# DEVELOPMENT OF COMPOSITE CURING PROCESS BY VISIBLE LIGHT

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## 1 Introduction

An application of Carbon Fiber Reinforced Plastics (CFRP) has been spreading for structure of commercial aircraft for a few years. However, as for the curing process of CFRP for aircraft structure, cost reduction is difficult issues due to autoclave curing. In addition, thermal residual stress during cure process at the higher temperature(180℃) is a critical issue for the quality of product. In recent years, non-heating curing technology is noted in the aerospace industrial field because of the reduction of a molding cost, and of thermal residual stress (1).

Authors are developing a curing process by collective irradiation of visible light for low cost curing and a non-heating curing process of CFRP for aircraft.

A CFRP laminate of 2mm thickness with visible light curing material that developed by Toray was cured by collective irradiation. This paper present the results of feasibility study.

## 2 Experimental Method

### 2.1 Prepreg

It is a unidirectional prepreg that made from carbon fiber (T700) and visible light curing resin. The prepreg is supplied from Toray. This visible light curing resin is stiffens by both effect of the light irradiation and the heating caused by curing reaction. Fiber volume(Vf) of the prepreg is approximately 55%.

### 2.2 Instrument

F300SQ Ultraviolet Lamp System that produced by Fusion UV Systems, Inc. is used to irradiate visible light. The Lamp System consists of Irradiator and Power Supply. A wavelength of visible light generated by this lamp system is 407 nm from 405 nm mainly.

The irradiator of lamp system put on a stand as shown in Fig.1. The laminate of CF prepreg was irradiated a visible light by the lamp system. on a mobile stand.

Intensity of the visible light is controlled by height of the mobile stand, and is measured by UV checker UVR-T1 that produced by TOPCON Technohouse Corp.

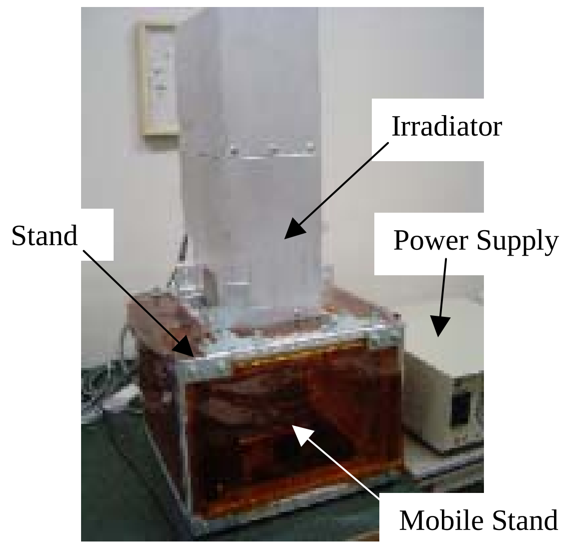


Fig.1 Set up overview of irradiation device

### 2.3 Manufacturing process

The prepregs were laid up to unidirectional laminates by 13 plies（about 2mm in thickness）, 100mm in length and 100mm in width.

A thermocouple is set on the center of a lower part in the laminate as shown in Fig.2. And then the laminate is bagged using a heat-resistant film after covered with mold release films and glass plates.

Finally, inside of the bag is evacuated by a vacuum pump. Temperature of laminate is measured by the thermocouple during thecuring process by visible light irradiation.

### 2.4 Visible Light Irradiation

A visible light intensity of 1.5W/cm$^2$ is irradiated until 188℃ at the temperature of a lower part in the laminate. Again, The intensity of the visible light is confirmed by UVR-T1.

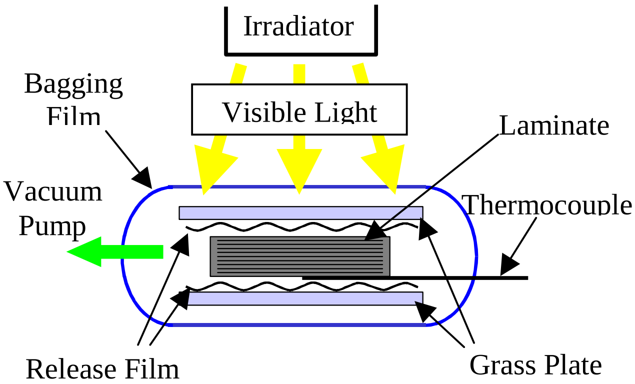


Fig. 2 Methods of visible light irradiation

### 2.5 Property of Laminate

In order to confirm the properties of the cured laminates by the visible light irradiation, we carried out some kind of test.

The reactivity calculated from the ratio of two heating process that is in prepreg before irradiation and is remaining in laminate after irradiation. The reheating energy is measured by the differential scanning calorimeter DSC7 that produced by Perkin Elmer.

To confirm inside quality, void volume is measured from a cress-section photograph of the laminate.

As a mechanical property, short beam shear strength test carried out by using Instron Model 1127 testing machine according to SACMA SRM8R.

## 3 Results

Reactivity of the laminate was 91.0% in center section, and was 99.7% in edge section. The test sample is almost cured in center section, but is not in edge section.

Void volume was 0.2% in the center section. Fig.3 shows center section of the laminates.

The short beam shear strength shows 90MPa. The values of void volume and short beam shear strength were equivalent as CFRP laminate for airplane structure.

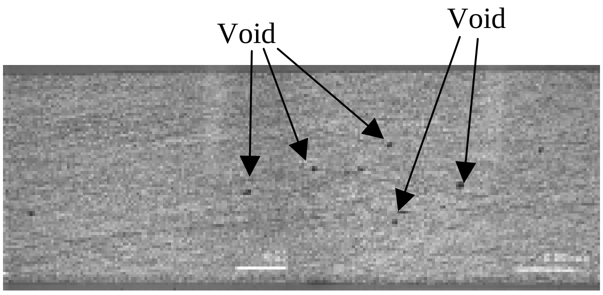


Fig.3 Central Cross-Section of Cured Laminate

## 4 Conclusions

The cured Laminate in 2mm thicknessthat made from carbon fiber and visible light curing resin is irradiated by continuity visible light. The property of the laminate was almost same when compared with conventional CFRP for aircraft structure. As the results, It was verified that a collective curing process by visible light irradiation could become promising technology of CFRP laminate for aircraft structure.

However, irradiation range of visible light is so small (about 100mm square). In addition, big irradiation energy and time is needed to add for thicker CFRP curing. There are some problems for establishment of a CFRP curing process for aircraft.

## 5 Acknowledgement

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## References

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