Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 207 (2017) 90–94

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on the Technology of Plasticity, ICTP 2017, 17-22 September 2017, Cambridge, United Kingdom

A characterisation of tool-ply friction behaviors in thermoplastic composite

Jeong-Min Lee[a], Byung-Min Kim[a], Chan-Joo Lee[b], Dae-Cheol Ko[c],*

[a]*Division of Precision and Manufacturing Systems, Pusan National University, Busan, South Korea*
[b]*Dongnam Regional Division, Korea Institute of Industrial Technology, Gyeongsangnam-do, South Korea*
[c]*Department of Convergence Science, Pusan National University, Busan, South Korea*

Abstract

Generally, the compression forming process is mainly used to fabricate the pre-form of CFRP product in resin transfer molding(RTM) process. The laminate is deformed under the low pressure because only fabrics and binders are used in pre-form process. However, the laminate consisted of prepreg is deformed under the high pressure and warm temperature to improve the surface quality and remove the voids in perperg compression forming(PCF) process. Therefore, the evaluations of tool-ply friction behaviors are required under the condition of high pressure and warm temperature. Several parameters have been investigated to determine their effect on the friction coefficient between the tool and laminate: normal pressure, laminate temperature, tool temperature, atmosphere temperature, and laminate orientation. In this study, the friction behaviors were evaluated for several important parameters of normal pressure, laminate orientation and atmosphere temperature. This paper describes two experimental method for measuring the friction behaviors of thermoplastic composites. The pull-through and rotational friction tests were performed to compare the friction behaviors according to the operating direction in the tests. In addition, the relationship of stribeck curve was evaluated under the conditions of high pressure and warm temperature.

Peer-review under responsibility of the scientific committee of the International Conference on the Technology of Plasticity.

Keywords: CFRTP; Prepreg compression forming(PCF); Rapid heating and cooling system; B-pillar reinforcement; Heat transfer; Thermal forming analysis;

* Corresponding author. Tel.: +82-051-510-3697; fax: +82-051-581-3075;
*E-mail address:*dcko@pusan.ac.kr

1877-7058
Peer-review under responsibility of the scientific committee of the International Conference on the Technology of Plasticity.
10.1016/j.proeng.2017.10.743

1. Introduction

Manufacturing process using high performance carbon fiber reinforced plastic(CFRP) is an important consideration to increase productivity and reduce defect production rate. PCF is well known for the highest productivity among the CFRP manufacturing processes. The laminate consisted of prepreg is deformed under the high pressure and warm temperature to improve the surface quality and remove the voids in PCF process. As shown in Fig. 1, the maximum stress acting on the automobile part of B-pillar reinforcement consisted of prepreg is about 5MPa. Especially, the forming pressure may be higher when the CFRP consisted of thermoplastic matrix with high viscosity was used. However, many researchers studied a friction behavior under the low pressure because the dry fabric is used in pre-form forming process of resin transfer molding(RTM)[1-3]. Therefore, the evaluations of tool-ply friction behaviors are required under the condition of high pressure and warm temperature.

Generally, several parameters have been investigated to determine their effect on the friction coefficient between the tool and laminate: normal pressure, laminate temperature, tool temperature, atmosphere temperature, and laminate orientation[4-6]. This paper describes two experimental methods for measuring the friction behaviors of thermoplastic composites. The pull-through and rotational friction tests were performed to compare the friction behaviors according to the operating direction in the tests. In addition, the relationship of stribeck curve was evaluated under the conditions of high pressure and warm temperature.

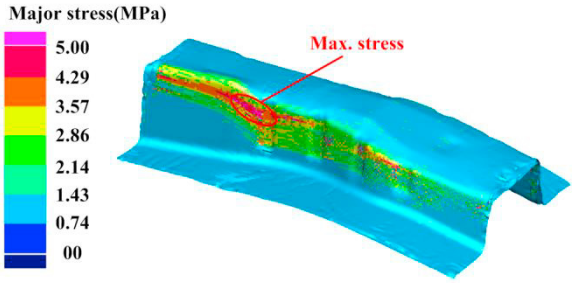

Fig. 1. Stress distribution of B-pillar reinforcement.

2. Test material

A balanced 2 x 2 twill weave pre-consolidated thermoplastic textile composite, SK Chemicals, has been tested. It has an areal density of 700g/m^2. The carbon fiber (MRC PYROFILTM TR30S 3K) used in the prepreg was fabricated by MITSUBISHI RAYON. The resin used in the prepreg is a polyester-based thermoplastic polyurethane with a T_g of 110℃. The thickness of the prepreg is 0.3 mm and the carbon fiber volume fraction and the density of prepreg were evaluated as 39.64% and 1.52 g/cm^2, respectively. Typical properties of CFRTP are summarized in Table 1.

Table 1. Typical properties of CFRTP.

Properties	Values
Matrix	Polyurethane
Viscosity	5740cps, 25℃
Fiber volume fraction	39.64%
Weaving	Twill
Glass transition temperature	110℃
Thickness	0.3mm