] M. Ali, I –N. Lin, Controlling morphology-structure of gold tiny particles, nanoparticles and particles at different pulse rates and pulse polarity, Adv. Nat. Sci: Nanosci. Nanotechnol. 10(2) (2019) 025015 (14pp).
- [15] M. Ali, I –N. Lin, Formation of tiny particles and their extended shapes: origin of physics and chemistry of materials, Appl. Nanosci. 9 (6) (2019) 1367-1382.

- [16] M. Ali, Tiny-Shaped Particles Developing Mono Layer Shape Dealing with Localized Gravity in Solution Surface. (2019), <http://arxiv.org/abs/1609.08047>.
- [17] M. Ali, Nanoparticles-Photons: Effective or Defective Nanomedicine, J. Nanomed. Res. 5 (2018) 241-243.
- [18] M. Ali, I –N. Lin, C. –J. Yeh, Predictor Packing in Developing Unprecedented Shaped Colloidal Particles, NANO 13 (9) (2018) 1850109 (15 pages).
- [19] M. Ali, E. Hamzah, M. R. M. Toff. Hard Coating Deposits: Incompatible Working Energy and Forced Behaviors of Gas and Solid Atoms. (2019) <https://www.preprints.org/manuscript/201802.0040/v10>.
- [20] M. Ali, I –N. Lin. Nucleation and Structural Identification in Gold Particles of High Aspect Ratios through Mechanistic Approach. (2019), <https://www.researchgate.net/publication/329066950>.
- [21] Y. Gao, *et al.*, Ultrahard carbon film from epitaxial two-layer graphene, Nature Nanotechnol. 13 (2018) 133-138.
- [22] J. -B. Wu, M. L. Lin, X. Cong, H. N. Liu, P. H. Tan, Raman spectroscopy of graphene-based materials and its applications in related devices, Chem. Soc. Rev. 47 (2018) 1822-1873
- [23] R. Shoukat, M. I. Khan, Synthesis of vertically aligned carbon nanofibers using inductively coupled plasma-enhanced chemical vapor deposition, Electr. Eng., 100 (2018) 997-1002
- [24] M. S. Cao, *et al.*, Graphene nanohybrids: excellent electromagnetic properties for the absorbing and shielding of electromagnetic waves, J. Mater. Chem. C, 6 (2018) 4586-4602.
- [25] L. Fu, *et al.*, A glassy carbon electrode modified with N-doped carbon dots for improved detection of hydrogen peroxide and paracetamol, Microchimica Acta 185 (2018) 87.
- [26] D. Y. Hu, J. X. Hu, H. L. Jiang, J. Xu, A highly effective energy mitigation system combining carbon nanotube and buckyballs, Eur. Phys. J.-Spec. Top. 127 (2018) 155-166.
- [27] C. P. Hsu, *et al.*, Buckball-, carbon nanotube-, graphite-, and graphene-enhanced dehydrogenation of lithium, Chem. Commun. 49 (2013) 8845-8847.
- [28] C. Y. Chen, *et al.*, Laser writing of coherent colour centres in diamond, Nature Photonics 11 (2017) 77-80.

- [29] Z. Liu, *et al.*, Graphite-graphene architecture stabilizing ultrafine Co_3O_4 nanoparticles for superior oxygen evolution, *Carbon* 140 (2018) 17-23.
- [30] A. Taylor, *et al.*, Precursor gas composition optimisation for large area boron doped nano-crystalline diamond growth by MW-LA-PECVD, *Carbon* 128 (2018) 164-171.
- [31] X. Cheng, W. J. Zong, Anisotropic evolution of damaged carbons of a mechanically polished diamond surface in low-temperature annealing, *Diam. Relat. Mater.* 90 (2018) 7-17.
- [32] M. Maruyama, S. Okada, Geometric and electronic structure of a two-dimensional covalent network of sp^2 and sp^3 carbon atoms, *Diam. Relat. Mater.* 81 (2018) 103-107.
- [33] A. Narjabadifam, F. Vakili-Tahami, M. Zehsaz, Elastic and failure properties of carbon nanocones using molecular dynamics simulation, *Fuller. Nanotub. Carbon Nanostruct.* 26 (2018) 777-789.
- [34] A. T. M. A. Rahman, *et al.*, Burning and graphitization of optically levitated nanodiamonds in vacuum, *Sci. Rep.* 6 (2016) 21633; doi: 10.1038/srep21633.
- [35] A. C. Frangeskou, *et al.*, Pure nanodiamonds for levitated optomechanics in vacuum, *New J. Phys.* 20 (2018) 043016.

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/>