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大気圧プラズマジェット照射によるアルミ基板の表面化学修飾と樹脂密着性の評価

Chemical Modification of the Aluminum Surface by Atmospheric Pressure Plasma Jet and Evaluation of Its Adhesion Property

伊藤　康介[1]，永津　雅章[2]
Kosuke Ito[1], Masaaki Nagatsu[2]

[1]静大院工，[2]静大創造科技院
[1]Graduate School of Engineering, Shizuoka University
[2]Graduate School of Science and Technology, Shizuoka University

1. Introduction

Recently, transportation equipment industry has desired to reduce the weight of parts, because fuel economy would be improved. Aluminum alloys are lightweight and have a good electrical conductivity. Also, plastic materials are lightweight and have excellent moldability. For these reasons, aluminum and plastic have been used in transportation equipment industry and their adhesion techniques are demanded to develop. Conventionally, the main method of aluminum surface treatment is wet process with chemical. However, issues of this method are in their cost and environmental problem by waste. Contrarily, plasma surface treatment is a dry process and environmentally-friendly. In this study, we developed a new adhesion technique by using the atmospheric pressure plasma jet (APPJ).

2. Experimental setup

Figure 1 shows the schematic drawing of experimental setup for aluminum surface treatment using APPJ. The APPJ was driven by a radio frequency (RF, 13.56 MHz, 100W) and jetted out from a quartz nozzle. Working gas was Ar (2000 sccm). APPJ was irradiated to the hydrochloric acid solution (10%) on aluminum substrate. Treatment time was 1 min. Aluminum surface morphology was analyzed by AFM. Surface roughness was evaluated with an arithmetic average roughness (Ra). The adhesion properties were tested by shear fracture strength test. The test was performed by epoxy bonding agent, and adhesion area was 5 mm × 5 mm. We compared the three samples; (a)untreated, (b)dropped 10% HCl (substrate temperate was 100°C), and (c)10% HCl with APPJ, respectively.

3. Results and discussion

Table.1 shows the values of Ra and the results of the shear breaking strength test. The values of Ra of samples(a), (b) and (c) are 206.7 nm, 1752.7 nm, and 1031.65 nm, respectively. The shear breaking strength of samples (a), (b) and (c) are 4.8 MPa, 7.3 MPa, and 8.1 MPa, respectively. The Ra of sample(b) was bigger than sample (c). However, the shear breaking strength of sample (c) was bigger than sample (b). As a result, we confirmed that adhesion technique by plasma is beneficial.

We will also discuss the relation between aluminum surface composition analyzed by XPS and adhesion property at the conference.

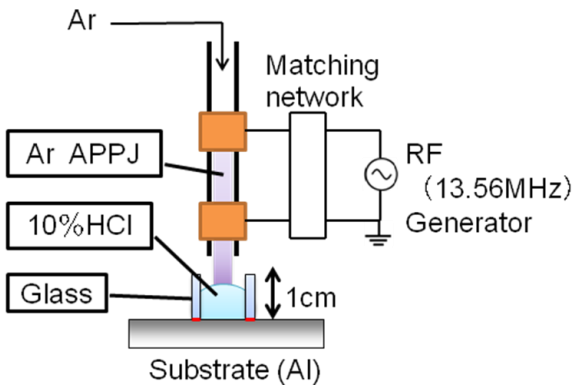

Fig.1 Schematic drawing of experimental setup for aluminum surface treatment.

Table.1 Results of the shear breaking strength test

Treatment condition	Ra [nm]	Shear breaking strength [MPa]
(a)Untreated	206.7	4.8
(b)Dropped 10%HCl (substrate temperate was 100°C)	1752.7	7.3
(c)10%HCl with APPJ	1031.6	8.1