

## ELECTRICITY GENERATION OF ELECTRIC COASTER IN TRAPPING SOLAR HEAT

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**ABSTRACT:** Environmental concerns and shortages of electricity and battery capacity limitations have prompted efforts aimed at the mass production of biodegradable materials. Renewable energy from solar trap heat is the optimal way to prevent climate change and decarbonization. The new technology of the EV body made with Al<sub>2</sub>O<sub>3</sub> Epoxy Resin (ER) filler sandwiched by Carbon Fiber and Lithium thin plates is an advanced technology used to generate electricity by trapping solar heat. The developed laboratory-scale model car body will be able to generate 15% energy from the 8.46 kWh battery pack and reduce 20% of the 30-kWh traction power by reducing 15% of the car's total weight of 1800 kg. Furthermore, the proposed body is very environmentally friendly as it can be easily recycled for new products. Based on the overall benefits, the proposed car body has the potential to reduce oil dependence and environmental emissions. However, the main limiting factors are thermal behavior and ionic conductivity at high temperatures.

**ABSTRAK:** Kebimbangan alam sekitar dan kekurangan tenaga elektrik dan had kapasiti bateri telah mendorong usaha yang bertujuan untuk pengeluaran besar-besaran bahan terbiodegradasi. Tenaga boleh diperbaharui daripada haba perangkap suria adalah cara optimum untuk mencegah perubahan iklim dan penyahkarbonan. Teknologi baharu badan EV yang dibuat dengan pengisi Al<sub>2</sub>O<sub>3</sub> Epoxy Resin (ER) diapit oleh plat nipis Serat Karbon dan Litium ialah teknologi canggih yang digunakan untuk menjana elektrik dengan memerangkap haba suria. Badan kereta model skala makmal yang dibangunkan akan dapat menjana 15% tenaga daripada pek bateri 8.46 kWj, dan mengurangkan 20% daripada kuasa cengkaman 30 kWj dengan mengurangkan 15% daripada jumlah berat kereta sebanyak 1800 kg. Tambahan pula, badan yang dicadangkan itu sangat mesra alam kerana ia boleh dikitar semula dengan mudah untuk produk baharu. Berdasarkan manfaat keseluruhan, badan kereta yang dicadangkan itu berpotensi untuk mengurangkan pergantungan minyak dan pelepasan alam sekitar. Walau bagaimanapun, faktor penghad utama ialah kelakuan terma dan kekonduksian ionik pada suhu tinggi.

**KEYWORDS:** *Electricity generation, Energy saving, Lithium thin plate, Carbon fiber, Epoxy resin*

### 1. INTRODUCTION

Carbon fibers composites are generally known as Carbon-fiber-reinforced polymer, carbon-fiber-reinforced plastic or carbon-fiber reinforced thermoplastic (CFRP, CRP, CFRTP or often simply carbon fiber). Carbon fiber is an extremely lightweight material consisting of fibers about 5–10 .m in diameter and composed mostly of carbon atoms. Sometimes, it is known as graphite fiber, carbon graphite or CF. Composite materials offer many advantages including high specific mechanical properties, high stiffness-to weight ratio and high

strength-to-weight ratio. It is used as an alternative for structural materials in automotive and aerospace field by replacing not only steel but light alloys. In the auto industry, the use of carbon composites has been limited to race cars, high-end performance vehicles and some high-end luxury vehicles. The higher cost of these materials is more easily justified based on performance advantages. There are a number of design modifications that can improve engine efficiency, structural weight reduction and it has a multiplier effect on fuel economy.

Much research is being done to develop effective material combinations of polymer nanocomposites with tailored properties. Commercial products such as automotive parts, sporting goods, and packaging materials are already available that make use of nano-sized fillers. Typically, the mechanical, barrier, and fire performance of polymer nanocomposites is better to that of traditional microcomposites. Author [1] has demonstrated load bearing capability and electrochemical cyclability of a structural battery with tunable mechanical properties by fabricating carbon nano-fiber-reinforced active material composites. They postulated that a fiber form of electrodes would be ideal for structural batteries. The study has been conducted [2-5] on the carbon fiber electrochemical properties. They reported that its electrochemical potential against Li is less than 0.5 V throughout the state of charge (SOC) and specific capacity of 372 mA h/g is larger than common cathode materials such as LiCoO<sub>2</sub>, LiMn<sub>2</sub>O<sub>4</sub>, and LiFePO<sub>4</sub>. The multifunctional battery cells based on the assumed advantage of carbon as both an electrochemical substrate and a structural material has focused on either (a) predictions of total device improvement based on assumed properties of multifunctional materials [7][9] or (b) demonstrations of specific technologies built on structural materials platforms [10][11][12].

Polymers with thermally conducting fillers such as AlN, BN, Al<sub>2</sub>O<sub>3</sub>, and SiC are emerging as cost-effective materials to cope with thermal management issues [13][14]. A very high micro-filler loading, normally 60 vol.% or even higher, is needed to satisfy percolation thresholds and to obtain a high thermal conductivity to form continuous heat conducting chains in the polymer. However, conductive metal fillers and polymeric resin can give a better conductivity because of their high electrical characteristics and chemical stability [12]. Fundamental studies at the nanoscale level to develop filler materials with enhanced thermal performance have been conducted [15][16][17]. They reported that filler materials are generally the inner materials used in composites materials to reduce cost and improve mechanical and electrical properties. Author [18] has studied the performance of dielectric properties of solid polymer electrolyte. He reported that the dielectric properties of solid polymer electrolyte can be increased by adding 15wt% of Al<sub>2</sub>O<sub>3</sub> filler and 20wt% plasticizer at ambient temperature. The influence of the type of polymer matrix and filler on the electrical characteristics of the composite has been studied in many works [19][20][21]. The filling of a polymer with metallic particles results in an increase of both electrical and thermal conductivity of the composites obtained.

The use of a hybrid filler comprised of carbon nano materials has been explored and composite performance has been improved by combining the advantages of each type of filler. However, although a remarkable thermal conductivity (5W/mK) has been achieved with an extremely high concentration of nano fillers of about (50 wt.%), the mechanical properties have not been adequate for applications because this practice has resulted in a high density and poor mechanical properties [22][23].

## 2. METHODOLOGY

The carbon-polymer composites do not depend on chemistry, which not only means a longer life but a quicker charge as well. The carbon fiber (CF) plate will be developed in this study with epoxy resin totaling 2% and 2.5% of the mass. The mold has been developed with two aluminum alloy plates spacer of 200 $\mu$ m. The Araldite CY231 epoxy resin with anhydride hardener Aradur HY925 has been used to develop CF. Nanotechnologies are estimated to impact and influence at least \$3 trillion in the worldwide economy by 2020. Nanocomposites proposed perfections over conventional composites in mechanical, electrical, thermal, and resistance (barrier) properties [24][25][26]. The nano particle Al<sub>2</sub>O<sub>3</sub> has been used to prepare the solidified electrolyte for the energy source [27]. Epoxy resin (ER) filling Al<sub>2</sub>O<sub>3</sub> micro particles fabrication has been conducted by following the steps: as below:

- Mixing ER with Al<sub>2</sub>O<sub>3</sub> by conventional mechanical high shear stirring
- Degassing
- Mixing in an ultrasonic bath at 42 kHz
- Casting into the molds of spacer 200  $\mu$ m
- Curing for 3 hours at 140<sup>0</sup>C
- Post curing for 3 days at 140<sup>0</sup>C

The epoxy resin specimens (200 $\mu$ m) with loading concentrations of Al<sub>2</sub>O<sub>3</sub> filler 0.1wt%, 0.3wt%, 0.5wt%, 1wt%, 3wt% and 5wt% will be produced. Samples for the investigation of thermal conductivity and electrical characteristics will be prepared. Polymer electrolyte films of Al<sub>2</sub>O<sub>3</sub> filler PEO resin for the solid electrolyte was prepared by using solution – cast technique. Specimen of 20 $\mu$ m micro meter were prepared in room temperature and stored under dry condition with considering the following steps:

- The liquid solution of PEO has been heated at 100<sup>0</sup>C for 15 to 20 minutes to reduce its viscosity. Furthermore, cooling process occurred in room temperature.
- Different amounts of Al<sub>2</sub>O<sub>3</sub> has been added to ER with a high speed mechanical vacuum centrifugal mixture @ 4000 rpm for stirring about 30 minutes.
- The mixture has been poured to the mold and placed under the oven at 80<sup>0</sup>C for 4 hours.

### 2.1 Thermal Conductivity

The thermal conductivity investigation was made with a THASYS system, produced by Hukseflux Thermal Sensors. This system will be used to perform the determination of the absolute value of the thermal conductivity. With a combination of a thin heater, homogeneous thermal field has been made through the samples with a well-defined heat flux. The thermal conductivity of polymer can be calculated using the following formula:

$$\lambda = \rho C_p \alpha \left( \frac{T_i - T_f}{T_i} \right) \quad (1)$$

where,  $\lambda$  is the thermal conductivity in the W/m.K,  $\alpha$  thermal diffusivity in m<sup>2</sup>/s,  $C_p$  the specific heat capacity j/g.K,  $\rho$  is the density of the sample in g/m<sup>3</sup>,  $T_i$  and  $T_f$  are the initial and final temperature in <sup>0</sup>K.

## 2.2 Electrical Conductivity

The electrical conductivity of Al<sub>2</sub>O<sub>3</sub> filler ER can be estimated by using the equation:

$$\sigma_c = \frac{4}{\pi} \left( \frac{d_c l}{d} \cos^2 \theta \right) (V_p \sigma_f) x \quad (2)$$

$$\text{with, } V_p = \beta V_f, \beta = \frac{V_f - V_{crit}}{V_t - V_{crit}}; x = 0.59m, m = m_{\max} \left( \frac{V_p}{V_t} \right)$$

where,  $\sigma_c$  is the conductivity of the composite,  $\sigma_m$  is the conductivity of the matrix,  $\sigma_f$  is the conductivity of the fibers,  $d_c$  is the diameter of the circle contact,  $d$  is the diameter of the fiber,  $l$  is the average fiber length, and  $\theta$  is the fiber orientation angle. For the equation (2),  $\beta$  is equal to 0 below the percolation threshold,  $V_{crit}$ , and 1 at a 'saturated' volume fraction  $V_t$ . Symbol  $x$  represents a factor depending on the contact number of fibers,  $m$ . For all cases, the maximum number of contacts  $m_{\max}$  is assumed to be 15.

The dielectric strength of Al<sub>2</sub>O<sub>3</sub> filler ER electrolyte composite has been conducted in this study by using lithium foil (Li-F) as electrodes and Carbon Fiber (CF) as anode. The sample has been placed between the electrodes and the AC voltage @ 50 Hz with continuously increasing till the sample brake down (fail).

The breakdown voltage,  $V$  (kV) of the samples has been record and the dielectric strength,  $E$  (kV/mm) has been calculated as

$$E = V/t \quad (3)$$

where  $t$  is the thickness of the sample in millimeters. During all of the measurements, the temperature will be maintained at room temperature. Thus, the influence of temperature on results can be ignored. The permittivity can be calculated by:

$$\text{Log } \epsilon_c = \phi \cdot \text{Log } \epsilon_f + (1 - \phi) \text{Log } \epsilon_m \quad (4)$$

$$\text{with } \epsilon_c = \epsilon_m + \frac{2 \cdot \phi \cdot \epsilon_m \cdot \epsilon_f}{2 \epsilon_m + (1 - \phi) \epsilon_f}$$

where,  $\epsilon_c$ ,  $\epsilon_f$ ,  $\epsilon_m$  is the dielectric constant of the composite, filler and matrix respectively and  $\phi$  is the volume fraction of the filler. The voltage can be calculated by:

$$V_0 = \frac{\Delta C}{2(2C + \Delta C)} V_{in} \quad (5)$$

where,  $V_0$  is the developed voltage from car body in volts,  $V_{in}$  is charging voltage of Al<sub>2</sub>O<sub>3</sub> of the electrolyte polymer in volts, and  $C$  is capacitance in farad. The  $V_0$  will be zero if the solid polymer electrolyte charging voltage ( $V_{in}$ ) reaches to cut-off voltage (or 85% of  $V_{in}$ ). The capacitance of the capacitor can be estimated as,

$$C = \epsilon_c \frac{A}{d} \quad (6)$$

where,  $\epsilon_c$  is the dielectric constant, A is area of plates in  $m^2$ , and d is the distance between plate in m. Instantaneous charging current of the capacitor by the car proposed body can be estimated as,

$$I_s = \frac{C_s}{t_s} (V_s) \quad (7)$$

where,  $I_s$  is the instantaneous charging current of the capacitor in ampere,  $C_s$  instantaneous capacitance,  $V_s$  is the instantaneous voltage developed by the car body in time  $t_s$ .

### 3. COMPOSITE BODY FABRICATION

This section has discussed the development of proposed car build with  $Al_2O_3$  filler ER sandwiched by CF and Li thin plate. The following section has presented the fabrication for each of the components.

#### 3.1 Fabrication of Carbon Fiber

The fabrication of the composite plate in this paper has done by using vacuum bagging method as shown in Fig. 1. This method uses the hand lay-up's technique as shown in Fig. 1(a). Hand lay-up involves the construction of a composite material through integration of resin and reinforcement (fiber) components to form a matrix. The resin provides stiffness to keeps the fiber in position and structure to the component while the fiber component provides the strength.

A few specimens of carbon fiber with different thicknesses need to be produced for the comparison of strength performance and also the effective thickness for conductivity. Four layers of carbon fiber sheet with 10.0 cm length and 10.0 cm height is prepared. The epoxy resin and the hardener were mixed together with 2:1 ratio respectively. The mixture was then stirred till it became lukewarm. The mixture then was poured a bit onto a mold layered by lamina plastic and brushed evenly. The processes were repeated until all the carbon fiber sheets have been put in. The upper part of the mold was then put on the layers and compressed tightly with a force of 250 N to prevent air bubbles exist in the carbon fiber mixture.

For ensuring the air carbon fiber mixture, a vacuum bagging process with a pump has been adopted as shown in Fig. 1(b). Then, the vacuum hose is connected to the vacuum pump. The handle on the pump is turned to 900 as an indicator that the pump's valve is closed. The presence of the air is detected if the maximum level of vacuum not achieved (-28"Hg). The leaking is around the sealed area and which can be confirmed if the hissing sound is heard. The vacuum pump is left to turn on for 45-60 minutes. Then, the pump is switched off. The weight of 20N is applied to the laminated composite and left to cure for 24 hours. Nine test plates for tensile test and 6 specimens for impact test are obtained from the whole process and the thickness of each plate is measured using a digital Caliper Gauge. The specimen was left to be compressed for 24 hours. Different thicknesses of specimens were made by repeating the process as shown in Fig. 2.

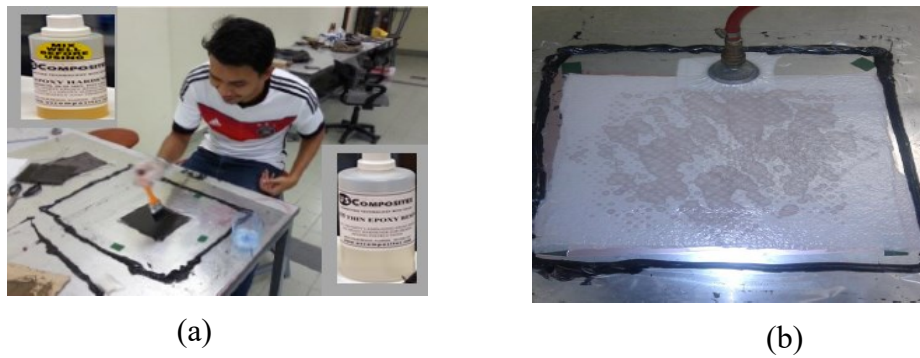


Fig. 1. Carbon fiber fabrication (a) hand lay-up's method, (b) Vacuum bagging process

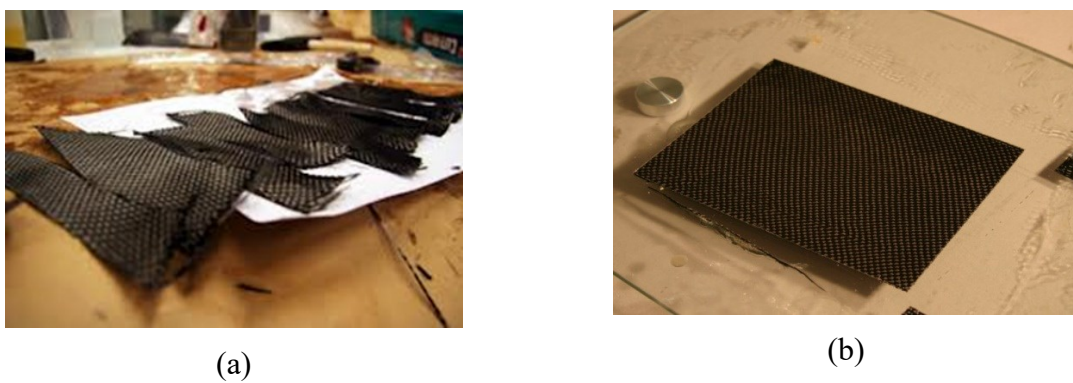


Fig. 2. Carbon fiber plate (a) Woven carbon fiber, (b) Carbon fiber plate with 6 piles (26.9g and 2.39mm thickness).

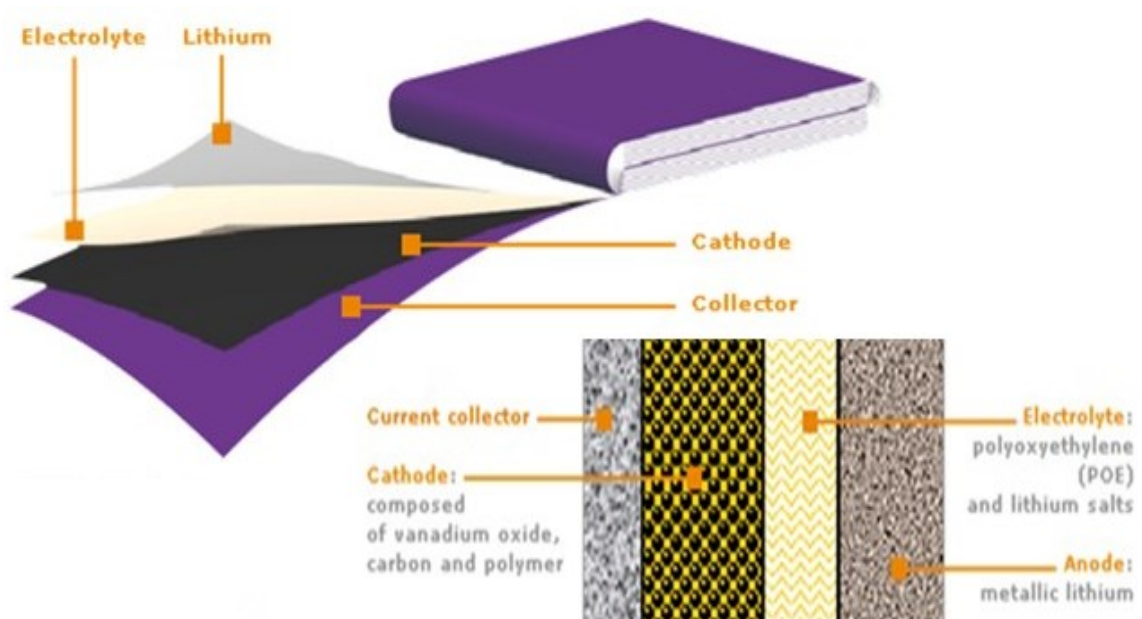


Fig. 3. Proposed composite car body sample.

### 3.2 Fabrication of Polymer Electrolyte

Acetonitrile, polyethylene oxide (PEO) aluminum oxide (Al<sub>2</sub>O<sub>3</sub>) and ethylene carbonate which are used to make polymer electrolyte. The specimen was made via solution casting technique. The polyethylene oxide acts as host matrix, acetonitrile as dissolver, aluminum oxide as filler and ethylene carbonate as plasticizer. The polyethylene oxide was first dissolved using acetonitrile. Then the Al<sub>2</sub>O<sub>3</sub> of 15% wt was added to the mixture followed by the ethylene carbonate of 20% wt. The mixture was then stirred for 24 hours to ensure a complete solution. Then the mixture was poured into a mold of 10.0 cm length and 10.0 cm wide and was put into a desiccator and let to be dried for 1 – 3 days. The procedure was done under room temperature and stored under dry place. Fig. 3 shows the proposed car body. It was then being compress and the electricity test was performed using voltmeter.

Table 1: Description of the specimen

1st specimen . Number of plies: 3 layer . Size: 200mm x 50mm . Stacking sequence: 0/0/0 . Nominal thickness: 1.17mm . Mass: 12.85g	2nd specimen . Number of plies: 3 layer . Size: 200mm x 50mm . Stacking sequence: 0/0/0 . Nominal thickness: 1.24mm . Mass: 13.59g	3rd specimen . Number of plies: 3 layer . Size: 200mm x 50mm . Stacking sequence: 0/0/0 . Nominal thickness: 1.18mm . Mass: 12.5g
4th specimen . Number of plies: 6 layer . Size: 200mm x 50mm . Stacking sequence: 0/0/0/0/0/0 . Nominal thickness: 2.29mm . Mass: 24.51g	5th specimen . Number of plies: 6 layer . Size: 200mm x 50mm . Stacking Sequence: 0/0/0/0/0/0 . Nominal thickness: 2.35mm . Mass: 26.72g	6th specimen . Number of plies: 6 layer . Size: 200mm x 50mm . Stacking Sequence: 0/0/0/0/0/0 . Nominal thickness: 2.39mm . Mass: 26.9g
7th specimen . Number of plies: 9 layer . Size: 200mm x 50mm . Stacking Sequence: 0 0 0 0 0 0 / 0 / 0 / 0 ] . Nominal thickness: 2.9mm . Mass: 32.92g	8th specimen . Number of plies: 9 layer . Size: 200mm x 50mm . Stacking Sequence: 0/ 0/ 0/ 0/ 0 / 0 / 0 / 0 ] . Nominal thickness: 2.85mm . Mass: 31.9g	9th specimen . Number of plies: 9 layer . Size: 200mm x 50mm . Stacking Sequence: 0 0 0 0 0 0 / 0 / 0 / 0 ] . Nominal thickness: 2.81mm . Mass: 32.63g

Table 2: Strength of Carbon Fiber

Number of woven plies	Specimen no.	Nominal thickness (mm)	Maximum force (N)	Maximum stress (N/mm <sup>2</sup> )	Maximum stroke
3	1	1.17	3789.6	101.06	2.53
	2	1.24	5271.3	140.57	3.5
	3	1.18	4301.1	114.69	3.13
6	1	2.29	17369.2	458.7	4.10
	2	2.35	17445.0	465.2	4.16
	3	2.39	17507.2	466.86	4.50
9	1	2.90	29928.8	798.1	6.11
	2	2.85	27988.1	787.29	5.98
	3	2.81	27690.9	780.20	5.91

### 3. RESULT AND DISCUSSION

Laboratory experiments have been conducted to investigate the strength of CF, thermal and electric conductivity of  $\text{Al}_2\text{O}_3$  filler ER and the ionization characteristics of Li thin plate. The carbon fiber tensile strength tests were carried out in accordance with ASTM D30392, by using nine specimens. The tensile tests were performed by using a UNIVERSAL TESTING MACHINE MTS, model 744, with hydraulic grip and MTS 632 12C-20 extensometer, at constant speed of 2.0 mm/min at room temperature on each of the specimens of CF for investigating strength. The thickness of the composite laminated has been made by adding the number of plies 3, 6 and 9 were considered. The nominal thickness of the samples varies from 1-3 mm as shown in **Table 1**. The tensile test results are presented in Table 2 and Fig. 4. The strength test of carbon fiber has been carried out for laminated woven carbon fiber with number of plies and nominal thickness. The stress was recorded 530.5 N/mm<sup>2</sup> for specimen 1 number of plies 9, 417 N/mm<sup>2</sup> for specimen 3 number of plies 6, and 140.5 N/mm<sup>2</sup> for specimen 2 number of plies 3 for the strain of 3.85%. The modulus of elasticity 133 Gpa for specimen 1 of composite plies 9, 103.86 for specimen 3 for composite plies 6, and 36.51 Gpa for 36.51 for specimen 3 for composite plies 3 indicate that increasing thickness of laminated composite increase the tensile strength, stiffness, and modulus of elasticity. The number of composite piles of carbon fiber is good for car body in terms of electric and thermal conductivity as the requirement for the objective of this study. However, the composite size optimization depends on the car manufacturer.

#### 4.1 Impact Testing

The impact testing has been conducted by using LS-DYNA and validated by the results [15] by designing a hemispherical shape composite and an impactor. The mesh of composite plate is made up of 8 plies with the diameter and nominal thickness is 75mm and 2mm respectively. Each ply thickness is considered as 0.25 mm. The first ply, the layer is located at the center point considering coordinates as (0 mm, 0 mm, 0 mm). The second ply, the layer is located below the first layer with coordinates  $z = -0.25$  and the remaining layer are repeat with the same step with the -0.25 decrement value in z-coordinates. Figure 6 below shows the 8 plies plate after mesh. The shape for the laminated composites is circular plate with 75mm in diameter and nominal thickness is 2mm. For the impactor, composite has been designed as hemispherical shape with diameter of 15mm. Impactor's mass and energy imposed on the composites is considered as 1.5 kg and 11.025 J respectively. The maximum of the force for this simulation is considered as 3.6 kN and the force approaches zero at time 8ms with 8 plies mesh composite and an impactor. The agreement between simulation studies [15] and simulation result has a closed agreement, which is substantially valid the result. Figure 6 shows the velocity impact behavior of laminated composite of specimen 3, 4 and 5 for applied energy of 5 J and 10 J respectively.



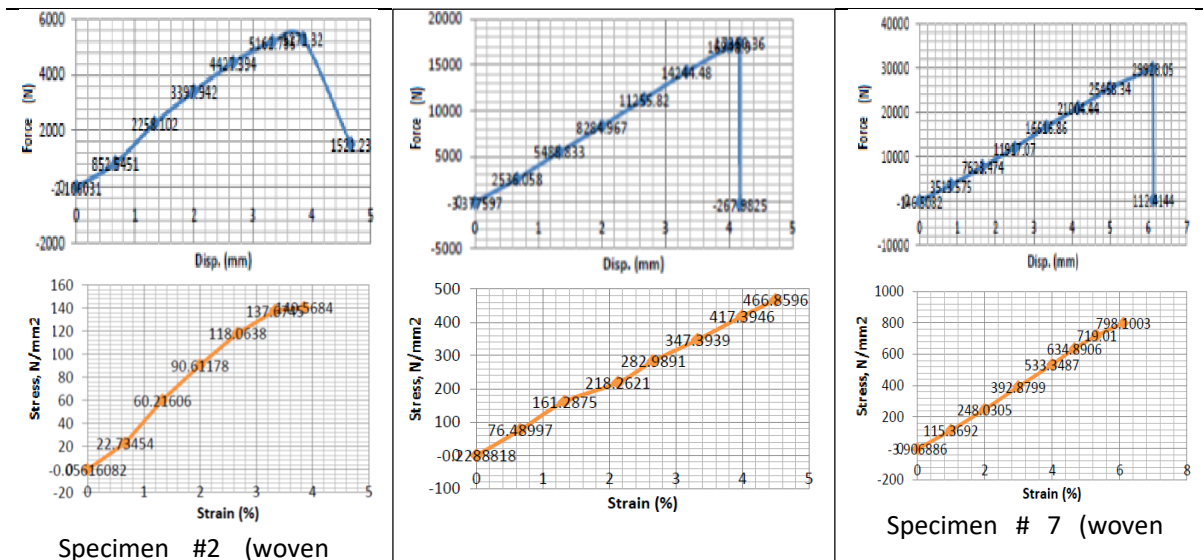
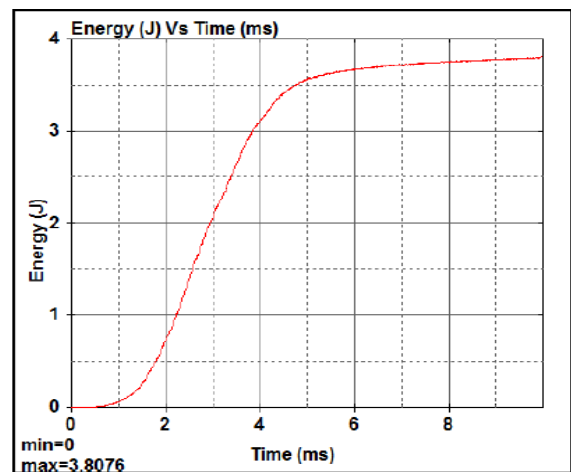
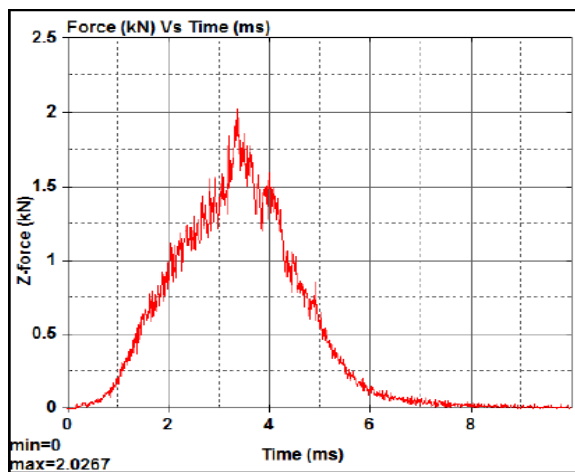
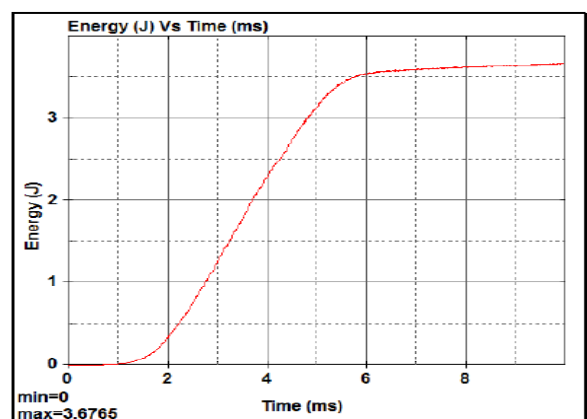
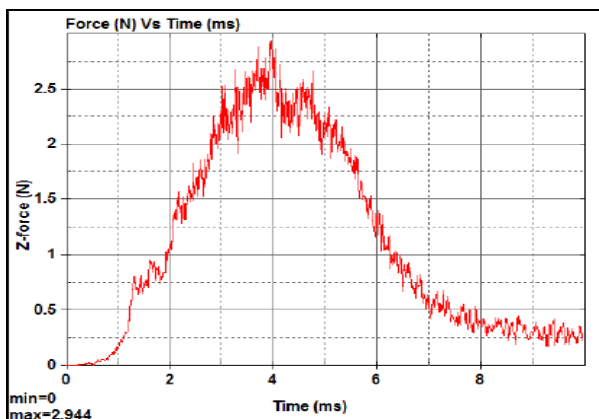


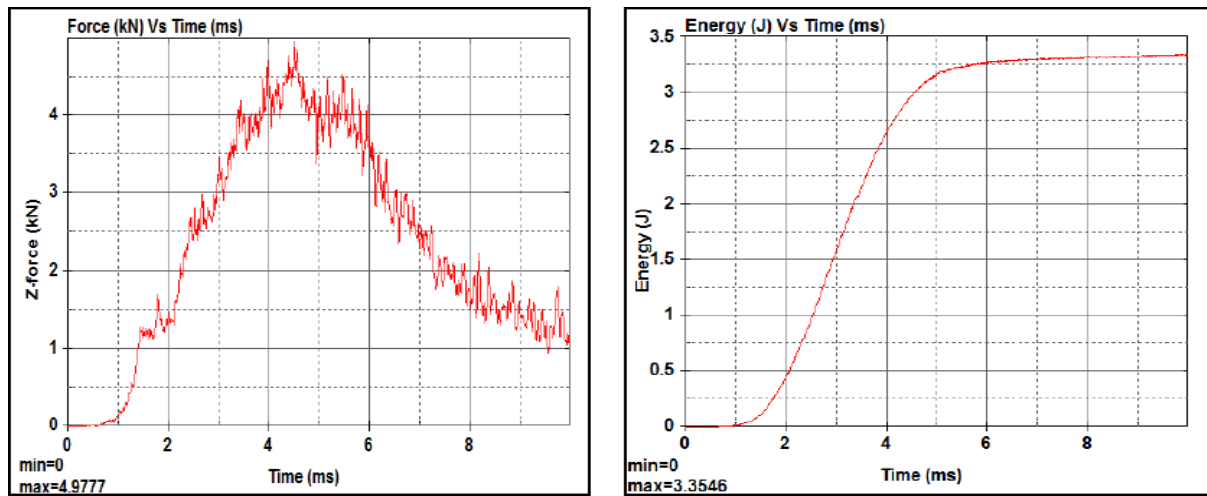
Fig.4. Tensile test result for specimens.



Specimen 3 for impact energy 5 J

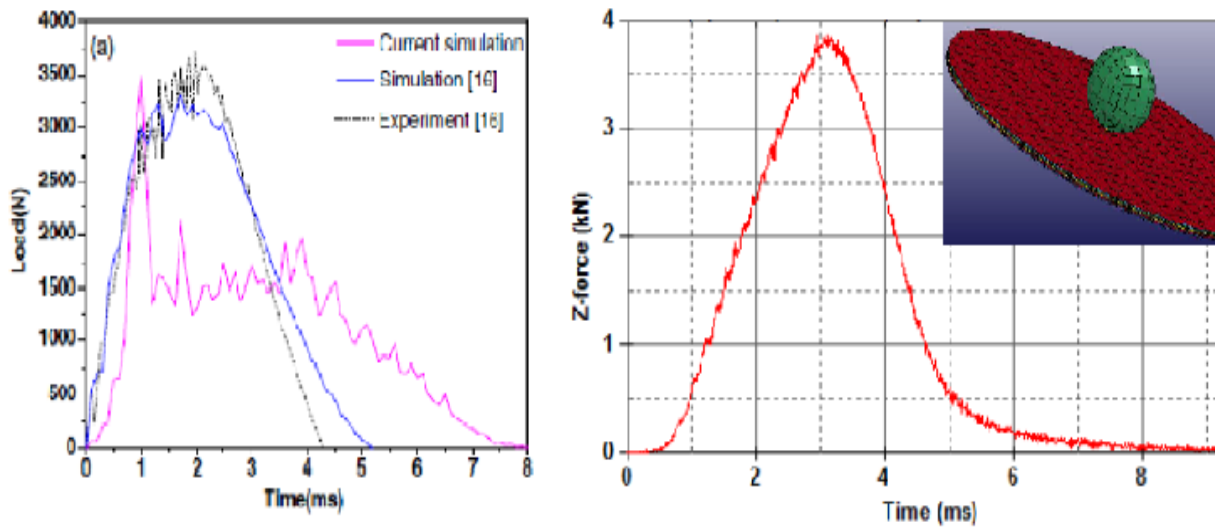


Specimen 4 for impact energy 10 J



Specimen 5 for impact energy 10 J

Fig. 5. Impact testing of CF for low velocity



(a) Qiu et al. (2014)  
DYNA

(b) Simulated result by LS-

Fig. 6. Impact testing of Carbon Fiber Composites.

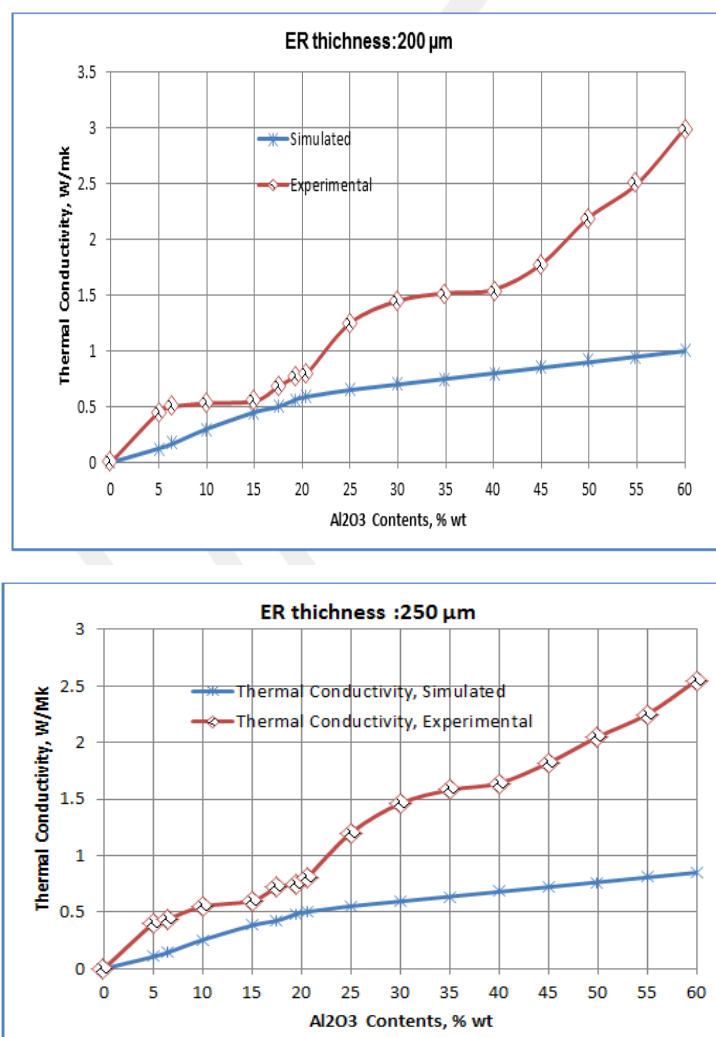


Fig. 7. Thermal Conductivity of Al<sub>2</sub>O<sub>3</sub> filler ER electrolyte

Table 3: Electrical resistance for composite car body

Sample Thickness (mm)		Electrical strength (V/mm)				Thermal Conductivity (experiment) W/m <sup>0</sup> K)	
Polymer electrolyte + % wt of Al <sub>2</sub> O <sub>3</sub>	CF	Theoretically		Experimentally			
		Sample surface area, m <sup>2</sup>					
		25	1000	25	1000		
0.3 +15% wt of Al <sub>2</sub> O <sub>3</sub>	0.3	0.5	26	0.3	12.8	29A	0.5
0.3+20% wt of Al <sub>2</sub> O <sub>3</sub>	0.3	0.55	27	0.33	13.15	30A	0.56
0.4 +15% wt of Al <sub>2</sub> O <sub>3</sub>	0.4	0.6	30	0.35	14.4	34A	0.63
0.4+20% wt of Al <sub>2</sub> O <sub>3</sub>	0.4	0.7	32	0.38	15.2	34.5A	0.71
0.5+15% wt of Al <sub>2</sub> O <sub>3</sub>	0.5	0.8	32	0.40	16.22	37A	0.72
0.5+20% wt of Al <sub>2</sub> O <sub>3</sub>	0.5	0.85	33.5	0.45	17.32	38A	0.76

Notifications: CF represents carbon fiber composite of woven plies 3 and 'A' represents ampere

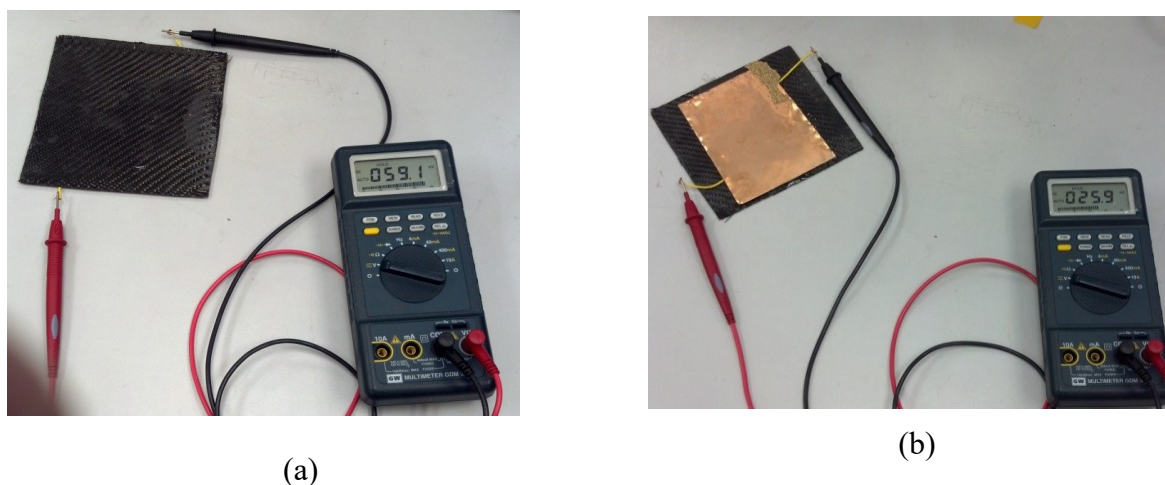


Fig.8. Sample performance measuring under the solar temperature 32C (Sample with carbon fibre (b) sample without carbon fibre).

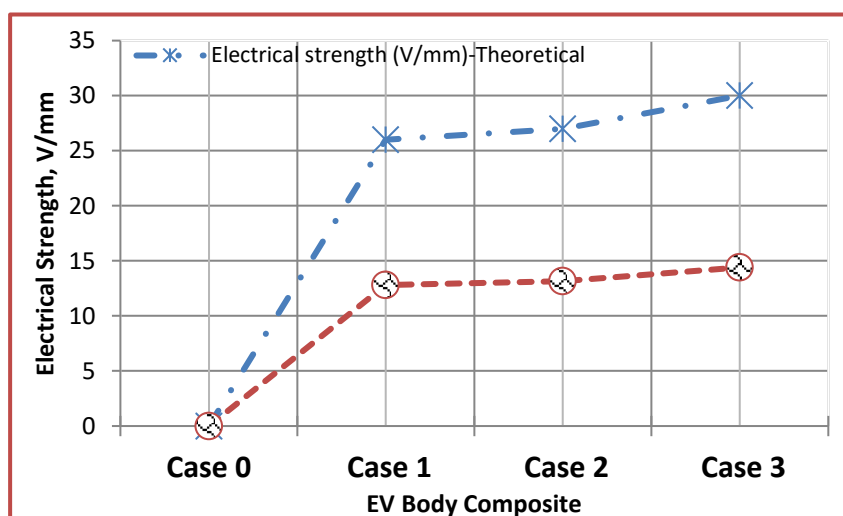


Fig. 9. Electrical strength measurement of proposed car body.

#### 4.2 Solid Polymer Ionic Conductivity Testing

Solid polymer electrolyte has many advantages such as high ionic conductivity, high specific energy, solvent-free condition, wide electrochemical stability windows, lightweight and ease of process ability. The dielectric properties of fillers and thermal treatment are major determinants for the ionic conductivity enhancement of solid electrolyte. The fillers will affect the orientation of matrix which is PEO (poly ethylene oxide) by their ability to align dipole moments, whereas thermal conductivity determines the flexibility of the polymer chains for ion migration. Fig. 7 shows the thermal Conductivity of  $Al_2O_3$  filler ER electrolyte. The ER thickness 250 $\mu$ m has performed better than the polymer thickness of 200

$\mu\text{m}$  for the different contents of  $\text{Al}_2\text{O}_3$ . The result indicates that increasing the filler materials with ER has increased the ionic conductivity which increases the electrical strength and makes filler ER more stable and linear incremental trends. Table 3 shows the thermal conductivity of different ER thickness with different % of filler  $\text{Al}_2\text{O}_3$ . Figure 8 shows the experimental measurement of the electricity generation of proposed car body for the three cases by using the voltage and current measuring digital meters. The results have been presented in Fig. 9.

## 5. CONCLUSION

Filler Polymer and Copper foil embedded car body can generate 38A current and a power of 489 W. However, 700 W is needed to operate the actuator of a car. If we can increase the power generation, the actuator can be replaced and thus the production cost of the vehicle will decrease meanwhile performance will increase. However, a voltage of 13.2 V is not enough to recharge the battery. In conclusion, due to financial incapability we could not use lithium foil; although lithium has greater thermal conductivity and greater ionization potential compared to copper foil. Therefore using lithium foil we surely can generate more current and power that can replace the actuator of a car for power generation.

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