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Hydrophobic coating production with its hydrophobic properties and pollution self-removed by concentrations of silica nanoparticles

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The main purpose of this study is investigation hydrophobic coating production with its hydrophobic properties and pollution self-remove by concentrations of silica nanoparticles on final performance polyvinyl chloride (PVC) composite coating with silver thiol based on silica nanoparticles. The effect of the concentration of nanoparticles and polyvinyl chloride with anti-solvent coating production based on thiol silver nano-coating silica on the final properties will be studied which the method used to produce PVC cover with silver thiol solution casting method. In this study, the polyvinyl chloride as raw material, as solvent tetrahydrofuran and the thiol silver and silica nanoparticles to influence the ultimate performance in terms of hydrophobic coating is used. With cloud cover hydrophobic surface modification of PVC can be achieved. In this study, control of process parameters (temperature and concentration of nanoparticles) and forming appropriate, nano-based thermoplastic polymer with hydrophobic and self-cleaning properties based on silica nanoparticles of silver were obtained with anti-solvent thiol.

Keywords: hydrophobic coating, pollution self-remove, silica nanoparticles

INTRODUCTION

Super hydrophobic nano-coating to remove pollutants, including the most important achievements in the field of manufacturing using nanotechnology coatings are considered. The main purpose of this study is investigation hydrophobic coating production with its hydrophobic properties and pollution self-remove by concentrations of silica nanoparticles on final performance polyvinyl chloride (PVC) composite coating with silver thiol based on silica nanoparticles [1]. The most important use of nano would be in a building or car windows, glasses, optical windows, electronic equipment, prevent corrosion caused by water, used in batteries and fuel cells, building industry and other industries as well as improve the life of industrial and construction equipment. The effect of the concentration of nanoparticles and polyvinyl chloride with anti-solvent coating production based on thiol silver nano-coating silica on the final properties will be studied that the method used to produce PVC cover with silver thiol solution casting method is based on silica [2].

Polyvinyl chloride happened on two occasions, the child was discovered in the 19th century: The first time in 1835 by Henry Victor Regnalt and in 1872 by Eugen Baumann. In both situations polymer when it became apparent that a white solid inside flasks of vinyl chloride was exposed to sunlight. By polymerization of vinyl chloride monomer and polyvinyl chloride is formed [3].

Before the twentieth century Russian chemist Ivan Straw Mislenski and Fritz Clitt generalization of the German chemical companies' electron, both tried to PVC in commercial products operate, but the problems in the process, the hardness and brittleness of polymer sometimes put their efforts fruitless. In 1926, Waldo Simon B. F. Goodrich way to soften PVC expanded by mixing it with various additives. The result was a flexible material that was simply in the process and soon became widespread commercial use [4]. Finally, the most important advantages of this polymer compared to other plastics, unparalleled quality that would have to be easily mixed with all kinds of emollients, plastic products of the most difficult form to produce the most flexible form. Such diversity does not show any other plastic.

PVC APPLICATIONS

PVC for many applications, including vinyl siding, magnetic signs, vertical cut, gramophone records, pipe, plumbing, channel and fixture, cheap bags, dark windows (no view) and application form for clothing, upholstery, such as curtains, flooring and the roof, electrical cables shells, guns are lightweight game. The substance often used for water pipes and sewage systems due to the low cost of natural and flexibility [5].

Thiol silver is white substance that smells like garlic. The smell is often blunt, nasty and strong. It's about lower molecular weight thiols is much more pronounced. Silver thiol can establish a strong link with the proteins in the body. Natural gas

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industries dependent on large amounts of thiols (usually ethane thiol) is added to natural gas are inherently odorless. This is to avoid unintended bursts of natural gas that can not be discerned. Tivoli antibacterial silver coating can also be used. Due to silver metal bond with the thiol group of foul-smelling gases are produced, and inhibits the growth of bacteria [6].

Wu Yang and his colleagues zinc oxide nano rods cloud hydrophobicity successfully on the platform through a combination of thermal oxidation and modifying the surface of zinc oxide nanorods produced the contact angle of water on the surface was 153.6 temperature is 4 degrees. Compared with the unmodified nanorods of zinc oxide, zinc oxide nanorods Cloud superhydrophobic surface can effectively demonstrate its high resistance to corrosion that this is a new valve design and manufacture of stainless steel is super hydrophobic properties[7].

In another study, Zhang using a solution casting and spraying the leather cover Cloud hydrophobicity reported emulsion coating, spraying obtained containing polyacrylate, ethanol and silica substrates with polyurethane and epoxy. Xingrong Zeng and his colleagues studied hydrophobic coating of PDMS and silica produced by solution casting surface PDMS / SiO2 with hierarchical roughness, surface water contact angle was about 153 degrees. Picture of SEM (Figure 1), shown the scope of PDMS / SiO2 super hydrophobic in Fig. 1. Many protrusions of small size and irregular distribution is on the surface[8].

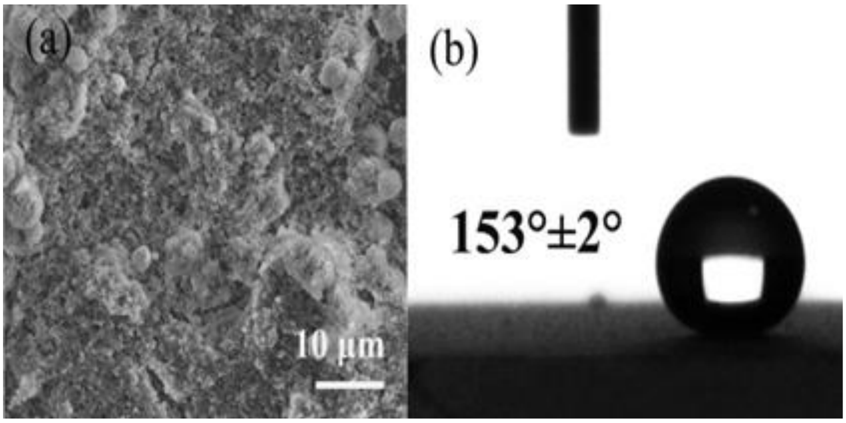

Fig. 1. SEM images of clouds hydrophobic PDMS/SiO2 and drop contact angle with the surface.

By Zhiqing Yuan and colleagues [9], a simple and easy way by casting solution, to prepare a super hydrophobic surface containing the PDMS / CaCO3 was developed. Coverage can be obtained on different substrates such as paper, glass slide and copper sheets used. The results showed that the contact angle of a hydrophobic cloud cover obtained with the optimum ratio of PDMS and CaCO3 nanoparticles can reach 160 degrees. In another study published in 2010 an effective way to produce a clear polymer coating with hydrophobic silica was present by adding silica nanoparticles modified polyvinyl chloride coating can be greatly increased excretion of water. This avoids the need for additional surface modification with low surface energy is not a solution that was actually the casting method. [10].

Yingke Kang and colleagues, and cloud hydrophobic porous coating of polyvinyl chloride (PVC) were prepared without providing compounds with low surface energy. The contact angle was 150° coverage with high resistance to corrosion than indicated for separating water from oil, high performance show cased [11].

In another study Ching-Yee Loo and colleagues, cloud cover made from PVC provided hydrophobic and antibacterial. To prevent the formation of biofilm and fixes emission levels following devices PVC, polyvinyl chloride level was revised level of 150 degrees was reported that the water contact angle while in the unmodified PVC contact angle was 78 degrees. Attract bacteria on the surface of untreated PVC happened quickly absorbed on the surface of polyvinyl chloride modified bacteria postponed 24 hours[12].

MATERIALS AND METHODS:

In the present experiment, the polyvinyl chloride as raw material, as solvent tetrahydrofuran and the thiol silver and silica nanoparticles to influence the ultimate performance in terms of hydrophobic coating is used. In the present experiment casting solution and impregnation solution was used to prepare coatings, so that 0.5 grams of poly vinyl chloride at a temperature of 40 ° C in 30 ml of tetrahydrofuran was dissolved 3 ml of silver thiol was added to the solution. The silica nanoparticles at different concentrations (0.003, 0.008, 0.01, 0.05, 0.1, 0.2, 0.3 g) were dissolved completely in the solution at 80 ° C, and the solution was stirred for 90 minutes at rpm 1000. Silica nanoparticles are dispersed as well. Ultrasonic bath for 90 minutes then placed in the solution by pre-cleaned glass was poured and dried at 50 ° C[13].

RESULTS AND DISCUSSION

Model analysis on samples quizzes and tests CA, SEM and AFM was performed. In the present work, a coating of PVC with silver thiol concentrations of silica nanoparticles were prepared that all tests and analyzes mentioned above, cloud hydrophobicity confirmed contact angle, hydrophobicity, high coverage analysis, testing micro- and nano-structured coating surface morphology SEM and AFM topographic roughness on the surface of the coating test shows. The concentration of nanoparticles is an important parameter in determining the results according to the analysis is done. The finer the grain size is used to increase the hydrophobic silica nanoparticles due to changes in surface energy would be more effective.

Silver Tivoli also use hydrophobicity in a way that stimulates the polymer structure was coated silver and that's why the cover shows good surface roughness. According to the results obtained contact angle, it can be concluded that increasing the silica nanoparticles plays a significant role in hydrophobicity. There can be increased and decreased hydrophobicity nanoparticles that can be paired together with the hierarchical structure of micro and nano-coating it.

Contact angle between the droplet and the surface coating produced 5.0 grams of pure PVC to determine the hydrophobicity was measured (Figure 3). Due to Contact angle of about 90 degrees, with a hydrophobic coating is very weak Left and Right Angle drops in contact with the surface covered by 87.8 and 95.1 degrees. Interestingly, Right Angle drops tend to be weak in contact with the surface hydrophobic and hydrophilic angles tend to be left the difference in angle drops to about 8 degrees left and right angles of a drop in non-uniformity is achieved between the coating and also offers. Drop shape on the surface of the coating, which is almost half the butter and crescent like being outside angles are symmetric mode in discussing hydrophobic, smooth surfaces and surface Contact angle close to 90 degrees to receive are the form of drops on the surface of the coating comes in the form of hemispheric PVC coating net with respect to Contact angle of 90 degrees cannot be directly classified as hydrophilic and hydrophobic groups. Compared with hydrophilic and hydrophobic surfaces of the hydrophilic and hydrophobic surface free energy drops lot of poor Asin hemispherical coverage and adhesion to the surface will result in drops the result will be getting a very poor coverage, and hydrophobicity. Figure 3 shows the arrangement of a drop of water on the surface of the sample containing pure PVC contact angle is observed.

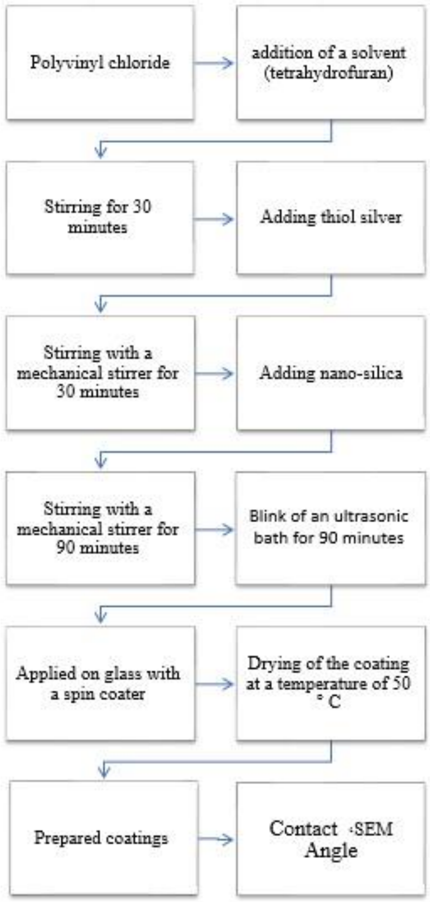

Fig. 2. Flowchart of production stages covering.

Hydrophobicity behavior detection is the most important criterion for measuring Contact angle between the water droplet contact angles with the surface area of composite 0.5 g of polyvinyl chloride with 5 ml thiol concentration of silver and 0.2 g silica nanoparticles for coating hydrophobic behavior was measured.

Table 1: The amount of hydrophobic samples obtained with respect to the contact angle.

Sample (Mg)	PVC	PVC (5000)	PVC (5000), Silica (50)	PVC (5000), Silica (100)	PVC (5000), Silica (200)	PVC (5000), Silica (300)
Silver thiol (ml)	-	5	5	5	5	5
Contact angle (°)	90	142	152	155	157	149

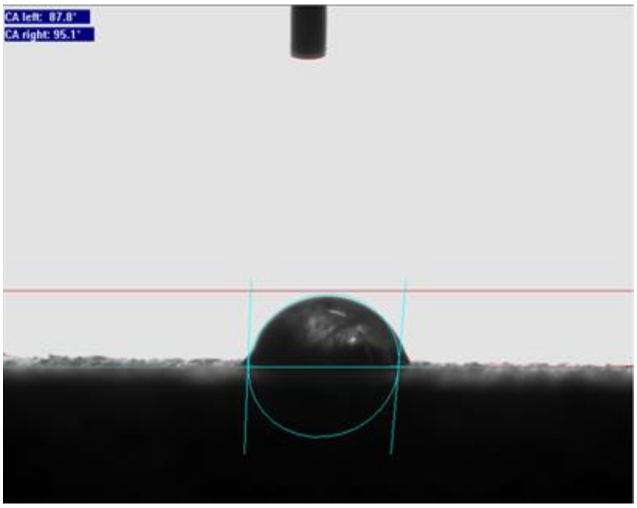

Fig. 3. A drop of water on the surface coverage of 0.5 g of pure polyvinyl chloride.

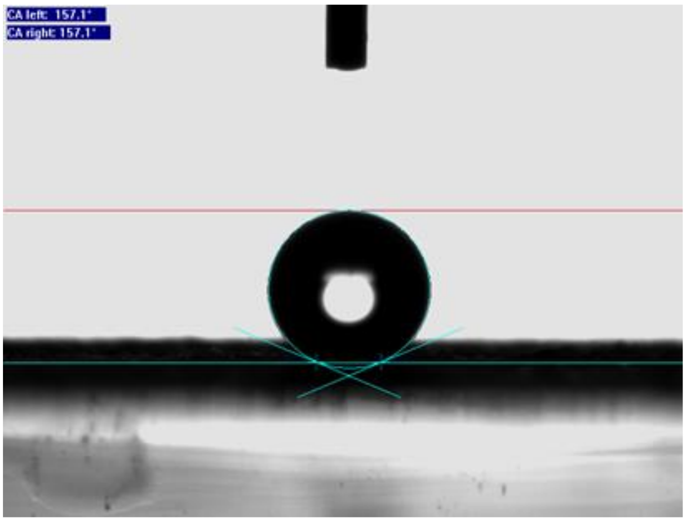

Fig. 4. The form of drops of water on the surface covered with 5 ml of 0.5 grams of polyvinyl chloride Tivoli Composite silver and 0.2 g silica nanoparticles.

Contact Angle Measurement results in Figure 4 show that drop contact angle with the surface area of nanoparticles increased with increasing concentration and Contact angle of 157 degrees is reached. Interestingly, the left and right full equality angle is covered with water drops high uniform level of coverage shows that cloud cover both angles that are hydrophobic and the same cleaning power of 157.1 degrees. According to the results of Contact angle at a concentration of 0.2 g silica nanoparticles to an optimal amount arrive the best super hydrophobic behavior of nanoparticles show up well resolved and are dispersed in a solution of 0.2 g. This causes the hydrophobicity cloud after drying exhibit the best behavior in accordance with the principle of minimum energy, the energy level is less than the cover is stable.

In this case, a mixture of the interface liquid - vapor and solid - vapor drops below the left. In this sense the Cassie-Baxter state compared with Wenzel in terms of sustainable energy is there to better understand the behavior of hydrophobic Cassie-Baxter equation is required.

$$\cos\theta_{CB} = f_s \cos\theta_e - (1 - f_s) \qquad (1)$$

This theory is widely used in such coating with super-hydrophobic properties of cloud, according to the Cassie-Baxter state behavior in the sample, the cloud hydrophobic non-sticky drops of water to the surface and leads to a drop glide on the surface of the sample. In the example above, a nucleus is bombarded polymer nanoparticles very rough on the surface of the nanoparticles have core polymer core by increasing the concentration of nanoparticles completely covered with nanoparticles and creates more roughness in the difference between the contact angle of a drop of 4 samples, pure PVC and composite PVC with silver thiol ml, 5 ml polyvinyl chloride with silver thiol concentrations 0.5 and 0.1 g, are 2, 5, 15 and 85 degrees, respectively. According to the obtained angles process of transition from Wenzel to the Cassie model is clearly visible. Reducing the surface energy which causes more roughness of the nanostructure coating with high roughness, terrain nanometers in size were considered. Whatever the ups and downs coated surface is, the larger the contact angle, also in this case more nanoparticles to the surface roughness of the surface roughness and more finds are micro and nano dual structure in Fig. 4 the form of drops of water on the surface of the composite sample of 0.5 g of polyvinyl chloride and 5 ml of silver thiol concentration of 2.0 g silica nanoparticles with it during the test, the contact angle is shown. It can be seen that the shape of a globe and it is symmetrical angles. Due to the cloud cover shows when the film-forming hydrophobic the drop on the surface is in a state of partial wetting. Thus, changes in surface free energy creates a homogeneous and cloud the view for a hydrophobic surface to give a good answer, but use it while taking a rough surface made it very clear that the force and angles smaller make it harder. Another view is that the surface free energy changes for the turmoil consider the line of contact in the contact angle is obtained. Cover the surface hydrophobic was quite clear that for it in terms of energy, having any contact with the surface is undesirable [14].

As the SEM image obtained from the sample surface can be observed 5.0 g of pure polyvinyl chloride (Figure 5). Does not have any roughness of the surface and a smooth structure can be easily identified in it. Due to the contact angle is obtained, and SEM image taken can be seen that the cover does not want to hydrophobicity and no change in the behavior of both hydrophilic and hydrophobic not occur at an angle of 90 degrees. Due to the smooth surface morphology of the obtained film drops when placed in contact with the surface and half have come in for a lot of the coverage area encompasses. This could indicate high surface energy coating that smooth morphology confirms that it covers[15].

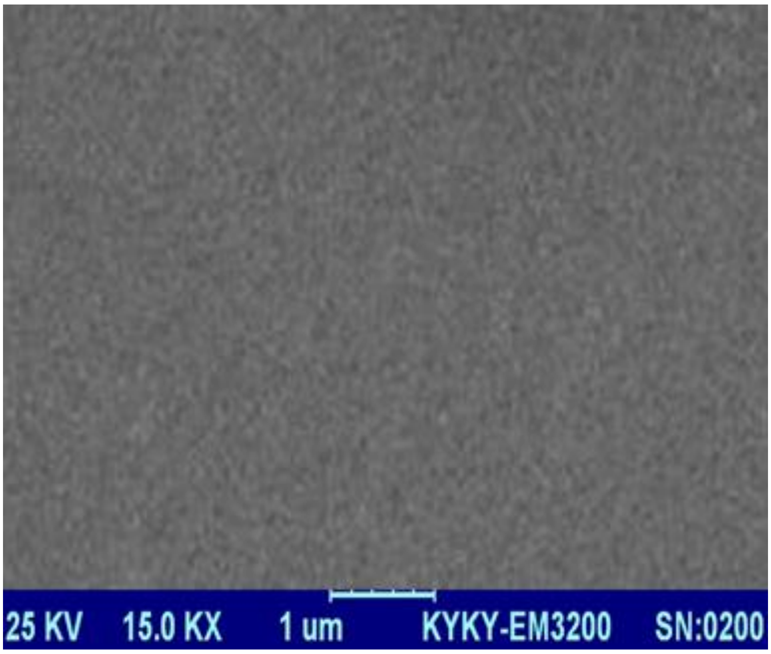

Fig. 5. Image scanning electron microscopy (SEM) coverage of 0.5 g of pure polyvinyl chloride.

Nanostructures low surface energy and roughness up for the fact that this property covers surface hydrophobicity and wettability raises much lower level of cover and set it. For that tiny drop of water air bubbles and roughness of micro and nano structures are formed is mounted and self-cleaning effect of the polymer coating silica nanoparticles with thiol silver to happen. The cloud of hydrophobic self-cleaning coating is good wettability coverage directly associated with surface energy that controls the wettability with low surface energy is possible. This enables high dispersion silica nanoparticles during drying silica nanoparticles also have the power of high permeability low and high levels are well distributed coverage. The high permeability of the lower levels of silica nanoparticles to increase the number of high levels and then with other nanoparticles covered the surface of the micro frequently resulting in the formation of micro and nano structure is a hierarchy. Silica nanoparticles with a good density of the surface structure have created between stability and hydrophobicity raise and its surface energy reaches a minimum amount structuring mechanism can be attributed to phase separation resulting from the addition of thiol silver and then the process is complete hydrophobic silica nanoparticles performed (Figure 6).

AFM images taken from a sample of 0.5 g of polyvinyl chloride with 5 ml thiol shows that the roughness of the surface roughness is relatively well in the micro (Figure 7). The height difference in roughness of the surface covered with 5 ml of 5.0 grams of polyvinyl chloride thiol caused by ups and downs in coverage the air can be trapped in the ups and downs of the hydrophobicity when water contact with the surface to be covered. Given that the coverage of micro-roughness is too much, the cloud's behavior demonstrates that the hydrophobicity of water to the surface adhesion of the coating strengthens the Wenzel theory.

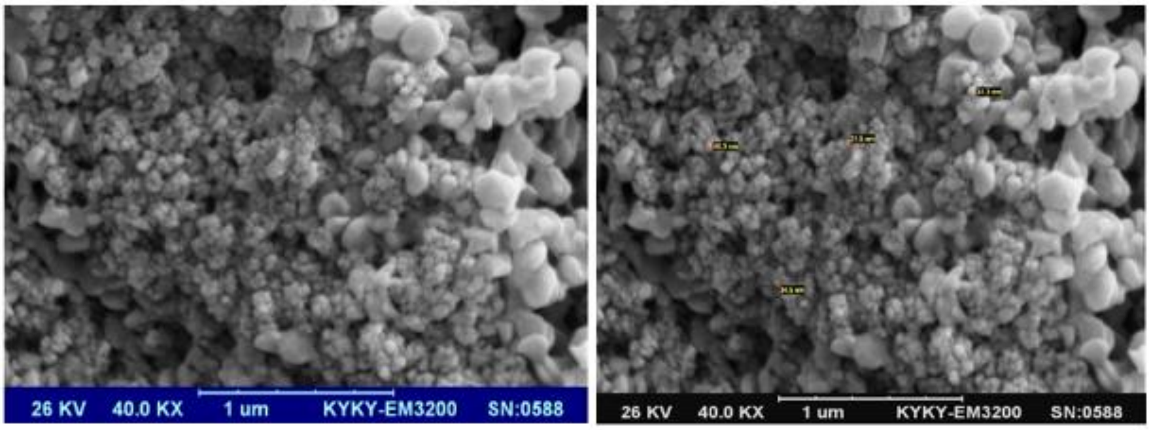

Fig. 6. SEM images of the surface of the coating substrate of polyvinyl chloride 0.5 g and 0.2 g with 5 ml of silver thiol silica nanoparticles with a magnification of 40,000.

Table 2. The following roughness values for three samples

Sample	RMS	Ra
0.5 g of polyvinyl chloride with 5 ml thiol	2.85 (mμ)	2.16 (mμ)
0.5 g of polyvinyl chloride with 5 ml and 0.05 grams of silver thiol concentration of silica nanoparticles	117.5 (mμ)	116.9 (mμ)
0.5 g of polyvinyl chloride with 5 ml Tivoli Composite silver and 0.3 g silica nanoparticles	114.5 (mμ)	113.8 (mμ)

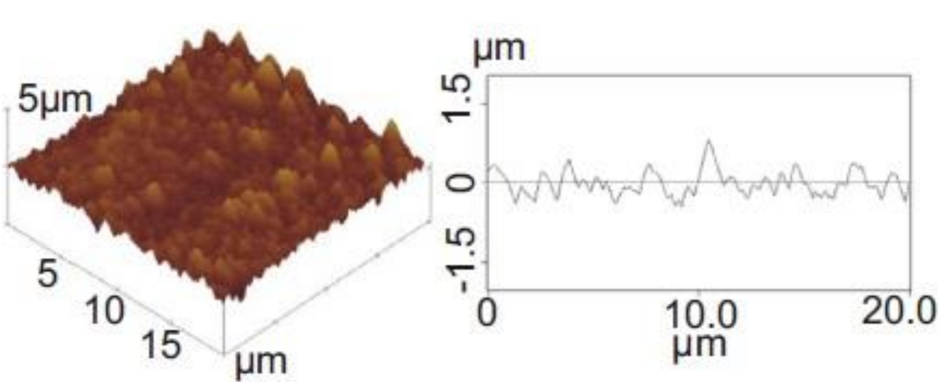

Fig. 7. The surface topography of 50.5 g of polyvinyl chloride with 5 ml of thiol with micro roughness on its surface.

CONCLUSION

1. Silver thiol can be used without the hydrophobic nanoparticles for polyvinyl chloride.

2. The silica nanoparticles decreasing wettability of PVC coverage.

3. The increase in size make more wettability coverage is polyvinyl chloride.

4. Die-casting method suitable solution is an important parameter.

5. Nano particles at a concentration of less than 0.3 g optimal value.

6. With cloud cover hydrophobic surface modification of PVC can be achieved.

7. The evaporation of the solvent and silver change for the better, the result will be better hydrophobicity.

8. Silica nanoparticles due to very rough surface topography and micro and nano structure on the surface are covered.

9. Each porous structure and roughness cannot do action of hydrophobicity.

10. By controlling the concentration of silica nanoparticles can be easily adjusted wettability of PVC coating.

11. Cloud hydrophobicity depends heavily on surface topography.

SUGGESTIONS

1. The stability of hydrophobic nano-composite PVC examined in detail.

2. The method of casting nano-coatings is widely studied.

3. Environmental effects of PVC nanocomposite coating hydrophobic behavior are examined.

4. Other methods used for surface modification of polyvinyl chloride.

5. The antimicrobial properties of nanocomposite coating PVC have been widely studied.

6. The cover of nano topography simulation and compared with the existing model in this field of study.

7. Other nanoparticles coated polyvinyl chloride is used to adjust the wettability.

8. Nano-coating performance polyvinyl chloride are widely investigated.

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