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A STUDY OF ANODIZING CURRENT ON ALUMINIUM SURFACES FOR FOOD CONTACT MATERIALS

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ABSTRACT
Aluminum is becoming more popular as a food contact material due to its high heat conductivity, lightweight, and inexpensive cost. As a result, it is commonly employed. Aluminium cooking and storage equipment has a problem with soil remained on food contact surface, which are difficult to clean. At the same time, Teflon-coated equipment cannot be used at high-temperature processes. To address these issues, anodized aluminium enhances the surface of the aluminium to be more hydrophobic behaviour. This procedure is intended to assist less food fouling deposited to the metal surface, making cleaning easier. This research focuses on two anodizing parameters likely to affect contact angle: current and process time. An electroplating machine was used in anodizing process. Using electricity at 13, 15, 17, 19, and 21 A, plating times of 5, 10, and 15 minutes, and a contact angle was determined. The experiment revealed that the electric current and plating duration affect the surface's contact angle, with the maximum contact angle being 74.9° at a current of 19 A for 5 minutes.

Index Terms: Anodization, Food contact material, Contact angle

INTRODUCTION
Aluminum is a ubiquitous material used in cooking utensils and food packaging. It is visible in everyday life. The benefits include light weight, high thermal conductivity, a high melting point of 660°, and a low price. As a result, aluminium is frequently used. When it comes into food contact surface, however, the usage of aluminium containers is problematic. For instance, deposited food on utensil surfaces is difficult to remove and case corrosion with highly corrosive agents are used during cleaning. Teflon is a commercial name for polytetrafluoroethylene (PTFE). Its remarkable qualities include a low friction coefficient, a hydrophobic substance, remained adherence reduction, and ease of cleaning. As a result, this material is used as a coating on numerous food contact surface, particularly the surface of various kitchen equipment. During frying, Teflon answersthe problem of food sticking to the container. Teflon has a melting point of 327°, which helps reduce the oil used in cooking. To avoid Teflon contamination of food, coated utensils should only be used at low to medium heat (Twoseadj, 2009). The contact angle value expresses the wetting ability of a material surface exhibiting the change in the appearance of the hydrophobic will have a higher than hydrophilic. The contact angle, measured with a contact angle meter, determines the wettability of liquids such as water and oil. There are two sorts of wetting abilities a liquid comes into material contact surface: Non-wetting or hydrophobic property when a liquid contact the surface, it exhibits hydrophobic qualities and contact angles greater than 90°. Wetting or Hydrophilic property this surface has hydrophobic characteristics. The contact angle is less than 90° when the liquid contact with the material surfaces (Tidarat, 2012). Hence, the research team used anodizing to improve the surface of aluminium components to eliminate food concerns. For usage in high temperatures and adhering to the container. It may be used in place of Teflon-coated containers. The authors investigated several elements expected to influence the contact angle value, such as electric current and plating time.

OBJECTIVES OF RESEARCH
To study the anodizing process aspect that influences on the contact angle of aluminium materials surface.

SCOPE OF RESEARCH
The most frequent process is sulfuric acid anodizing. The Type II method of sulfuric acid anodizing uses sulfuric acid as the principal solution and produces medium film thicknesses ranging from 1.8 µm to 25, according to the

MIL-A-8625 standard. We operate thicker than 25 µm Type III, Hardcoat or Engineered anodizing very thin plating (using sulfuric acid as the main solution). This method is known as Type lIB. Extremely thick plating necessitates a technique and equipment for temperature control. Therefore, it employs a chiller to cast the plating solution near the freezing point of water and employs a higher current than thin plating. Thick plating provides film thicknesses ranging from 25 to 150 µm. Thick anodic plating improves corrosion resistance, abrasion resistance, heat resistance, and insula simultaneously. MIL-A-8625 defines standard electrical controls for thin (Type IIB) and medium thick (Types lI) plating as AMS 2471 (unplated), AMS 2472 (plated), and AMS 2473 (plated) (plated). MIL-A-8625 defines Category III thick plating control, notably AMS 2469. (Kritwan Kiewchaisong, 2018). Material: Aluminium sheet, grade 1100, thickness of 2 mm.

Variable

- Independent variables: electric current, plating time
- Dependent variable: Contact angle value
- Control variable: Aluminum plate

METHOD

Aluminium anodizing Preparation of anodizing solution Solution used for anodizing is sulfuric acid (H_2SO_4).

Mixing using the AAA rule, means Always Add Acid to Water. Mixing, prepare 2,200 ml of water beforehand. Then, slowly pour it in 220 cc (10%) sulfuric acid. Never throw water into the acid during this operation because it can explode.

After the acid is poured, let the mixture cool after mixing because it will be hot. During anodizing, when the solution is hot, the plating will be affected (Aluminum anodizing, 2019).

Surface treatment of aluminium sheets Soak the anodized metal workpiece in Sodium hydroxide (NaOH) for 10 minutes at a rate of 50 grams per 1 liter of water.

The anodizing procedure Amount of electric current

Table 1: Show the amount of electric current case in each plating time.

Electric current case (A)	Time (Minutes)		
	5	10	15
13	45.5	78.3	61.8
15	62.4	71.5	65.5
17	73	53.5	69.2
19	74.9	58.9	70.7
21	67.2	51.4	72.1

Then, continue in example 6 and 7 after preliminary tests to see the trend of the graph.

Table 2: Show the amount of electric current case 6 in each plating time

Electric current case (A)	Time (Min.)									
	1	2	3	4	5	6	7	8	9	10
19	30.9	39.9	64.6	66	74.9	67.7	68.9	50.3	31.7	26.7

The peeling procedure Start with an anodised workpiece. Wash with fresh water.

Soak the work items for 10 minutes in boiling water at 80-90° to close the anodizing tube (Mopon, L. et al. 2021). Measure the contact angle by using contact angle meter

RESULTS AND DISCUSSION

Contact Angle Measurements Figure 1. shows the aluminium plate's contact angle. Ten replicated measurements were exammined, with plating times of 5 minutes, and were averaged over the anodized sheets at 13, 15, 17, 19,

and 21 amperes. The figure shows how the amount of electric current effect on the contact angle. At a current of 19 amperes, it has a maximum contact angle value of 74.9^0.

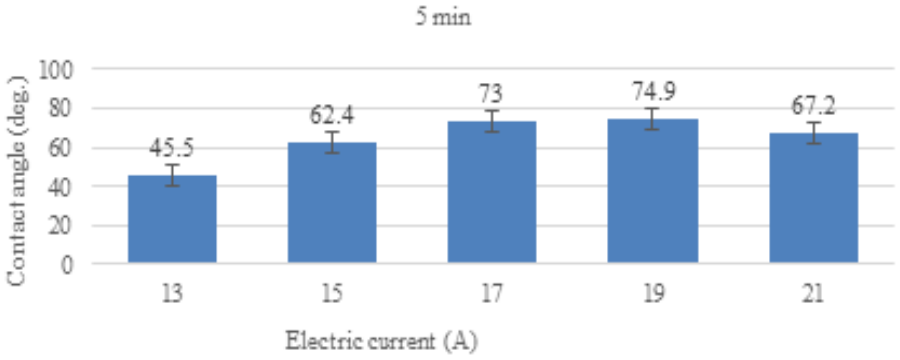

Figure 1: The relationship between the current and the contact angle after the plating time for 5 min.

The contact angle of the aluminium sheet is shown in Fig 2. Ten replicated measurements were examined, with plating times of 10 minutes, and were averaged over the anodized sheets at 13, 15, 17, 19, and 21 amperes. The figure shows that the amount of electric current influences on the contact angle. At a current of 13 amperes, it has a maximum value of 74.9^0.

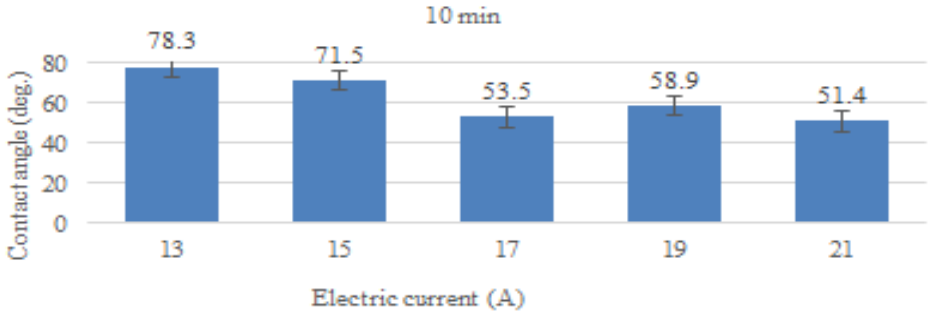

Figure 2: Relationship between current and contact angle after 10 min.

The contact angle of the aluminium sheet is depicted in Figure 3. At 13, 15, 17, 19, and 21 amperes, 10 points were measured and averaged over the anodized plates, with a plating duration of 15 minutes. The figure shows how the amount of electric current influences the contact angle by contact angle at a current of 21 amperes and a maximum value of 72.1.

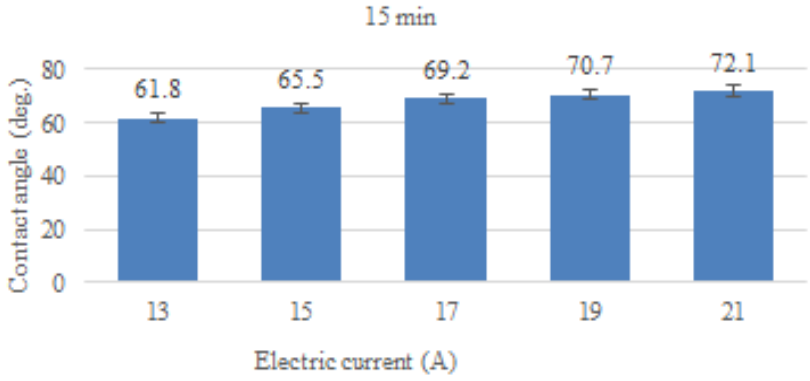

Figure 3: Relationship of the 15-minute connection between current and contact angle.

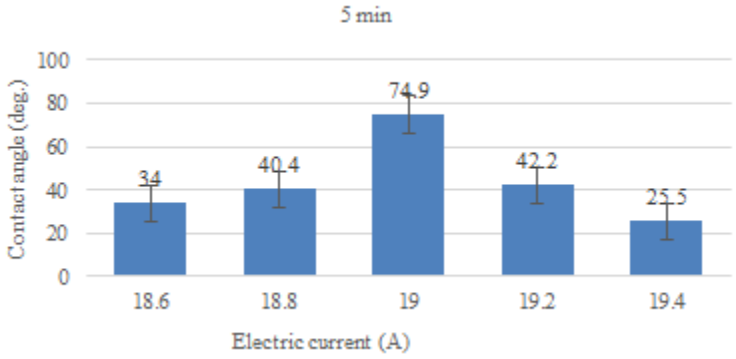

Figure 4: Relationship between the 18.6, 18.8, 19, 19.2, and 19.4 A currents and the contact angle length of 5 minutes.

Figure 4. depicts the aluminium sheet's contact angle. Ten measurements were taken, each at 18.6, 18.8, 19, 19.2, and 19.4 amperes, with a plating time of 5 minutes. The figure shows that the contact angle increases with increasing distance. At a current of 19 A, the maximum contact angle is 70°, and the contact angle drops substantially with increasing current.

The contact angle of the aluminium sheet is depicted in Figure 5. Ten points were measured and averaged across the entire sheet. Anodizing at 19 amps with a quenching duration of 1 to 10 minutes. The figure shows that the contact angle increases with increasing distance and the contact angle reached a maximum of 75 after 5 minutes, and the contact angle decreased dramatically as time passed.

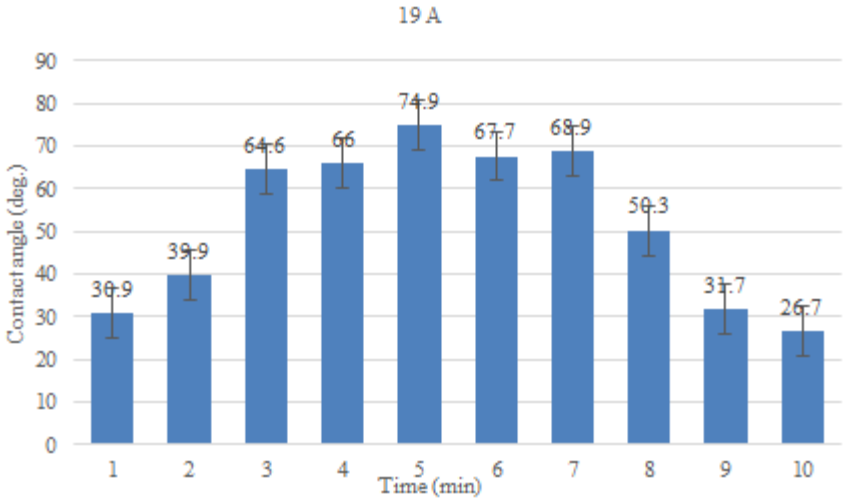

Figure 5: Relationship between current 19A and contact angle for 1-10 minutes.

CONCLUSION

This research aims to study the improvement of aluminum surfaces by anodizing the surface and making them hydrophobic through experiments and analysis. The result is as follows. The maximum value of 74.9 Degree was obtained from the experiment of anodizing aluminium to make the aluminium surface have hydrophobic qualities by examining the contact angle at an electric current of 19 amperes and a plating duration of 5 minutes. Anodizing causes the aluminium surface to gradually form a film layer to the point that the film layer is completely, and the aluminum surface cannot add another film layer. Moreover, if anodizing is continued, the resulting film layer will be eroded by the anodizing agent instead.

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