Evaluation of Adhesion Between CFRP and SUS Plates Using RPT-3000W
Comparison of Adhesives (New and Old, Product Numbers) and Surface Treatments

Jan. 31, 2023
A&D Marketing Department
Yoshihisa Sugoh

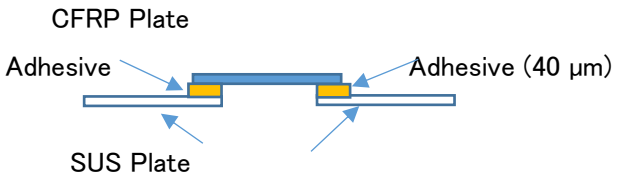
■ Introduction

When using adhesives, it is fine to stick things that you have experience using, but if you made a special order product, you may have had some concerns and consulted with the adhesive manufacturer. Adhesive issues in mass production can result in significant damage. Therefore, it is important to conduct preliminary tests such as tensile and peel tests. It is also necessary to confirm that the adhesive fully cures, which often requires preparing numerous test samples.

In our own company, we had instances where delamination occurred during the bonding of CFRP (Carbon Fiber Reinforced Polymer) and SUS (Stainless Steel) plates. We resolved the issue by using RPT-3000W, and we would like to share our findings with you. We prepared and measured samples with different adhesives (new and old), adhesive varieties, adhesive product numbers, and surface treatments. As a result, we gained insights into the performance changes of adhesives, which varieties are suitable, the effect of surface treatment on the adhered surfaces, and the estimated time required for complete curing in practical applications. We hope this information will be useful for your future reference.

※ In our previous report, we investigated the relationship between temperature and curing time:
https://www.aandd.co.jp/pdf_storage/tech_doc/test/t_rpt_data04.pdf

■ Cross-sectional Diagram



■ Adhesives

A1	Company ■■■■■, Acrylic-based, Lot 200417 (old)
A2	Company ■■■■■, Acrylic-based, Lot 220127 (new, opened on June 8, 2022)
E1	Company ■■■■■■, Epoxy-based Adhesive, Product Number ○○○○○○
E2	Company ■■■■■■, Epoxy-based Adhesive, Product Number □□□□□

■ CFRP Adhered Surface (The woven fibers are solidified with resin, forming a plate)

Glossy Surface
Corona-treated Surface

■ SUS Plate

SUS-polishing	SUS Glossy surface (polishing)
SUS-2B	Non-glossy SUS with 2B
SUS-RPT	Standard Stainless Steel Plate for RPT

Since the parameters became numerous, we performed the minimum number of experiments that could be judged. The adhesive thickness was set to 40 μm and applied using a coating jig.

Contents of the report

■-1 Acrylic Adhesive Differences Between A1 (Old) and A2 (New)

I used an acrylic adhesive A1 that I had. A peeling problem occurred. I wasn't sure why, but I thought maybe it was because it's old, so I bought an adhesive with the same product number.

Substrate used: SUS-RPT

Checked by ISO-12013-1 method (heating test at 10℃/min)

Result-1)

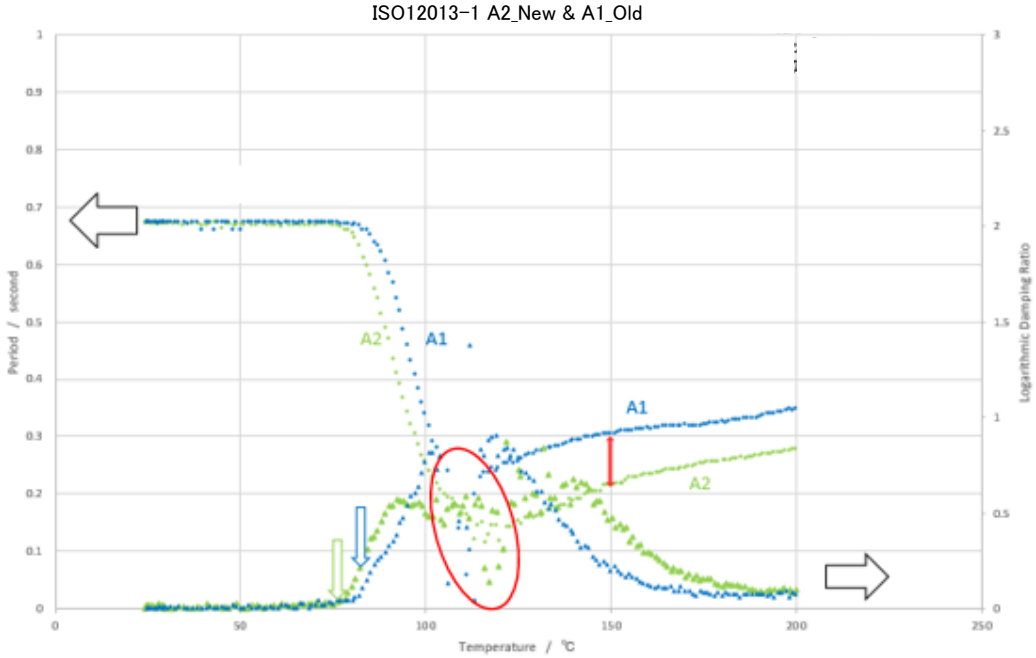


Fig. 1　Comparison of acrylic adhesive A1 and A2

◇ Temperature at which the logarithmic decrement rate begins to rise

A1: Temperature at which the logarithmic decrement rate rises (approx. 80℃)

A2: Temperature at which the logarithmic decrement rises (approx. 74℃)

Since the rising temperature of A1 (old) is higher than that of A2 (new), it can be said that the reaction initiation temperature rose. This is assumed to change over time.

◇ From period data

A1 is less than A2 (length of the red arrow) and there is less curing (low elasticity).

This may be a change over time due to storage conditions.

From around 110℃, both period and logarithmic Damping Ratio data are disordered. (Partial peeling is suspected.)

At 120℃ and above, the period increases with temperature rise, and it may be softening or gradually peeling off.

■-2 Differences in epoxy adhesive product numbers (heating test)

Substrate used: SUS-RPT

Checked by ISO-12013-1 method (heating rate is 10℃/min)

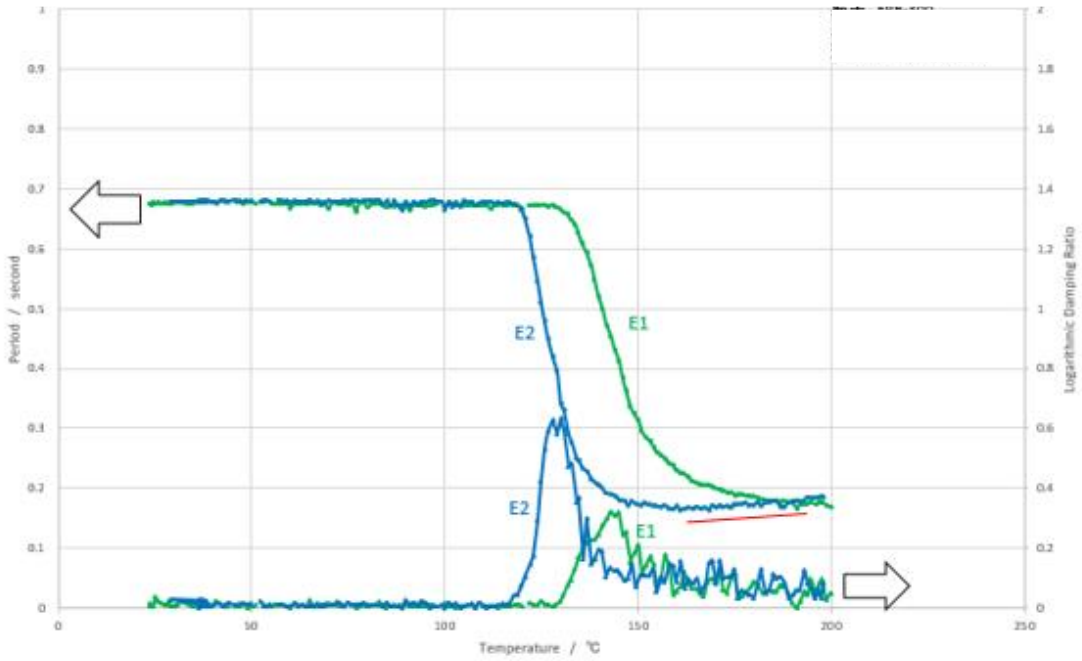


Fig. 2 Differences between epoxy adhesives (E1 and E2) (ISO12013-1)

Result-2)

◇ Rising temperature of Logarithmic Damping Ratio

Epoxy adhesive E1 129℃

〃 E2 118℃

A difference of 11℃ was seen.

Compared to acrylic A1 and A2, no peeling occurred.

At 160℃ or higher, the period of E2 increases, so a slight softening tendency can be seen. (Red line part)

(If use above this temperature is not anticipated, it would also be fine to use E2.)

■-3 Difference in the product number of the epoxy adhesive (120℃ hold)

Substrate used: CFRP （ Glossy Surface ）

Looking at the rise temperature of the Logarithmic Damping Ratio from the results in Fig. 2, E2 is 118℃ and E1 is 129℃, but we compared the situation at 120℃ hold.

Temperature profile

0 to 10 minutes　Room temperature to 120℃

10 to 50 minutes　120℃ hold

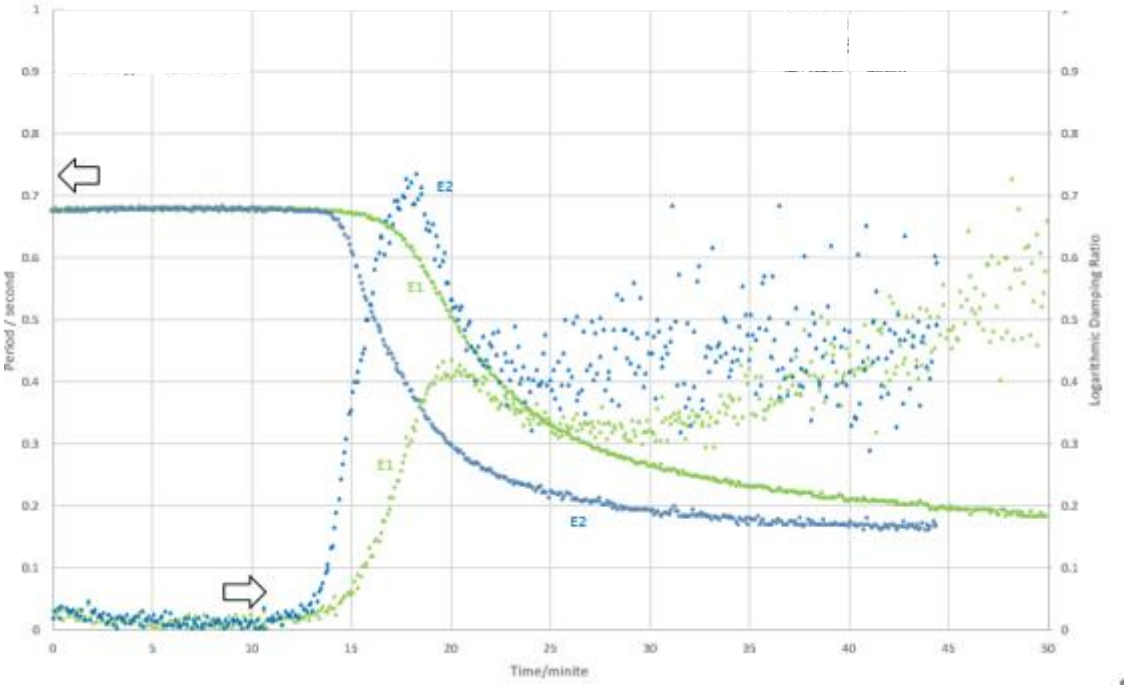


Fig. 3 Differences in behavior due to different epoxy adhesive model numbers when held at 120℃

Result-3)

E2 takes about 40 minutes to harden, but E1 takes longer.

E2 is more superior in curing reaction at low temperature.

■-4 Differences in epoxy adhesive product numbers (room temperature curing)

Substrate used: SUS-RPT

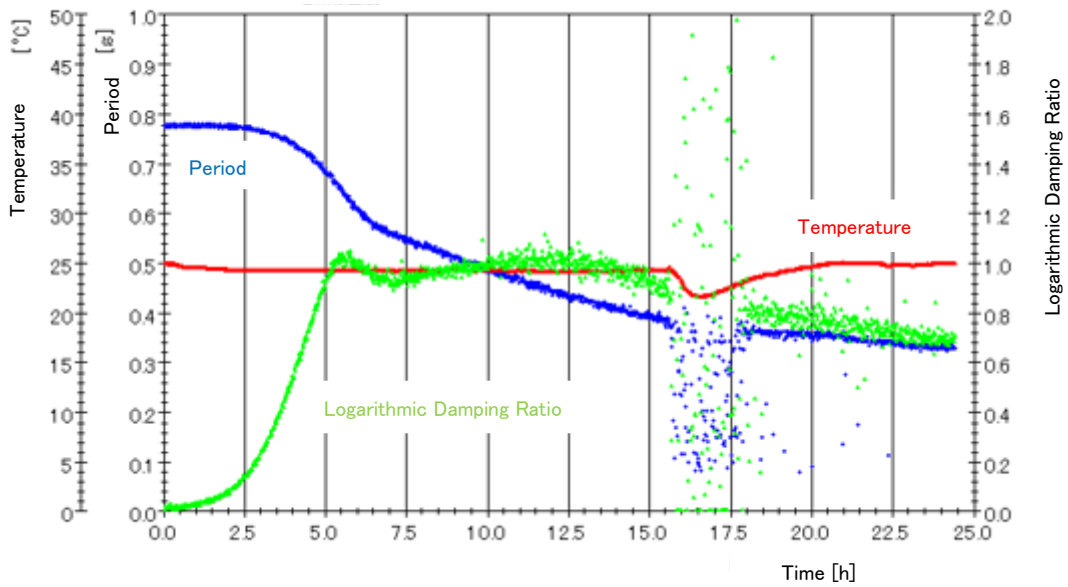


Fig. 4 Room temperature curing of epoxy adhesive E1

◇ E1 curing time is about 24 hours

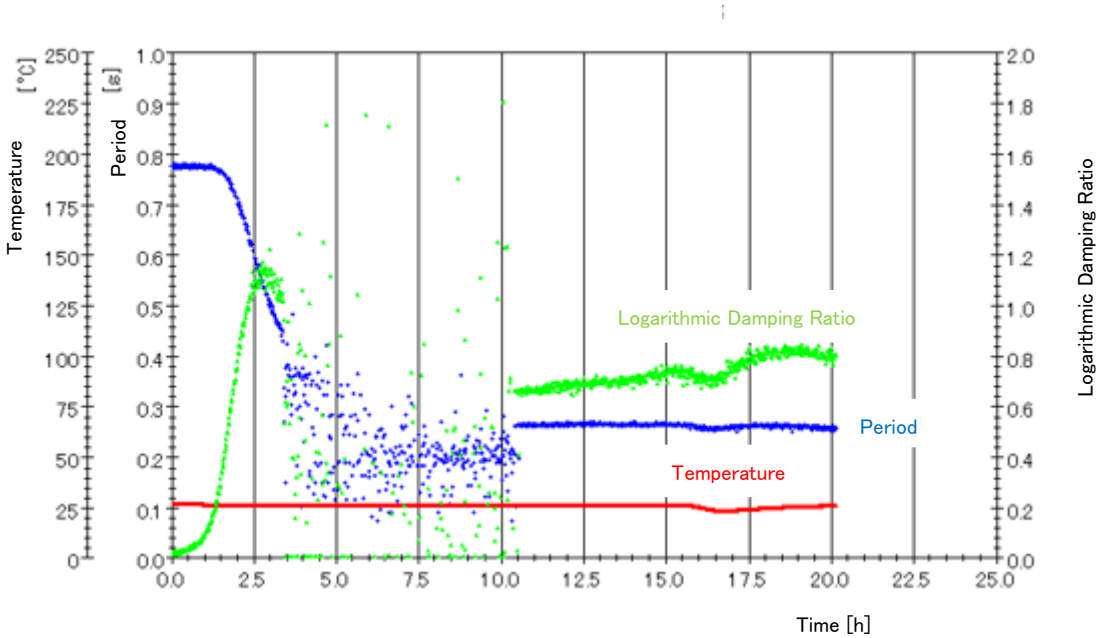


Fig. 5 Room temperature curing of epoxy adhesive E2

◇ E2 is around 12 hours. (E2 is easier to use when working in the field.)

■-5　Differences in surface treatment　（ CFRP　&　SUS ）

Epoxy Adhesive **E1**

0～10 min :　RT　⇒　120℃ ⇒ 120℃ Hold

◇-1 CFRP gloss & corona treatment

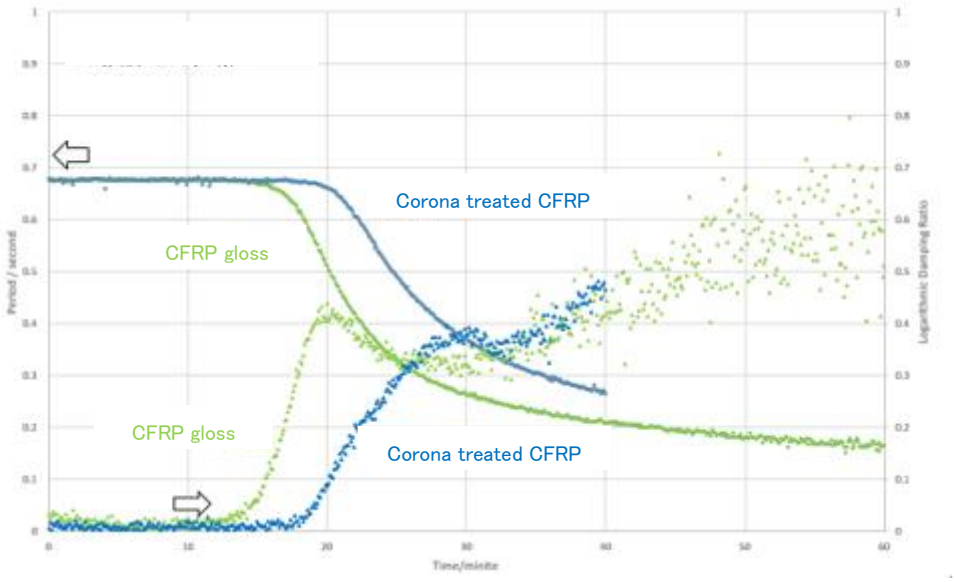


Fig. 6　CFRP glossy & corona treated surface

◇-2 SUS-polishing & SUS-2B

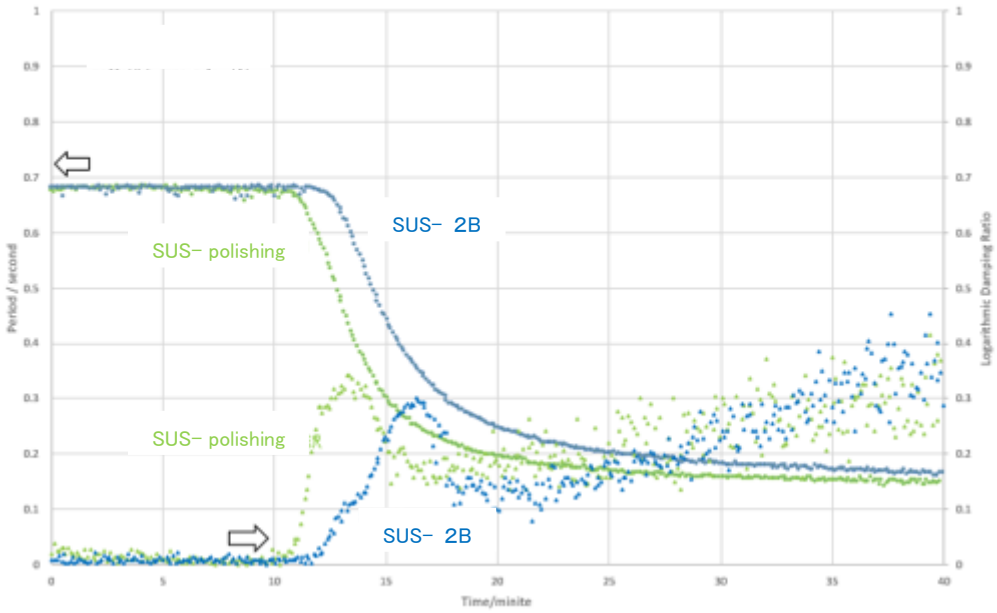


Fig. 7 SUS-polishing & SUS-2B

■−6 Differences in surface treatment (SUS polishing & 2B)

Epoxy adhesive **E2**

0～10 min :　RT ⇒ 120℃ ⇒ 120℃ Hold

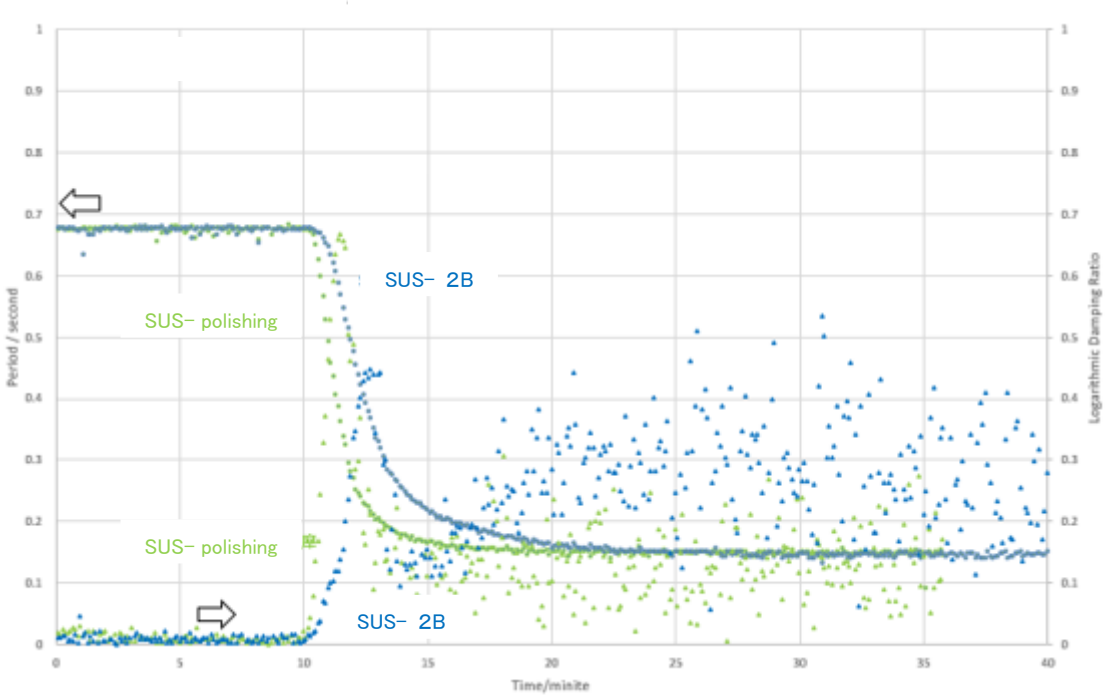


Fig. 8 SUS−polishing & SUS−2B epoxy adhesive E2 (120℃ hold)

■−7 Conclusion

◇ Compared to acrylic adhesives, the epoxy adhesive strength is greater and peeling is less likely to occur.

(It was later found that the surface of the CFRP plate was made of epoxy resin.)

E2 takes a short time to harden and is easy to use on site.

◇ Corona treatment of CFRP

With this CFRP plate, convergence of the curing reaction of the epoxy adhesive is faster without the corona treatment applied.

◇ SUS polishing & 2B processing

In E1, 2B processing takes more time to converge. Polished surfaces gave better results.

(Although the final convergence value of the period may be the same)

In E2, the value at which the cycle becomes flat over time is almost the same as E1.

■-8 Summary

By using the RPT-3000W, we learned the following.

1) You can check the performance of a stored adhesive before using it.

2) Compatibility of adhesives and substrates can be examined and compared in a short time.

3) It is possible to evaluate the effectiveness and non-effectiveness of the surface treatment on the substrates.

4) The curing time of an adhesive can be confirmed.

5) Essentially, accelerated tests and environmental tests that can determine long-term stability in as short a time as possible are necessary.