

엄수현<sup>†</sup> · Piyush K. Dutta<sup>\*</sup> · 권순철<sup>\*</sup> · 김국진<sup>\*\*</sup> · 김윤해<sup>\*\*\*</sup>

## Effect of Fabrication Methods on Static Strength of Polymer Based Composites under the Low Temperature Range

S.H. Eum<sup>†</sup> · P.K. Dutta<sup>\*</sup> · S.C. Kwon<sup>\*</sup> · K.J. Kim<sup>\*\*</sup> · Y.H. Kim<sup>\*\*\*</sup>

**Key Words:** Wind Turbine Blade ( ), Vacuum Bagging Process ( ), RIM (Resin Injection Molding), Composites ( )

### Abstract

When the wind turbine is used in cold regions, the mechanical properties and dimension stability of the blade will be changed. The proposal of this paper is to test the durability of the blade for wind turbine. It is necessary to select the most comfortable materials and fabrication processes for more stable wind turbine blade in cold regions. To select the most comfortable materials and processes, the static strength has to know through the tensile static tests at the severe condition as cold regions. First, the tensile static specimens made by RIM (Resin injection molding) process & vacuum bagging process with reinforcement materials and resin. Tensile static tests were carried out on three laminate lay-ups (carbon prepreg, carbon fiber dry fabric and glass fiber dry fabric) at different test temperature(24℃ -30℃ determining properties such as the mechanical strength, stiffness and strain to failure. At different test temperature, in order to test the tensile strengths of these specimens used the low temperature chamber. Next, the results of this test were compared with each other. Finally, the most comfortable materials and fabrication processes can select based on these results. The results show the changes in the static behavior of three laminate lay-ups at different test temperatures. At low temperatures, the static strengths are higher than the ones at room temperature.

### 1. 서론

가 가 ,

가 .

가 .

(reinforcement)

(matrix)

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E-mail : kaku25@lycos.co.kr  
TEL : (051)410-4966 FAX : (051)410-4355

\* U.S.Army Cold Regions Research & Engineering Laboratory, U.S.A.

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wet lay-up  
 .  
 가 . 가 가  
 prepreg vacuum infusion  
 .  
 .  
 가  
 가 ,  
 ,  
 가 , 가  
 , 가  
 가

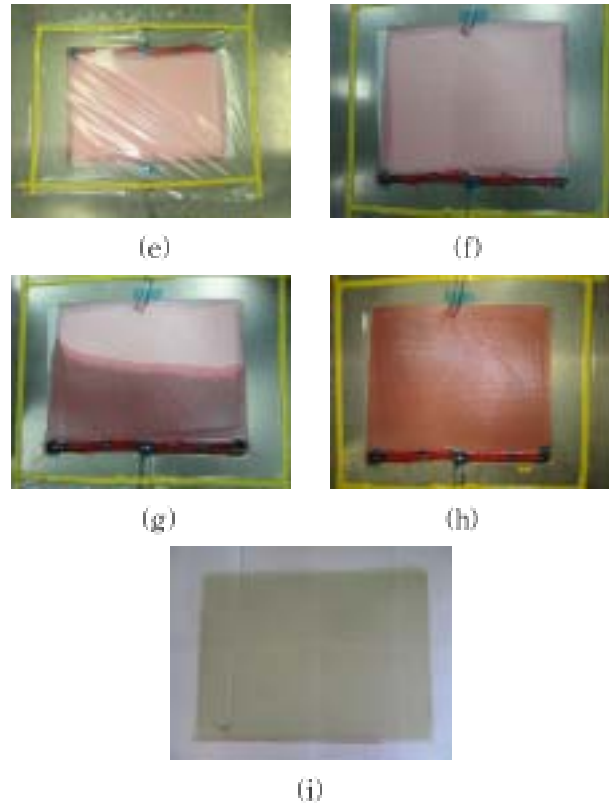


Fig. 1 RIM process

RIM(Resin injection molding)

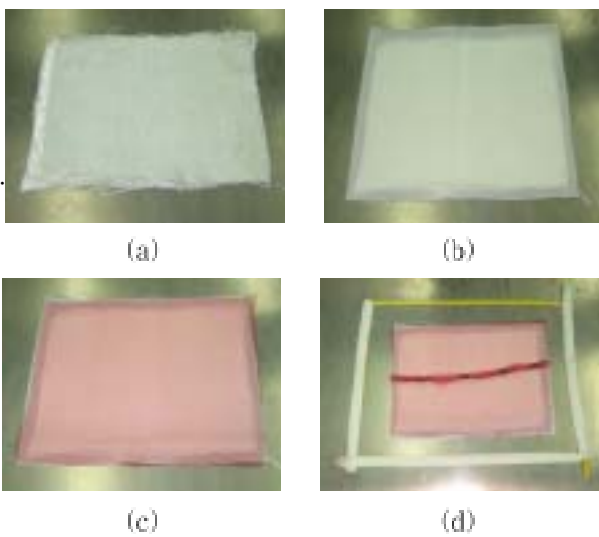
(peel ply)

(resin flower)  
 tape)

(sealant  
 (vacuum bag film)

2. 시편제작

2.1 RIM process



가 . 가

RIM

가

2.2 Vacuum bagging process

Vacuum bagging process

RIM

dry fabric , dry fabric  
 가 B-stage  
 prepreg 가 (Fig. 2). RIM  
 vacuum bagging process  
 fabrication Fig. 3

2.3 시편

(183mm × 19mm)

ASTM D638-9 (Fig. 4)  
 Tensile kut (dog bone)

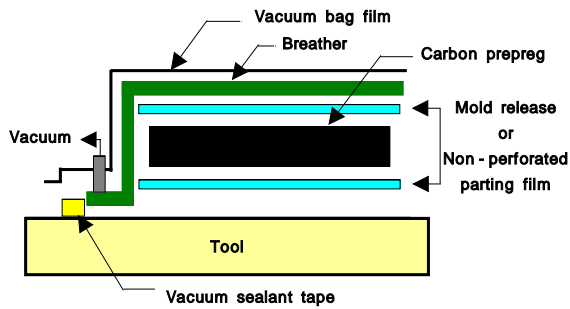


Fig. 2 Vacuum bagging process

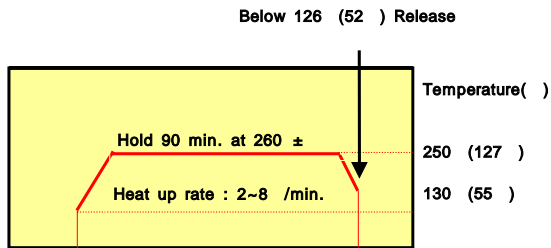


Fig. 3 Cure cycle for vacuum bagging system

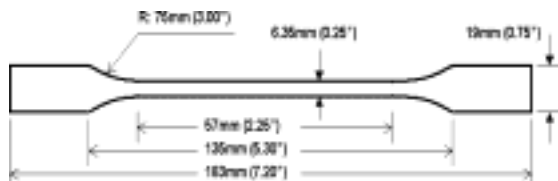


Fig. 4 The shape of specimen (ASTM D638-9)

Table 1 Overview of materials and fabrication method

Group	Reinforcement		Resin		Process	Test Method
	Type	Volume %	Type	Volume %		
A	Carbon prepreg	56.6%	Epoxy	43.4%	Vacuum Bagging	Tensile
B	Carbon fiber dry fabric	45.7%	Epoxy	54.3%	RIM	Tensile
C	Glass fiber dry fabric	59.6%	Epoxy	40.4%	RIM	Tensile

Table 1 vacuum bagging process RIM process

volume %  
 ( ) TB 社 C3327 dry fabric prepreg,  
 社 G635 dry fabric prepreg  
 YD-115, RIM  
 G-A0432, D-230  
 vacuum bagging process prepreg

G-A0432	D-230	50:50
YD-115		100:35

3. 실험

3.1 Test set up

MTS  
 , controller  
 (Fig. 5). -30

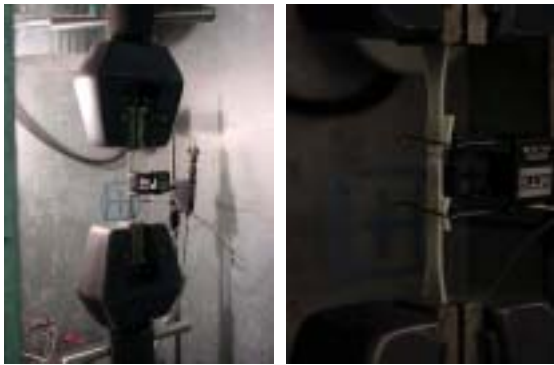
1

3.2 Test

tensile strength Young's modulus  
 ultimate strain



Fig. 5 Test set up( )



(a) Before the test (b) After the test

Fig. 6 Test set up( )

glass dry fabric carbon  
dry fabric RIM  
carbon prepreg vacuum bagging  
process 3가 ,  
(-30 )  
, cross head speed  
1.27mm/min.(0.05in/min.)

4. 결과 및 고찰

4.1 Static tensile test

Fig. 7 Fig. 8

carbon prepreg

carbon dry fabric  
가

dry fabric , glass  
가

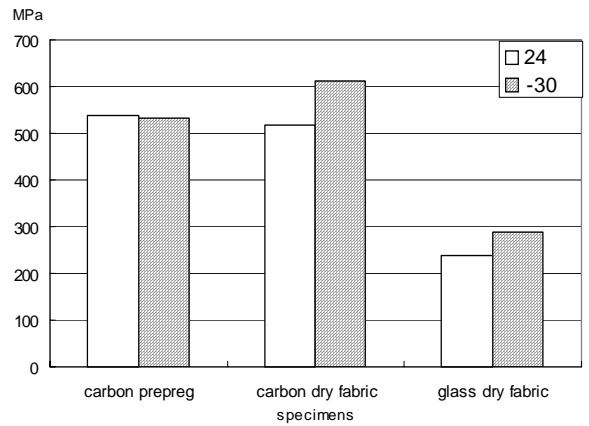


Fig. 7 Comparison of strength

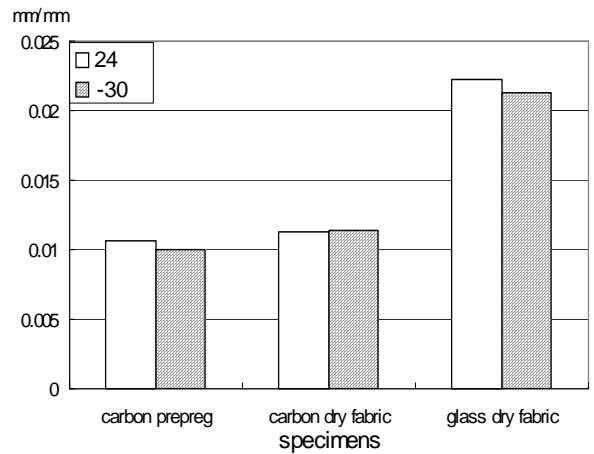


Fig. 8 Comparison of strain

carbon fiber fabrication method  
bagging system prepreg vacuum  
가 . Table 1  
RIM process vacuum bagging system  
가 RIM process  
가 breather  
carbon dry fabric  
RIM process

. RIM process  
vacuum bagging system

1  
가 brittle  
가

4.2 SEM analysis  
Static tensile test

SEM(Scanning electron microscopy)  
. static tensile test

SEM

가

(end)

pull-out

pull-out  
가

Fig. 9 24 -30  
matrix가

ductile

matrix가

matrix

가

matrix

brittle

matrix

matrix

matrix

가 pull-out

(end)가

가

Fig. 10 Fig. 11 가 24

matrix

, -30

matrix

가

matrix가 brittle

matrix

pull-out

가

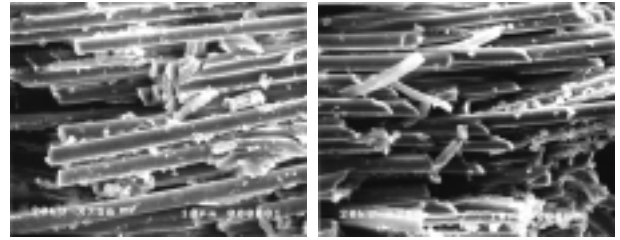
5. 결 론

(1) static tensile test carbon prepreg

가

, carbon dry fabric

glass dry fabric



(a) 24

(b) -30

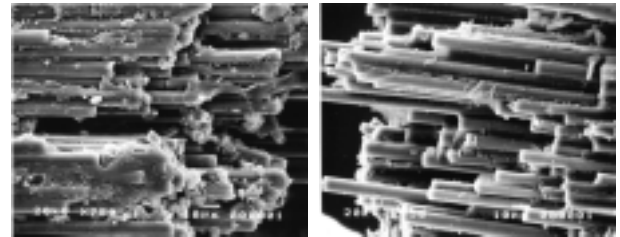
Fig. 9 Fractography of glass dry fabric



(a) 24

(b) -30

Fig. 10 Fractography of carbon dry fabric



(a) 24

(b) -30

Fig. 11 Fractography of carbon prepreg

가 brittle matrix가

(2) carbon prepreg carbon

dry fabric

가

가

glass dry fabric

가

glass fiber가 brittle

(3) vacuum bagging system

carbon

RIM process

carbon

bagging

vacuum

vacuum bagging system  
가 가

vacuum bagging system

(4) SEM

matrix가

matrix

pull-out

, glass dry fabric  
가

가

(5)

carbon fiber glass fiber

, carbon fiber

glass fiber

glass

fiber carbon fiber

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