Tiny-Shaped Particles Developing a Mono-Layer Shape Dealing with Localised Gravity and Levity at the Solution Surface

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Abstract: In different solution-based approaches, atoms amalgamate at an electronically flat solution surface. Atoms amalgamate on dissociation from the precursor. The developing tiny-shaped particles form the building blocks of bigger-sized particles. Tiny particles of triangular shape developed when the pulses supplied the nano energy packets. On development, tiny-shaped particles leave the electronically flat solution surface. By entering the electronically decreasing level solution surface, tiny-shaped particles arrive at the center of the concave meniscus. Different approaches supplied the nano energy packets to develop tiny-shaped particles. In a triangular shape tiny particle, atomic arrays convert into structures of smooth elements, where traveling photons along the air-solution interface further flatten them. So, they nucleated a mono-layer shape. For later coalesced tiny particles, structures of smooth elements adjacently adhered to grow a nucleated mono-layer. In the upper-shaped mono-layer, the force of gravity becomes more significant than the force of levity. The opposite is the case in the lower-shaped mono-layer. Only a few microseconds are involved in adhering to two
mono-layers. The study highlights the development of gold devices in selective size and shape.

**Keywords:** Tiny particle; Surface force; Monolayer; Dynamics; Surface and Interface

1.0. **Introduction**

Synthesizing the materials for some planned applications always remained crucial. Controlling the size and shape of the material is at the frontier of material science, physics, chemistry, and nanoscience. Many research papers have been published, mainly emphasizing the size and shape of the material. Due to the shrinking of the scale of materials, new perspectives are also emerging. Such kinds of opportunities can open new avenues for thinking and gaining knowledge.

The development of morphological structures is a promising field. Geometric and anisotropic objects can lead to many unique applications. Some can build a social impact by cataloging medical fields’ applications. It is possible to observe the structure of materials at the nanoscale and atomic scale. Though, the visualization and observation of materials at high magnification are possible for a long time. Many high-resolution microscopic images in the scientific literature could reveal the dynamics of tiny-sized particles and their atoms. Nanoparticles and particles amalgamated in solution under different driving forces [1].

Some recent studies discussed the crucial role of attained and electron dynamics of atoms [2-5]. Carbon films deposited at different conditions revealed different analyses [6]. Carbon atoms deposited tiny grains of carbon film [7].
An atom is said to be in an original solid or gaseous state when it does not work for the change in force and energy [8]. Gold atoms dissociated from the precursor under the supply of heat energy [9].

Atoms of none of the elements ionize [10]. Heat energy converts into photon energy by electron dynamics of the silicon atom [11]. Suitable element atoms executed confined interstate electron dynamics to generate binding energy [12]. Tiny clusters of gold behave like simple chemical compounds [13].

The nanocrystals can design higher-order materials due to their unique features [14]. On trapping the energetic electrons, tiny particles oscillate collectively [15]. Nanoparticle-based technology has the potential to fabricate small electronic devices [16]. Self-assembly of tiny particles provides a way to develop intricate shapes of particles [17]. A big hurdle in assembling the nanoparticles at preferred sites is designing complex functional structures [18]. It is valuable to understand the development mechanism of the tiny particle [19].

Successful assembling of tiny particles into bigger particles will testify to the atoms and molecules materials of tomorrow [20]. Understanding dynamics is essential to developing nanoparticles into ordered arrays [21].

Precise control of nanoparticles' surface properties will help design their assemblies in higher-order structures [22]. Tiny particles are molecular-like structures, and fair numbers of atoms form hexagonal close-packed (hcp) structures [23].

One not only considers the structure to discuss the entropy and geometry but also the dynamics [24]. There are also metrics capable of characterizing the order in packing [25]. Many studies on plasma solution technologies discussed the development of
nanoparticles and particles. The synthesis of nanoparticles revealed different characteristics of the discharge [26].

At constant input current, the electron flux remains the same on the solution’s surface [27].

Plasma electrons convert H radicals into H₂ to lower the pH of the solution [28]. Brownian motion’s influence and the surface charge of nanoparticles explain their stability [29]. Some physical and chemical aspects contribute to synthesizing nanomaterials at the interface [30]. In atmospheric-pressurized plasma contact with the solution, the concentration of electrons can be controlled [31].

Numerous studies in the literature discussed the mechanisms of developing tiny particles. Despite the usefulness of those studies, the development mechanism of tiny-shaped particles and the conversion of atomic arrays into structures of smooth elements remained beyond understanding.

Here, gold atoms consider explaining the model. The study genuinely presented the mechanism of developing a geometric structure of a tiny-sized particle known as the hcp structure.

The study takes the edge to discuss the fundamental process of developing a mono-layer shape dealing simultaneously with localized gravity and levity. A mono-layer relates to a shaped tiny particle, nanoparticle, or particle. When atoms shape a single layer at the solution interface, and to differentiate it, it is a monolayer. A tiny-shaped particle is specific to the shape of a tiny particle.

A tiny-sized particle is specific to the size of a tiny particle. A tiny-sized particle is a quantitative description.
2.0. Experimental Details

The current study does not contain experimental detail. It is a model study based on the processing and synthesis of nano and micro-sized devices. The different-sized particles can develop by employing the electrochemical method or photochemical method.

Tiny-sized particles can also develop by employing a pulse-based electron photon-solution interface process. A solution-based process states plasma can also refer to this work. Therefore, the development of tiny particles, nanoparticles, and particles-based devices from any solution-based process can take the benefit below-presented scientific and technical details.

Several studies showed the processing of nano and micro-sized devices in the pulse-based electron photon-solution interface process [1-5, 32]. It is a robust method leaving behind other processing strategies. A pulse-based electron photon-solution interface process is a highly versatile process. It is a new, fast and straightforward process. As given in references 2-5 and 32, the earlier published studies have discussed the process sufficiently.

The advanced nano and micro-sized devices can effectively work for uni-directional and multidirectional photonic applications. When the tiny particles, nanoparticles, or particles develop in distorted shapes, they can effectively work for catalytic, composite-based materials and hybrid applications. The registered plasmonic phenomenon in various devices should relate to the field permeating-heat dissipating phenomenon, as briefly discussed in sub-section 3.4.

3.0. Models and Discussion
The hcp structure relates to a multidimensional shape. It does not relate to a two-dimensional shape. Then, how gold atoms can develop a triangular shape tiny particle is discussed here. The development of the structure in the gold element is not the original mechanism of the binding among atoms.

In the natural binding of gold atoms, they should evolve the structure. In this case, the exertion of forces should remain in the relevant format.

For suitable electrons, solid atoms should deal with the exertion of forces mainly in grounded format rather than in surface format.

However, gold atoms can develop the structure when the exertion of forces remains in the surface format. It is under the artificial approach or protocol.

Gold atoms develop the structure by different routes at the ground surface. It is not a natural approach.

In the natural approach, gold atoms evolve the structure. Numerous tiny-shaped particles developed in an auto-controlled setup of pulses supplying the nano energy packets [2-5, 9]. Those metallic entities developed under synthetic protocols.

As discussed previously, atoms of metallic elements bind under three types of forces; (1) Keesom force or the force between permanent dipoles, (2) Debye force or the force between a permanent dipole and an induced dipole, and (3) London dispersion force or the force between induced dipoles. The binding of atoms should partially follow the concept of van der Waals forces as energy also contributes. The force should also restrict the nature of involvement or engagement.

So, the binding of the atoms is under the distinctive-natured force when energy is there. In different element atoms, the binding should not discuss in the context of
positive and negative charges. The binding study also does not comply with the electrostatic interactions or Coulomb’s Law because atoms do not form the ions to amalgamate or bind [10].

Furthermore, the binding of atoms also does not comply with the concepts of Bravais lattices [12].

3.1. Developmental mechanism of tiny-shaped particles

Supplied nano energy packets convert atoms of the monolayer assembly into blocks of tiny-shaped particles. The tiny-shaped particles developed connecting by two at the solution surface.

Figure 1 (a) shows a supplied nano energy packet under the tuned bipolar pulse developed tiny-shaped particles connected by two, each in a triangular shape.

A tiny particle develops directly in a triangular shape when the nano energy packet is generated under the tuned unipolar pulse, as shown in Figure 1 (b). Usually, tiny-shaped particles develop in the shape and size of the supplied nano energy packets.

Gold atoms keep a re-crystallized state in the monolayer assembly at the solution surface.
Figure 1: Tiny-sized particles developing in the shapes of nano energy packets from a monolayer assembly of gold atoms; (a) connected triangular shape tiny particles developing under the bipolar mode of pulse and (b) a triangular shape tiny particle developing under the unipolar mode of pulse. When the higher amount of precursor concentration was opted for, bigger-sized tiny particles developed at the solution surface.

Figure 2 (a₁) shows a monolayer assembly of gold atoms. Under the bipolar pulse mode, connected tiny-shaped particles developed by joining two triangular shape tiny particles, as shown in Figure 2 (a₂).

Figure 2 (a₃) shows a directly developed triangular shape tiny particle in a bigger size. Packets of nano energy can supply from other suitable sources, too.

Figure 2: (a₁) monolayer assembly of gold atoms at the solution surface, (a₂) developed
connected tiny-shaped particles having triangular shapes, and (a₃) directly developed
tiny-shaped particle having a triangular shape

It is feasible to develop building blocks other than the ones shown in Figure 1 and
Figure 2. When packets of nano energy bind the atoms at the solution surface, they
remain in their maximal re-crystallization states. Gold atoms attain a re-crystallized state
in the process of dissociating and levitating.

3.2. **Separating connected tiny-shaped particles**

Figure 3 (a) shows the connected tiny-shaped particles, where the black dot indicates
the connecting point of two horizontally bound atoms. The horizontally bound atoms
connecting tiny-shaped particles deal with different force behaviors compared to the
force behaviors in atoms of the arrays. Label (1) in Figure 3 (a) shows two horizontally
bound atoms. On entering the electronically decreasing level solution surface,
connected tiny-shaped particles instantaneously separate into two triangular shape tiny
particles, as shown in Figure 3 (b).

Figure 3 (b) shows the connected tiny-shaped particles leaving the electronically flat
solution surface and entering the electronically decreasing level solution surface.

On just entering the electronically decreasing level solution surface, a force
difference would develop between the horizontally bound atoms. Each tiny-shaped
particle will separate from the connecting point of two horizontally bound atoms. Two
triangular shape tiny particles will result when separating from the connecting point of
tiny-shaped particles as labeled by (2) in Figure 3 (a).
Figure 3: (a) Connected tiny-shaped particles; (1) center, (2) connecting point of two horizontally bound atoms, and (3) electronically flat solution surface. (b) Separating connected tiny-shaped particles into two tiny-shaped particles; (1) east (E) and west (W) poles of horizontally bound atoms and (2) electronically decreasing level solution surface

When the connected tiny-shaped particles enter the electronically decreasing level solution surface, electrons of two horizontally bound atoms do not experience the same level of east-west forces. Two horizontally bound atoms are no more at the electronically flat solution surface.

All the electrons of horizontally bound atoms do not deal with equal force from all four poles when leaving the electronically flat solution surface to enter the electronically decreasing level solution surface. Horizontally bound atoms do not bind like the way atoms of the arrays. So, electrons of those atoms keep perturbed states. From the connecting point of two horizontally bound atoms, tiny-shaped particles separate to deal with the individual dynamics.

On entering the electronically decreasing level solution surface, the horizontally bound atoms at the connecting point of two tiny-shaped particles disregard the adhesiveness.
Two horizontally bound atoms at the connecting point of two tiny-shaped particles get disconnected by the termination of adhesiveness. Connected tiny-shaped particles separate into two tiny-shaped particles, and then each tiny-shaped particle works under individual dynamics.

3.3. **Elongation of atoms in arrays forming a triangular shape tiny particle**

Upon leaving the electronically flat solution surface and entering the electronically decreasing level solution surface, atoms of each array start elongating in a tiny-shaped particle. The elongation behavior of a gold atom under the exertion of even and uneven forces is discussed elsewhere [10].

Transitional atoms deal with the forces of immersing format at an electronically decreasing level solution surface, as discussed elsewhere [32].

When the atoms of arrays elongate at less rate in a tiny-shaped particle, as shown in Figure 4 (a), the energy knots clamped electrons also stretch at less rate. Figure 4 (b) shows the elongation of atoms at a higher rate.

Atoms of an array remain to adhere to each other in the elongation process. Figure 4 (a) shows the less elongation of atoms of the arrays, whereas Figure 4 (b) shows the more elongation of atoms of the arrays. In the array, an elongating atom binds to the lower-positioned elongating atom. In stretching energy knots clamped electrons, an elongating atom adjacentely adheres to the lower-sided positioned elongating atom.

Figure 4 (a) and Figure 4 (b) also show the single atom elongation under the competing actions of forces at opposite ends of their electrons.
Figure 4: A tiny particle having a triangular shape showing (a) elongation of the atoms in their arrays at less rate and (b) elongation of the atoms in their arrays at more rate; (1) energy knot of the lower-sided positioned atom and (2) electron of the upper-sided positioned atom. (Sketches drawn in estimation)

In developing the structures of smooth elements, a tiny-shaped particle works as one unit. At an electronically decreasing level solution surface, atoms of the arrays deal with a uniform elongation process. A mono-layer tiny particle still keeps its shape like a triangle.

3.4. Photons-matter interaction at the air-solution or air-matter interface

When photons of current leave the splitting argon atoms in the pulse-based electron photon-solution interface process, they lower the force and energy [10]. When such photons travel parallel with the air-solution interface after leaving the splitting argon atoms, they influence the below-positioned perturbed state electrons of the elongated atoms.

Perturbed state electrons of the elongated atoms gain alignment through the field of force and the heat of energy of those traveling photons. On splitting argon atoms, the lowered force-energy photons travel parallel with the air-solution interface instead of propagating through the medium of the interstate electron gap.
Through the field of force and the heat of energy, crest and trough sections of the traveling photons remained engaging to position the non-aligned electrons of the elongated atoms at the air-solution interface. In a triangular shape tiny particle, the structures of smooth elements further flatten under the field permeation and heat dissipation. The perturbed state electrons align from both the upper and lower sides of the elongated atoms in each array, as shown in Figure 5 (a). In a tiny-shaped particle, arrays of elongated atoms form the structures of smooth elements.

From both sides, traveling photons along the air-solution interface flatten each smooth element structure, which is evident in Figure 5 (a).

The width between structures of smooth elements is related to the inter-spacing distance. As shown in Figure 5 (b), two atoms keep a bit tilted position concerning each other.

The atoms deal with the elongation in a non-uniform manner concerning each other. But the positions of the elongated atoms are tuned by the featured photons traveling parallel with the air-solution interface.

**Figure 5:** (a) a triangular shape tiny particle further smoothens structures of smooth elements upon experiencing the traveling photons and (b) traveling photons along the
air-solution interface aligning the perturbed state electrons of a bit tilted-position atoms to convert them into the perfect structure of the smooth element

The smooth elements’ structures reveal the better shape of their tiny particle, but they also facilitate developing the highly geometric nanoparticles and particles [2-5, 9, 32]. The width of a structure of a smooth element varies by varying the pulse rate [4].

The width of the structure of a smooth element also varies under the application of force exerted in the space format and grounded format [5]. However, in Figure 5 (a), the width of each structure of the smooth element becomes ~ 0.12 nm.

Experimental proof of the width ~ 0.12 nm of the structure of the smooth element is given elsewhere [32]. The above-discussed results validate that the lattice of the tiny particle does not oscillate collectively.

The traveling photons along the air-solution interface do not trap by the atoms (or lattice) of a tiny particle. Instead, photons deal with different interactions with matter.

Atoms of the tiny particle flatten by the impact of photons traveling parallel with the air-solution interface. Those photons, which do not travel parallel with the air-solution interface, can spoil the lattice of a tiny-metallic colloid.

When photons travel parallel with the tiny-shaped particle, they position the misaligned electrons of the atoms. Hence, a studied plasmonic phenomenon is not in-line with the discussion of this work. The carrying force and energy of photons do not permit them to trap in the lattice of an atom or a tiny-sized particle.

Instead, the force and energy of the traveling photons show the impacts in different ways. As a result, those photons change their characteristics. Even traveling photons
show the impact while having interactions with the air medium. Photons of suitable lengths and numbers shape the lattice of an atomic element [8].

Photons propagated through the uniformly ordered interstate electron gap of the atoms of a tiny-metallic colloid preserving the features of carrying force and energy [10]. Not fulfilling the surface plasmon phenomenon is also discussed in earlier studies with preliminary details [5, 6]. Nevertheless, a surface plasmons phenomenon can initiate in a mono-layer tiny particle when it evolves structure as discussed elsewhere [12].

3.5. Mono-layer shape dealing with localized gravity and levity at the interface

Firstly, triangular shape building blocks from different regions of the solution surface assemble at the center of the concave meniscus. As a result, the shape of the mono-layer gets nucleated. In the nucleation process, structures of smooth elements adhere through the assembling process.

At the second stage, a nucleated shape of the mono-layer extends, where the structures of smooth elements adhere adjacently. However, they belong to the later coalesced triangular shape of tiny particles.

In the case of the development of the mono-layer having six sides, Figure 6 (a) shows a hexagon-like shape. Another similar shape mono-layer develops at the same point. An earlier-developed mono-layer automatically steps down. An earlier-developed mono-layer left the space above for a later-developed mono-layer shape. A later-developed mono-layer has the force of gravity more significantly than the force of levity.

An earlier-developed mono-layer has the force of levity greater than the force of gravity. Figure 6 (b) shows two shaped mono-layers that adhere lateral-wise. Adhering
to two shaped mono-layers completes within a few microseconds. Two laterally adhered mono-layers will sink if the time limit to develop the third mono-layer exceeds.

![Diagram of mono-layers](image)

**Figure 6:** (a) a mono-layer shape like a hexagon, (b) adherence of two mono-layers; (1) above-developed mono-layer, and (2) below-developed mono-layer

However, the adherence of only two shaped mono-layers would develop a very high aspect ratio particle. When the earlier developed shaped mono-layer is at the solution surface, an equal force of gravity and levity remains there. At the center of the concave meniscus, a mono-layer would stay until the space measuring lateral atomic width is not occupied by the next.

At an electronically flat solution surface, atoms deal with the equal forces of the relevant poles. However, this is not the case with tiny-shaped particle when it enters the electronically decreasing level solution surface. Now it deals with forces of immersing format.

In immersing format, four forces together involve in exertion [32]. A nucleating mono-layer keeps the center at the center of the concave meniscus. A center concave meniscus is formed at the center of the solution surface when there is no glow. On developing a shaped mono-layer above, the earlier developed mono-layer comes one step down, filling the space measuring length in the lateral atomic width. The later-developed mono-layer has a greater force of gravity than the force of levity.
The shape of the below-positioned mono-layer considerably stops the exerting of levitational force ($F_L$).

In this way, the above-positioned mono-layer shape deals with the gravitational force ($F_G$) to a greater extent when compared with its $F_L$, as shown in equation (1).

$$F_G\text{ of above-positioned mono-layer} > F_L\text{ of above-positioned mono-layer} \ldots (1)$$

The above-positioned mono-layer considerably stops the exerting $F_G$. In this way, the below-positioned mono-layer has $F_L$ to a greater extent when compared with its $F_G$, as shown in equation (2).

$$F_L\text{ of below-positioned mono-layer} > F_G\text{ of below-positioned mono-layer} \ldots (2)$$

Due to the more levitational force of the earlier developed mono-layer and the more gravitational force of the later developed mono-layer, two mono-layers adhere laterally.

In Figure 6 (b), the above-positioned mono-layer adheres to the below-positioned mono-layer in developing a hexagonal-shaped particle. Electrons of elongated atoms get trapped in the existing voids to adhere to mono-layers laterally. The whole process of adhering to two mono-layers took just a few microseconds.

### 3.6. General Discussion

Solid atoms keep the ground points below the ground surface. So, they should also evolve the structures below the ground surface [12]. However, a monolayer assembly of the atoms developed at the solution surface. In the routinely published studies, different synthetic protocols are involved developing the nanoparticles or particles.

Tiny particles develop in different aspect ratios depending on the pulse ON/OFF time [4]. The nano energy packets can supply from the tuned pulses or other means.
Building blocks can develop under the supply of nano energy packets. The surface forces play a vital role in isolating them from the rest of the monolayer assembly. By introducing ligands or surfactants, tiny-shaped particles can develop in many ways.

While dissociating from the precursors, atoms undergo a re-crystallization state by decreasing the potential energy of the electrons. It occurs when atoms amalgamate at the solution surface.

Metallic atoms change the original state behavior when undertaking the transition state. Gold atoms can attain the maximal re-crystallization state on reaching the solution surface.

In the levitating process, atoms do not retain their original state. Atoms undertake a transition state. In a beaker, suitable process conditions make it feasible to attain a greatly re-crystallized state at the solution surface.

Gold atoms almost keep a greatly re-crystallization state while under their transitional behavior. Following their re-crystallization state, gold atoms elongate under the exertion of forces exerting at the electron level. When atoms elongate, the electrons remain within the occupied energy knots.

Many published studies discussed the synthesis, characterization, and application of tiny particles, nanoparticles, or particles [33-49]. Underlying science still awaits.

The characterizations and analyses of the tiny particles, nanoparticles, or particles also missed the discussions in light of the original line of experiments. The present study can help out to address such challenges. It can start a new era of colloidal science and physical chemistry.
In various syntheses of tiny particles, nanoparticles, or particles, it is not feasible to develop them with the original shapes of atoms. Therefore, in addition to processing the materials in solution-based processes, characterizations and applications of tiny particles, nanoparticles, or particles should consider the modifications of the atoms.

The shape of a tiny-sized particle, nanoparticle, or particle cannot establish without having the proper elongation of atoms. It means the utilization of different capping agents cannot keep the original shapes of atoms.

Atoms keep their original shape in the structural evolution process rather than in the structural development process [12].

4.0. Conclusion

In developing a monolayer assembly at an electronically flat solution surface, metallic atoms dissociate first from the precursor. Gold atoms then levitate to configure the monolayer assembly at the solution surface. In retaining the monolayer assembly, gold atoms keep a greatly re-crystallized state. Nano energy packets crop monolayer assembly into tiny-shaped particles. When a unipolar mode of the pulse is employed, a straight triangular shape tiny particle develops. Different approaches to synthesizing nano and micro devices also supply nano energy packets to bind atoms in their shapes.

The monolayer assembly converts into shapes of supplied packets of nano energy. When there is a bipolar mode of the pulse, tiny particles of triangular shapes develop by joining two. When the force difference exerts at the border of electronically flat and decreasing level solution surfaces, the connected tiny-shaped particles separate into two tiny-shaped particles.
Both left and right electrons of the atoms of arrays tilt adjacent-wise when their triangular shape tiny particle enters the electronically decreasing level solution surface. In this manner, gold atoms forming the arrays elongate. Electrons of the elongating atoms keep the force energy owing to the established orientation and potential. As a result, lattices of the adjacently-positioned atoms stretch unidirectionally. Elongating atom adheres to the lower-sided positioned elongating atom. Atoms in arrays elongate less or more depending on their processing conditions.

When the photons travel parallel with a tiny-shaped particle at the air-solution interface, the misaligned electrons of the elongated atoms align precisely from both sides of their array. Permeation of the field force and dissipation of the heat energy of parallelly traveling photons align the misaligned electrons. Energy knots clamped electrons become further straight. In a tiny-shaped particle, structures of smooth elements keep equal width and the same inter-spacing distance. If there is any discrepancy in the position of elongated atoms, photons traveling parallel with the interface position them. Indeed, these investigations validate that a plasmonic phenomenon is related to the field permeating-heat dissipating phenomenon instead of the collective oscillation of the atoms of tiny colloids.

In a solution-based process, tiny-shaped particles first assemble at the center of the concave meniscus to nucleate the mono-layer of a geometric particle. To extend the shape of the mono-layer, structures of smooth elements in later coalesced tiny-shaped particles adhere adjacently.

An above-developed mono-layer shape deals with localized gravity more significantly than localized levity.
A below-developed mono-layer shape keeps localized levity greater than the localized gravity. The process of adhering to two shaped mono-layers is completed only in a few microseconds.

A shaped mono-layer is a subject of different processes developing different featured nano and micro-sized devices.

The model study discussed here is feasible to develop devices in different size ranges, from nanometres to micrometers. This work can also open new theoretical, simulation, computation, and design fields.

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