

Design and Manufacturing of UAV Backpack

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Abstract—The UAV Backpack is a good concept for spying and aerial documentation device. The design of the UAV backpack is compact and modular to make it easy to be carried by one person. The material used was EPP foam laminated by fiber reinforced composite. The manufacturing process of this concept is vacuum infusion process. The ultimate tensile test of the prototype (GFRP) is 330.45 MPa. The prototype succeed to fly for 23 min at average 60 km/h with belly landing at 45 km/h and survived.

Keywords—UAV, composite, glass-fibre, carbon-fibre, carbon-kevlar, vacuum infusion.

I. INTRODUCTION

UAV is one of the most popular spying and aerial documentation device. The concept of UAV backpack enable designers to deliver compact unmanned air vehicle that can be carried and controlled with one person. UAV backpack eliminate the need of runway to take off since it only need to be thrown to take off.

UAV backpack need to be strong, light, and portable enough to be carried and survive during its operation. The combination of Styrofoam laminated by Fiber Reinforced Plastic deliver enough strength with light weight. Manufacturing process also have critical effect since the composite properties will be vary depend on its manufacturing process. The vacuum bagging process were used in this research to deliver the required properties.

II. DESIGN

The design of UAV Backpack has been completed by our designer team with the specification shown in TABLE I. The design requires light and strong material properties. The UAV Backpack design is shown in Figure 1.

TABLE I UAV BACKPACK SPECIFICATION

Specification	
MTOW	1500 g
Wing Span	1300 mm
Body Length	420 mm
Landing Method	Belly Landing
Cruising Speed	31 m/s

This UAV Backpack has compact and modular design so it needs good locking system between all part including wings, tail, belly, and fuselage. The modular part is shown in Figure 2.

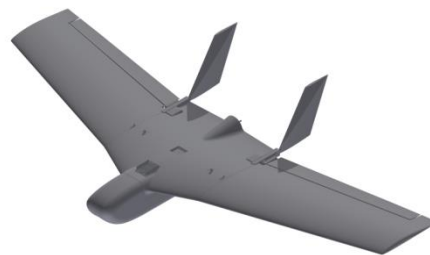


Figure 1 UAV backpack

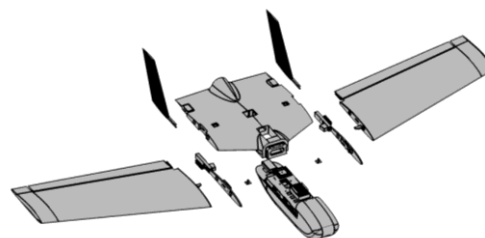


Figure 2 UAV backpack parts

III. MATERIAL SELECTION

Since the UAV Backpack require light material with good strength, Styrofoam laminated by fiber reinforced plastic composite is the one of the material that fulfills the requirement. The specification of foam and the fiber is shown in TABLE II.

TABLE II MATERIAL SPECIFICATION

	Density (g/cm ³)	Specific Strength
EPP Foam	0.019	-
Glass-FRP	2.1	571
Carbon-FRP	1.7	706
Carbon-Kevlar RP	1.5	657

All control surfaces use carbon fiber with 45 degrees of orientation to prevent the parts to twist. EPP foam with density 0.019 g/cm³ is used in all body parts to make the body keep

solid and keeping its shape. The EPP foam also absorbs impact energy very well. The Belly part uses the carbon-kevlar reinforced epoxy since the belly part is prone to friction and impact. The carbon gives high strength to prevent fail because of friction, and Kevlar gives high impact value since it can absorb energy efficiently.

The locking system between all parts is made of polycarbonate. The polycarbonate delivers high ductility, lightweight, and high elasticity.

IV. MANUFACTURING AND TEST

The manufacturing process we used in this concept was vacuum infusion method. The vacuum infusion process use Busch vacuum pump model RA-063L with specification 63 m³/h. The parameter we used in the process shown in TABLE III.

TABLE III VACUUM INFUSION PARAMETER

Parameter	
Vacuum Speed	63m ³ /h
Pressure	1x10 ⁻² bar
Viscosity	
Curing Time	8 Hours
Gel Time	45 Mins
Temperature	300 K
Resin Input Source	1

Figure 3 is the schematic figure of vacuum infusion process and the infusion layer is shown in Figure 4.

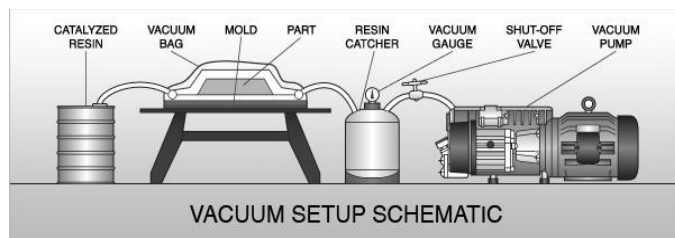


Figure 3 Vacuum infusion schematic [1]

In this infusion process, the mold used is made of aluminum 2024 (duralumin). The result of the process shows that there are some scratches. The scratch occurred because of the mold surface isn't fine enough. To remove the scratch, the prototype was repainted. The GFRP from infusion process is tested in ITB by using Tarno Grocki machine. The tensile test curve is shown in Figure 5. The result shows that the material properties are still far from the theoretical calculation.

The flight test is done in the airfield. The prototype equipped with 1.2 kg thrust powered with 8000 mAh 3 cells. The prototype tested to flew for 23 min with 60 km/h average speed and landing with belly at about 45 km/h. The prototype survive the test and shows that the current material still applicable.

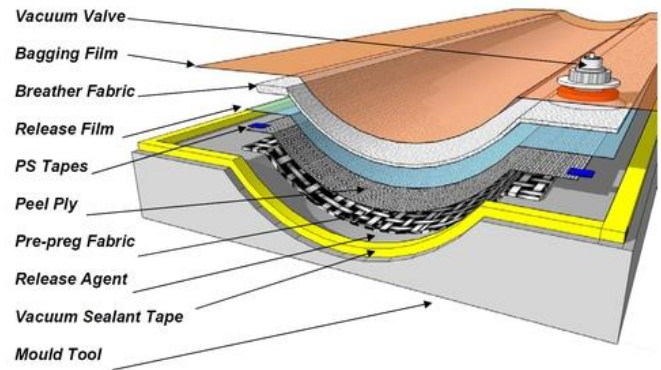


Figure 4 Infusion layer [2]

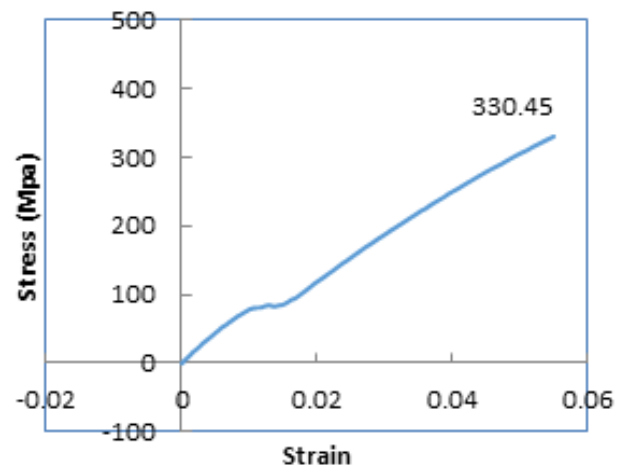


Figure 5 Tensile test curve

V. FUTURE WORK

The low tensile test result may be caused by the viscosity of the epoxy that was still too high. The high viscosity may lead to bad impregnation. By modifying the viscosity of epoxy in the future we may get better tensile strength. To get lower viscosity of epoxy, the temperature needs to be changed to about 37 °C. The viscosity of epoxy will drop significantly by just moderate heat.

Increasing the temperature may lead to faster gel time. To get longer gel time, the amount of epoxy hardener need to be changed so that the epoxy still have enough time to impregnate the fiber in all the part during infusion process.

The current mold we used is made by aluminum 2024. It was hard to make the fine-surface of the mold, and lead the mold to create scratch to the UAV backpack. By changing the mold material to steel coated by chrome may decrease the surface roughness and prevent scratch. The absence of scratch will remove the stress concentration and may lead to better tensile strength and the UAV backpack can be directly painted within the infusion process.

VI. CONCLUSION

The UAV Backpack is a good concept for spying and aerial documentation device. Since the UAV Backpack need to be easily carried, it contain modular parts that can easily assembled. The design of the UAV backpack with belly landing method needs strong material to survive without failing. The carbon-kevlar reinforced plastic is a good choice for the belly part since carbon will give good strength while the Kevlar can absorb energy efficiently.

The ultimate tensile test of the prototype (GFRP) is 330.45 MPa. The prototype succeeded to fly for 23 min at average 60 km/h with belly landing at 45 km/h and survived. The vacuum infusion manufacturing process is capable to produce the UAV backpack but the mold needs to be improved to prevent the scratch. The viscosity of epoxy also needs to be decreased to ensure good impregnation

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