

## Research Article

# Study of the Method of Electro-Crystallization and the Study of Effective Factors in the Production of Nanostructures in this Method

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**Abstract:** Due to the fact that nanostructures have very high-performance capabilities in various scientific and industrial fields, during the last few years these nanostructures have become available for production in order to produce particulate matter with appropriate composition and distribution. One of the focal points of the current study is the exploration of a number of different researches carried in the field. Considering that the method of electro crystallization compared to other methods available for the production of nanostructures is relatively new, this study gives a brief overview of the effective methods of electro crystallization and the effective parameters in the production of nanostructures produced at high speed, the integrity of materials and the sustainability of particles produced, the diversity in production, low cost and simple use of equipment. The findings of the study are presented that explore the effective parameters in the production of nanostructures, the voltage applied, the time it takes, the concentration of electrolyte and the temperature. The findings further show that the factors of change in voltage and oxidation has the greatest effect on the morphology and particle size. Moreover, the increase in voltage is due to the rapid increase in the speed that leads to the production of resistive crystalline sediments.

**Keywords:** Methods of Production, Nanostructures, Electro Crystallization, Voltage Oxidation.

## A. INTRODUCTION

With the development of nanotechnology and visual development in recent decades, this field of science has attracted a great deal of attention from scholars and researchers of various scientific and technical periods. Due to the small size of the nanomaterials, the chemical and physical properties are isolated, and in recent years there has been an increase in interest in these types of structures. Since the size, distribution, morphology, sincerity and number of crystalline nanoparticles are closely related to the method of production, these methods are of great importance (Fu & Wang, 2011).

The time we can control the size of the particles, the evolution of simple and functional devices will be possible beyond the surface of what we see today or even imagine. The reduction in the size of nanostructures as well as the formation of carbon nanoparticles, fragments and fragile films, structures based on DNA and laser exposure with unique features. The electro crystallization method is currently being considered as one of the most useful methods for producing Nano fluorescence materials (Trzaska & Trzaska, 2016).

## B. METHOD OF ELECTRO CRYSTALLIZATION

The term "electro crystallization" was first coined by Vladimir Alexandrovich Kistjakovsky, and was framed by the formation of crystalline hemorrhages and electrochemical processes. At the same time, it has been pointed out that among different

methods of production of nanostructures, the method of electro crystallization is a useful, attractive and relatively new method, which can produce all kinds of nanoparticles in this way (Xu et al., 2012).

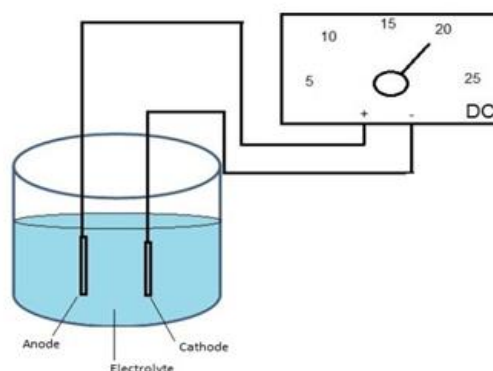
The charm of this approach is that it does not require expensive equipment to solve the problem itself. Among the reasons for the superior electro crystallization of nana-crystalline materials are the following:

1. Performance in low temperatures and no need for high temperatures.
2. Ability to control thickness, synthesis and final product structure with effective change of parameters.
3. Less equipment needed to be available.
4. Sincerity on particles produced.
5. Distinguished instrumentation.
6. Production of particles at high speeds.
7. Miscellaneous particle structure.
8. Easy-to-use and non-complex method of preparing nanomaterials using this method.
9. Control the appropriate number of particles with effective factor regulation in the testing system.

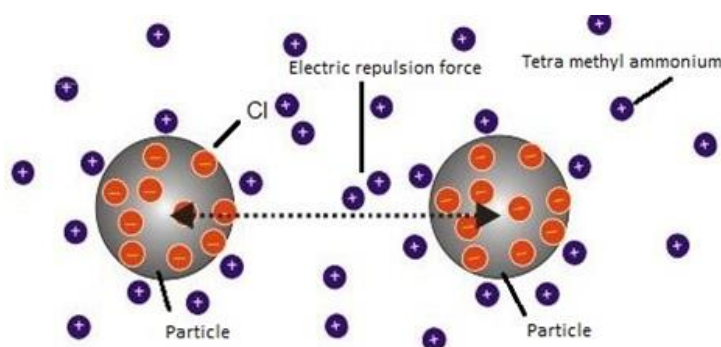
In addition to all these advantages, it should be noted that the correct use of electrolytes is considered to be part of the limitations and disadvantages, but of course controllable. In this way the focus is on the production of materials with different chemical, phase and structures that are organized with attention to changes in parameters. By selecting the type and composition of the electrolyte and parameters of the solution, such as the type and density of the flow, temperature and duration of the time, it is possible to produce a variety of materials with different characteristics (Pirifathabad, Mosivand, & Kazeminnezhad, 2018). The basis of this process is to maintain oxidation and regeneration in the liquid phase through the flow process and voltage. In order to do this, the existence of a three-part cathedral and electrolyte solution is essential. In this method, two electrodes are used to maintain the oxidation current in the cell during electrolysis (Shahanshahi, & Mosivand, 2019).

Round. Electrolyte is a substance that plays a role in the transfer of electrons and electrons to the environment. At the surface, catalysts also regenerate aqueous water and produce hydrogen and hydroxide units. The reaction of unicorns is formed around electrodes at the same time, leading to the production of nanostructures of oxides or hydroxides. Within the electrolyte solution, acceptable particulate matter is avoided. Sustainability is usually a synthetic tool consisting of water-friendly groups and aquaculture groups. The existence of double nature due to the special properties of these molecules, occur as they are dissolved in water and at the common surface of water-air or between two layers of two different phases of accumulation and causes surface tension.

The products produced are surrounded by sustainable molecular molecules, and with the coating of all the particles on the surface, the energy is absorbed between the particles, which in turn prevents the particles from sticking and clotting. In fact, the colony's defense is made up of two electric particles between two particles. In other words, using compounds such as amino acids, a double electric layer with opposite particles created around it and approaching two particles and coherent layers of double electric particles, the repellent between the particles is revealed and the particles are separated (Pirifathabad, Mosivand, & Kazeminnezhad, 2018; Kazeminezhad, & Mosivand, 2012).



**Figure 1. Symmetry of an Electrochemical System**



**Figure 2. Demonstration of the Role of a Type of Sustainer (Tetraethyl Ammonium Chloride)**

It is made of various metals such as cast iron (Shahanshahi, & Mosivand, 2019), aluminum (Pirifathabad, Mosivand & Kazeminezhad, 2018), nickel (Bagheri & Mosivand, 2021), zinc (Mosivand, & Kazeminezhad, 2015), copper and iron (Mosivand, et al., 2013; Kazeminezhad & Mosivand, 2011), titanium (Kardanzadeh, Kazeminezhad & Mosivand, 2018) and two pieces in dimensions. In this case, after the removal of contaminants and impurities from the surface of the surface, the electric current must be maintained in the oxidation of a single wire of copper wire on the surface of each of the electrodes. The electrodes are masked and then fixed within the electrolyte solution and certain distances. The electrolyte solution actually contains distilled water containing certain amounts of a stabilizer that exists in addition to its role as a self-contained particle surface to prevent the accumulation of particles in it. None of the electrochemical reactions were reported and the aggregate is then connected to a feed source DC to maintain the flow. After the electric current is maintained, the oxidation and regeneration reactions take place, forming a unitary reaction around the electrodes at the same time and leading to the production of nano-saturates of oxides or hydroxides.

The sedimentation yield is similar to that of nanomaterials obtained from electrolysis of metals, which were considered for structural and archeology studies after aggregation and drying. Different factors play a role in the way the particles are produced, as mentioned below (Xu et al., 2013).

The effective factors in the production of particles by electro-crystallization are as follows:

1. Voltage Oxidation: Changing voltage oxidation is possible by the synthesis of chemical particles as well as under the influence. The increase in voltage is usually accompanied by an increase in the flow rate and velocity, which in turn causes the crystalline sediments to be reset (Mosivand, & Kazeminezhad, 2016).

2. **Oxidation Period:** In order to produce nanoparticles, the time of germination and growth must be grammatically controlled so that the number of granules is sufficiently large but the growth of the granules is carried out in a limited way. Under these conditions, every change from time to time affects number of produced particles. With age increment the size of the particles decreases therefore this phenomenon is the primary cause of overgrowth. With the increase of growth time the particles are getting bigger too, so that there is not enough time for the growth of the young ones (Kazeminezhad, & Sadollahkhani, 2013).
3. **Electrolyte concentration:** Usually with increasing concentration of metals in the electrolyte the number of particles decreases. Since the rate of germination depends on the concentration of the solvent in the solution, therefore with increasing concentration, small particles are obtained.
4. **Additives:** Additives such as Butan, Diethyl, Amin and Saccharin have the effect of increasing the electrolyte content of particles. For instance, gold nanoparticles have been observed for using these modifiers to increase the number of particles in the material, halving the particle size. Of course, the intensity of the effect increases with the type of substance and the concentration is even higher.
5. **Temperature:** The increase in electrolyte temperature at a time is accompanied by a constant increase in the momentum and also the conductivity of the electrolyte solution (Kazeminezhad, Mosivand & Farbod, 2011).

Considering the findings made in this context, among the above factors, the most effective factor leading to the production of resistor crystal sediments is the voltage applied to the oxidation system. Examination of SEM images of different oxide or hydroxide nanoparticles produced in this way, in almost all cases gives a very large particle size, in a limited nanometer and the shape of the eye is suspicious. The number of particles that can be produced by different chemical reactions varies greatly. By the time they are produced, the first particle from a specific phase of matter come into existence. In atomic nuclei, the primary nuclei that combine to form the nucleus are reduced to one, eight, or molecules. Atomic warfare takes place in the same way and in the same way. In nuclear warfare, more or less the same number of primordial nuclei are produced simultaneously due to severe physical changes, and nuclear warfare is an inexhaustible fraction of particles. In the method of electro crystallization, sedimentation from a solution is usually carried out under conditions above supersaturation.

So, Methwan said that in it is highly saturated that starting point is nuclear. The faster the solution dissolves in the direction of sedimentation, the higher it saturates. The second stage is the crystalline growth of crystals, with the addition of a single structural crystal, it is possible for them to grow together and fit in the right place and right direction. During the nuclear phase, almost all particles are produced and the large size of particles are produced in very small quantities but with controlled growth, they are able to reach the same particle size. At the same time, with the growth and development of nuclear weapons, there is a growing consensus among the people. Nanoparticles have a very high surface energy level because they tend to condense and stick therefore, it is important to note that the role of sustainers in this regard needs to be fully explored. The existence of a sustainer creates a space defense that intercepts particles in space and causes the particles to stick together, which in turn prevents them from acting.

Based on this, the nanoparticles produced can be synthesized and clotted to a great extent. In the analysis performed by the SEM device, it is clear that the particles produced are uniformly similar in each sample, and that the size of the particles in each sample is uniform to the extent that it indicates the same growth of primary nuclei and the fact that they exist. The growth is almost complete before the fronds have grown. In the field of research, measurement

of nanoparticles under the influence of voltage has been performed. In fact, the increase in voltage leads to an increase in the speed of the atom, and by the time enough durable molecules are provided to cover the surface of the particles, the size of the particles becomes smaller. However, more studies have been done on the mechanism of nuclear and crystal growth in solution. The two-stage nuclear mechanism is the most important mechanism by which it is possible to regulate the paradigm of thermodynamic solutions by controlling nuclear fission. At the end of the day, the stimulus is required for crystallization and crystal growth. It is said that in us and  $\mu c$  there is a better potential for a chemical molecule in a solution and a crystalline phase in a warm state,

$$\Delta\mu = \mu_s - \mu_c. \quad (1)$$

The same could be said of the thermodynamic equations under which  $k, T$  and  $S$  are at constant bolts, absolute temperatures and relative saturation,

$$\Delta\mu = kT \ln S. \quad (2)$$

In case of  $\Delta\mu > 0$ , the solution is highly saturated and nuclear fission or growth takes place and if  $\Delta\mu < 0$ , then the solution is unsaturated and dissolved. The relation of ultrasonication to the system is observed (*gas / solid, solution / solid, liquid / solid*). For nuclear growth and development of solutions, this link is as follow,

$$S = \frac{\prod a_i^{n_i}}{\prod a_{i,e}^{n_i}}. \quad (3)$$

In relation to the above number of units in the crystal molecule,  $a_i$  and  $a_i$ , and the actual and equilibrium molecular functions of  $i$  in the crystal.

According to the theory of nuclearization, the difference between the free energy system in the end state and the primary, in addition to the sentence that is related to the formation of a common chapter between the nucleus and the solution, is necessary to produce the desired molecule (4) It is given and in that radius the core and the energy is free surface:

$$\Delta G_T = -n\Delta\mu + 4\pi \cdot r^2 \sigma \quad (4)$$

If each molecule occupies the volume  $V$  in the crystal, the contact (4) will be as follows,

$$\Delta G_T = -\frac{4}{3}\pi \cdot \frac{r^3}{V} \Delta\mu + 4\pi \cdot r^2 \sigma. \quad (5)$$

Figure 3 (a) shows the GT as subject to  $r$ . (3G 2)  $\Delta G^*$  is the energy barrier that must be passed through, to make the nucleus available. The amount of  $r$  is subject to the maximum,  $r^*$  is defined as critical radius or the size of the nucleus and is related to,

$$r^* = \frac{2\sigma \cdot V}{kT \ln S}. \quad (6)$$

With the increase in saturation, the amount of  $r^*$  and also the  $\Delta G^*$  decreases, which is due to the fact that in the system with higher saturation, the probability of nuclearization is higher. The speed of atomization (the number of atoms formed in a single time in a single volume) is explained by the following equation,

$$J = A \exp\left(\frac{-\Delta G^*}{kT}\right). \quad (7)$$

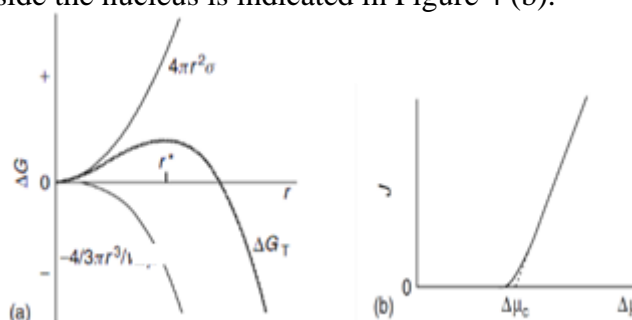
Which depends on  $A$  in saturation. Type  $J$  appears as a subspecies above saturation ( $S$ ) in Figure 3 (b). Considering that the speed of nuclearization has reached a critical level of near zero, almost zero, and then it has increased significantly (Xu, et al., 2013).

This ultrasonic crisis ( $\Delta\mu c$ ) defines regions in which crystal growth is possible without simultaneous nuclear development (Fu, & Wang, 2011). Crystal growth is the aggregation of fragments by which one-eighth or one molecule enters a crystalline surface and causes an increase in its size. It summarizes the different stages of transport in the eight stages of transmigration through the solution, the connection of the eight to the surface, the movement of the eight to the surface and the connection of the eighth to the tongue. The first attack is known as the attack attack, while the other attacks are considered as superficial attacks. Since

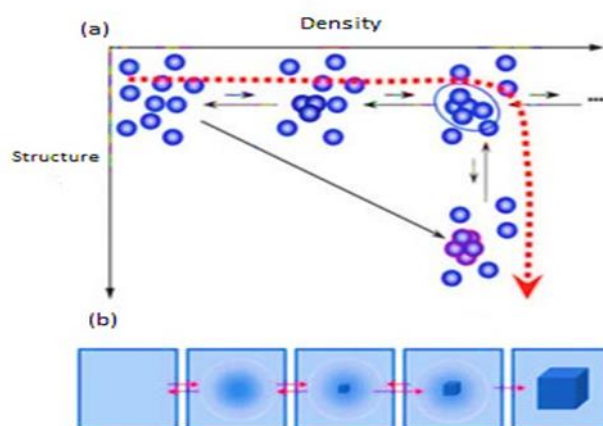
these different stages are usually performed on the back of the head, they control the growth of the crystal. Therefore, growth can be controlled by attack (when phase 1 has the lowest velocity) or by superficial controls (when phase 2-4 is the lowest velocity).

For the formation of a crystal from a solution of dilute gas, sufficient concentration and fluctuations of atomic and unitary flux are required (Figure 4A). The main assumption in the extraction equation (7) is that the molecules of the solution are directly altered in a happily arranged order. To understand this, we must consider the difference between a solution and a crystal. The resulting phase is a solution or two other components of each system in terms of concentration and temperature at constant pressure. This phase, as usual, consists of three stages, (a) dilute solution, (b) condensed liquid, and (c) crystal. If we were to compare them, we would have to say that the difference between a dilute solution and a condensed liquid is in the concentration of the substance.

From this point of view, shaping crystals in solution should be observed as the transfer of two parameters of concentration and structure, therefore the transfer and transformation of the solution from crystalline phase to crystallization takes place at the same time. It has shown in Figure 4, along the flash (concentration-structure) on the page. This transformation is accompanied by the formation of concentrated droplets of liquid and the formation of a crystalline nucleus inside the nucleus is indicated in Figure 4 (b).



**Figure 3. (a) The total amount of free energy displayed by the size of a cluster and (b) The speed of nuclear fission as a subspecies**

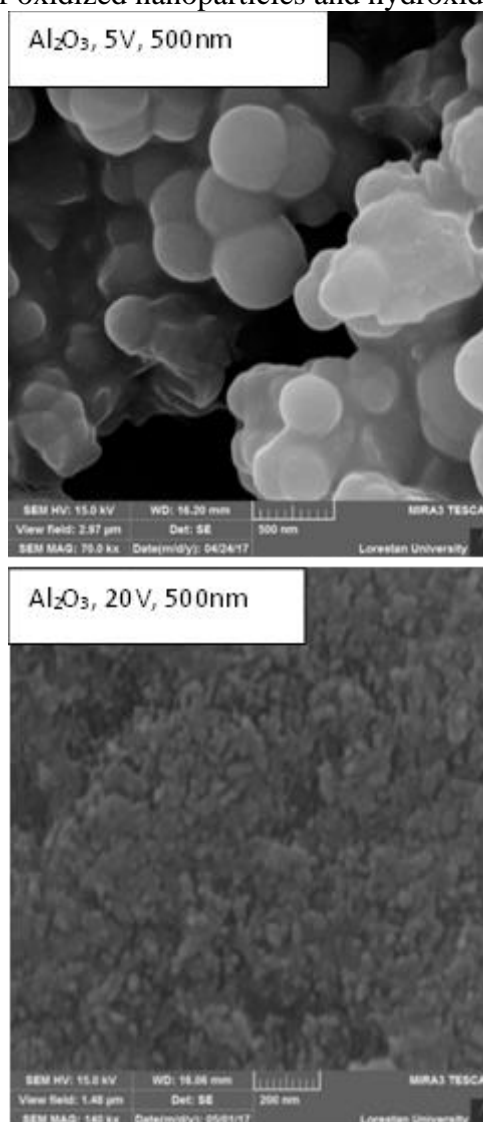


**Figure 4. A. Schematic image of a two-stage nuclear crystal. A cluster of condensed liquid is formed. A crystalline nucleus may form inside a cluster. (A) Microscopy view (b) Microscopy view of the events along the broken line (a)**

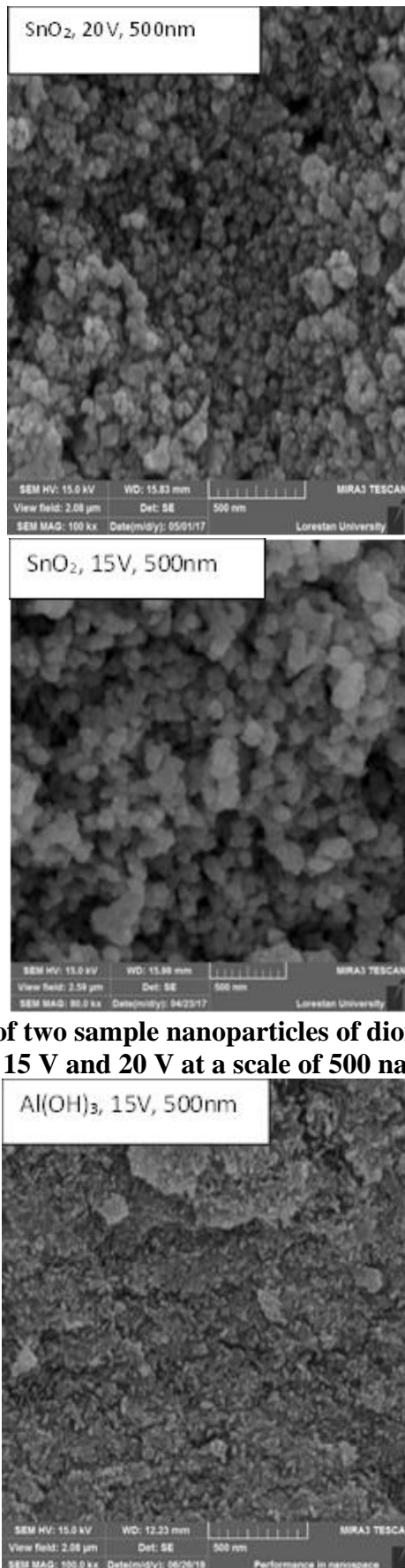
The speed of atomization and the speed of growth of particles are important in determining the size of particles. Particle size increases with the speed of atomic nucleus, slows down and growth rate increases with the growth of particles. The balance between these two effects is very delicate and sensitive and ultimately depends on the used experimental system. The process of measuring particles with increasing voltage is due to various factors, one of

these factors is the acceleration of electrolysis and the increase in electrolysis in the electrolyte. It is clear that with the increase of current, the motility of particles and the presence of particles in the solution increased and as a result nanoparticles formed faster and are more likely to be present which would also cause the particles to become larger and larger Blindfolded (Mosivand, & Kazeminezhad, 2015). By increasing the voltage according to the increase in the volatile molecular molecules present in the solution it is also considered that the chain is also covered by a better surface particle by the molecular molecules. Therefore, the magnetic field results in an increase in voltage, because the motion of the molecular sustainer is also increased and, accordingly, the reaction of the particles with the particles also increases. Covering the surface of the molecule with the molecular molecule prevails and with the molecular consistency of fine particles, the size of the molecule becomes more desirably controlled (Shahanshahi, & Mosivand, 2019).

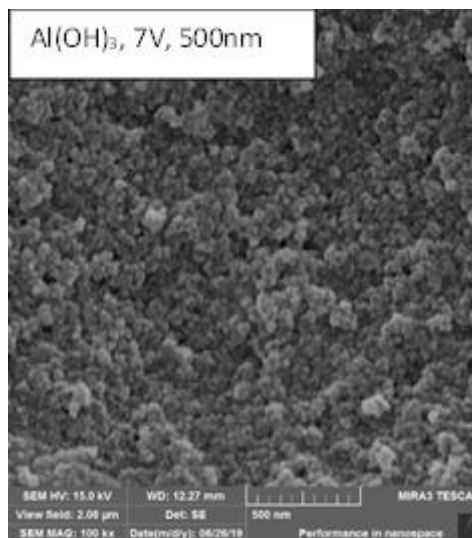
In the pictures below, several samples of electroblary nanoparticles are prepared using electro crystallization, which shows that with increasing voltage, the amount of oxidation in the cell increases the number of oxidized nanoparticles and hydroxide produced.



**Figure 5. SEM images of two samples of aluminum oxide nanoparticles prepared under voltages 5 V and 20 V at a scale of 500 nanometers.**



**Figure 6. SEM images of two sample nanoparticles of dioxide foil prepared under voltages 15 V and 20 V at a scale of 500 nanometers**



**Figure 7. SEM images of two samples of aluminum hydroxide nanoparticles prepared under voltages 7 V and 15 V at 500 nanometer scale**

### C. CONSEQUENCES

In this study the facilitative method of electro crystallization was fully explained and the effective factors on cell electrolysis were examined. Given the study of the factors that influenced the study, it was determined that the most likely effect would be related to the voltage applied to the electrochemical cell that was applied to the study. It is determined that the increase in voltage is due to the increase in the motility of the particles and the ions which are in the electrolyte solution. The stimulus increases the stability of the molecular molecules in the solution, which, in this case, stabilizes the molecular molecules well, covering the surface of the particles and preventing them from forming. Required better control.

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### CONFLICT OF INTEREST

This research is contributed by all authors and no potential conflict of interest to publish it.

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