Hydrophobic Aerogel-Based Film Coating On Glass By Using Microwave

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Abstract—Naturally hydrophobic films is currently receiving a lot of attention and has inspired efforts to create biomimetic surfaces. Application technology can be used as a water repellent coatings, for glass at a solar cell that can clean independently, so the use of outdoor solar cell can be used in a relative long period of time. In this study, the silica sol is made by making a solution of Na Silicate at 7%. and for the stabilization solution is used 1 M citric acid solution until a pH of about 2. Glass hydrophobic obtained by film coating on the glass test by means of dip coating, silica sol used is stabilized silica sol, glass coated silica sol are soaked in a surface-modifying agent that is TEOS, methanol, and n hexane in the ratio 1: 1: 1 volume ratio. The goal of treatment is to form silanol groups on the silica surface. The best hydrophobicity properties obtained on condition of Na silicate 7%, the modification time 2 hours at a temperature of 30^0C, the contact angle (Θ) of 128.4^0. The results of the study when compared to heating without microwave which takes 7 hours at 50^0C in terms of aspects of energy consumption, the use of the microwave can save energy by almost 85% to earn hydrophobic movie characters.

Keyword—coating glass, modified surface film, hydrophobic film

INTRODUCTION

Natural hydrophobicity of the currently receiving a lot of attention and has inspired efforts to create biomimetic surfaces. Especially the lotus plant, the leaves take advantage of Hydrophobicity as the basis of a self-cleaning mechanism: nearly spherical drops of water can easily roll off the leaf, bring unwanted particles and thus clean the surface. This observation is usually referred to as the lotus effect. Leaf surface indicates that the surface consists of a micro surface with nano particles of wax on it. Application technology can be used as a water-proof coating, for window cleaning independently. The criteria required to obtain hydrophobic surface there are two, the first hydrophobic surface should have a high contact angle with water (> 90 0 on a flat surface) and the surface should be structured micro or nano. Thrust satisfactory water can also be developed strong hydrophobic coating for self-cleaning, invisibility and anti-clogging applications in tooling coated, particularly on the optical detector. [1], [2]

Although some multinational companies have recently released products functional layer but their practical integration in the application for the building is still an open issue. High production costs associated with vacuum deposition technologies that already exist, as well as difficulties in expanding the function by a single layerrepresents a major limitation for diffusion on a large scale. The main topics in the field of functional coatings for architectural glass, focusing in particular on potential applications antireflektiv based sol - gel and cleaning independently has received tremendous attention in recent years. This illustrates recent research effort aims to improve the nature and to extend the range of applicability [3] [4]. Transparency films surface-modified silica gel as a% transmittance measured using a spectrophotometer, average has a value greater than 93.5% relative to the glass substrate [5]. Increased research and manufacturing hydrophobic surface films for practical applications, inspiring use in corrosion, erosion or general application to give protection degradation on the surface of solid metal, polymer and inorganic oxide (stone, glass, ceramic, etc.). In recent years, this area has developed into a major trading industry that includes modern application of anti - fogging and water and dust repellent / crust on the surface of construction materials, glass, automotive and aerospace technologies. Various methods / ways to reduce the coefficient of friction on wing aircraft and the ship's hull. Glass coated with silica using tetraethylorthosilicate (TEOS) as a source of silica can be made hydrophobic glass surface and has a cleansing effect independently. The removal of the independently has the key advantage to keep the surface clean while beads of rainwater will be rolled over so that the surface to avoid trapping dirt and particulates. The use of expensive materials such as TEOS and application process that takes a long time relative preclude practical applications, thus requiring the process of making the relative cost and relative usage process fast. Study filmmaking superhidrofobik using microwave assistance is expected to overcome the problems of hydrophobic film applications.

Microwaves refer to electromagnetic waves in the frequency range from 300 to 300,000 mega hertz (MHz) (millions of cycles per second). Electromagnetic waves are waves of electrical and magnetic moving together through space. They include gamma rays, x-rays, ultraviolet radiation, visible light, infrared radiation, microwaves and radio waves are less energetic. Microwaves can pass through materials such as glass, paper, plastics and ceramics, and is absorbed by the material and water; but reflected by metals. Microwave has many applications. In general, the electromagnetic field generated in the microwave oven will cause excitation, rotation / collisions of polar molecules and ions in the material. The molecular friction will generate heat and cause a further rise in temperature. Two main mechanisms are dipolar and ionic interactions, explains how the heat generated in the material. After the microwave energy is absorbed, polar molecules such as water molecules in the material will rotate in accordance with the alternating electromagnetic field. The water molecule is the "dipole" with one positive charged one end and a negative charge. Similar to the action of the magnet, "dipole" will adapt when they are affected by electromagnetic fields. Rotation water molecule will generate heat for heating. In addition to the dipole molecules of water, ionic compounds (ie dissolved salts) in the material can also be accelerated by the electromagnetic field and collide with other molecules to produce heat.

METHODS

Developing a hydrophobic film-making process by using microwave to speed up the production process and equipment design manufacture (reactor) to the film making process hydrophobic.

Materials used in this study include: glass slide microscopy to media coated, solution of Na silicate Merck (water glass, 28% SiO_2), NaOH, ethanol, citric acid, tetramethyl ortho silicate (TEOS), deionized water, NH_4OH and n heptane.

The equipment is planned to be used in this study :, glassware,, furnaces, reactors equipped with climate control, instrumentation equipment: FTIR, pH meter, SEM, Thermal conductivity HVS-40-200SF

a. Stages of Research

Synthesis superhidrofobik movie involves four main steps:

(i) preparation of a substrate for the quality of a good movie
(ii) preparation of a silica sol of sodium silicate
(iii) dipping and coating substrates in silica sol, and
(iv) the surface modification of the silica film in the microwave.

Preparation of glass substrates made by washing a glass slide with acetone for 15 minutes. The substrate is then dried in an oven at 105 ^{0}C. Silica sol prepared from dilution of sodium silicate, sodium silicate solution concentration is 7.0% by weight. The solution is then mixed with the cation resin H with a volume ratio of 1: 1 and stirred by magnetic stirrer for 30 minutes to exchange the Na ions in a solution of sodium silicate ions with H, add with 1 M solution of silicic acid until pH of about 2, a solution of silicic acid is used as a starting material for making the silica film on a glass substrate.

Then the substrate is coated with silica sol by dip coating method. In this case, the glass substrate is dipped and then pulled at a rate of 7.5 cm / min. Subsequently allowed to stand for a certain time (10 minutes) in the microwave at room temperature in order to strengthen the adhesion force between the glass and the silica film. Silica surface modification is done by solvent exchange method. This is done by dipping a glass substrate coated silica in methanol to exchange pore water with methanol, the treatment is done in the microwave. This step is necessary to modify the surface using the material, that is, the solution is the alternative that is TEOS, ethanol with a catalyst NH_4OH composition ratio of 3 ml of NH_4OH (30% in water) 50 ml of methanol and 3 ml of TEOS, soaking time is from 30 seconds to 10 minutes and the temperature at room temperature. Finally, the substrate was dried in an oven at 100 ° C for about 2 hours.

b. Characterization

Hydrophobicity of the film was measured by measuring the contact angle of water falling on the surface of the film with a syringe. Contact angle measurements performed by taking a drop of water by using a camera and measured the angle of the images obtained. The film surface morphology was observed by an optical microscope USB Transparency film was measured by measuring the transmittance using UV-vis spectrophotometer (Genesys 10, Thermo Scientific). The thermal conductivity is measured using a thermal conductivity HVS-40-200SF.

RESULTS AND DISCUSSION

Hydrophobic glass obtained by coating the film on the glass test by means of dip coating, the glass is dipped in silica sol is then withdrawn at a speed of about 7.5 cm / min. Silica sol used is stabilized silica sol (not yet formed a gel), glass coated silica sol are soaked in a surface-modifying agent that is TEOS, methanol, and n hexane in the ratio 1: 1: 1 volume ratio. Soaking with this solution performed in a microwave with time and temperature variations, namely 1; 2; 3 and 4 hours at a temperature of 30^0 C; 40^{0}C; 50^{0}C. The goal of treatment is to form silanol groups on the silica surface

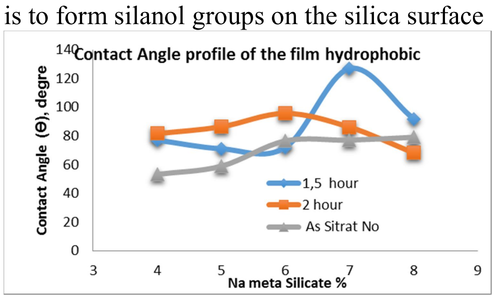
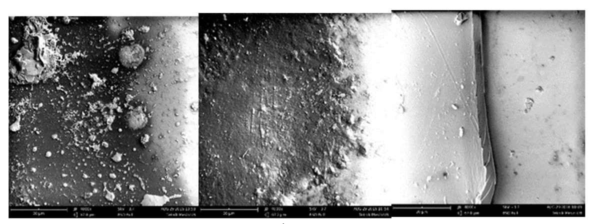


Figure 1: Profile contact angle with Na meta silicate %

Figure 1 shows that shows the results of the contact angle variation changes the heating time 1.5, and 2 hours in mocrowave at T = 50^{0}C, at 2 hours modified hydrophobic film surface for contact angle parameter is not detected properly < 90^0. This case has not given the expected results as hydrophobicity of the film with temperature variations in the microwave showed that at temperatures > 50 ^{0}C

Hydrophobicity decreases marked by the small value of the contact angle is <90^0. Meanwhile, the longer the time variation is > 1.5 hours and 2 hours. Shows the average contact angle is smaller than the 1.5 hours treatment. This is very different to that produced by the research [7], the largest contact angle is obtained with a time of 7 hours at a temperature of 50^{0}C with a solution of 9.7 M TMCs with a contact angle of 142.50.

In the figure 1 shows an increase in the contact angle with the addition of citric acid to help the formation of silanol affecting the nature of hydrophobicity. The highest contact angle values obtained at 128.41^0 in microwave for 2 hours at 50 ^{0}C. From these results it appears that using microwave heating was not long enough 1 hour at 50^{0}C compared to heating without microwave which takes 7 hours at 50^{0}C. Warming longer and higher temperatures will result in a decrease in the contact angle, viewed from the aspect of energy consumption, the use of the microwave can save energy by almost 85% to get a movie character hydrophobic but not in getting the optimal character, ie the contact angle reaches 145. At temperatures compared to the same without microwave heating, the longer the microwave will occur higher molecular collisions that result in the formation of silanol expected not formed from silica.



a b c

Figure 2: SEM resuls for a: contact angle 90^0; b 99.1^0; 128.5^0

Figure 2-c shown that the contact angle of a peak 125.5 obtained depens on the surface roughnee and the perfection of the process of growth of silanol. Figure 2-a show that hydrophoicity properties relative to the hydrophilic, depens on the scale grain surface. The nano particle size coating will increase the hydrophobicity properties are shown in figure 2-c.

CONCLUSIONS

1. Hydrophobic aerogel layer can be former by using a solution of 7% Na meta silicate with a solution of surface modification using a volume ratio TEOS, methanol and n Hexane: 1:1:1

Modification of the surface with a temperature 50^{0}C for 2 hours with microwave

Reduce to energy using is efficiency of about 85% compared to convensional heating

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