MICROSTRUCTURAL AND PROPERTIES CHARACTERISATION OF GLASS AND GLASS/CARBON HYBRID FIBRE REINFORCED POLYAMIDE 6,6 COMPOSITES

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ABSTRACT

Polyamide 6,6 (PA6,6) offers advantages of better mechanical properties compared to other polyamides. In addition to fibre applications, polyamides 6,6 is available as engineering thermoplastics that can be injection moulded into a wide variety of industrial products. Injection moulding of fibre reinforced composites is associated with the problem of fibre breakage. If the fibre length retained in the finish product is too short, it will limit the expected improvement in the property. In this work, glass fibre-reinforced PA6,6 composites were injection moulded at different fibre loadings and subjected to different conditions namely dry, 50% relative humidity (RH) and wet. They were tested for fibre length characteristics, tensile properties, flexural properties and impact properties. The results obtained show that tensile, flexural and impact properties improved with fibre reinforcement. However, the effect of absorbed moisture shows reduction in tensile and flexural properties despite improvement in impact properties. As for the glass/carbon hybrid fibre composites the properties were decreased compared to the predicted values, calculated using a modified rule of mixture. The mechanical behaviour and fracture surface morphology of these composites were investigated by mean of tensile and impact tests subjected to dry as moulded and wet samples. It is demonstrated that fracture surface morphology of such composites is dependent on fibre matrix interfacial strength.

ABSTRAK

Poliamida 6,6 mempunyai sifat mekanikal yang lebih baik berbanding poliamida-poliamida yang lain. Apabila diaplikasikan gentian kepadanya, poliamida 6,6 menjadi bahan termoplastik kejuruteraan yang boleh melalui pengacuan suntikan untuk menghasilkan pelbagai jenis produk industri. Pengacuan suntikan komposit poliamida 6,6 berkait rapat dengan pemutusan gentian. Jika kepanjangan gentian kekal dalam produk akhir adalah terlalu pendek, ia akan menghadkan peningkatan dalam sifat bahan. Dalam penyelidikan ini, komposit poliamida 6,6 dipelbagaikan kandungan gentian kaca melalui pengacuan suntikan dan diletakkan di dalam keadaan kering, kelembapan relatif 50% dan basah. Bahan komposit poliamida 6,6 diuji berdasarkan kepada panjang gentian, sifat regangan, lenturan dan impak. Berdasarkan keputusan yang diperoleh daripada kajian ini, poliamida 6,6 yang diperkuat dengan gentian kaca menunjukkan peningkatan dalam ujian regangan, lenturan dan impak. Walaubagaimanapun, kesan serapan kelembapan menunjukkan penurunan dalam ujian regangan dan lenturan tetapi menunjukkan peningkatan dalam ujian impak. Bagi komposit gentian hibrid kaca/karbon, sifatnya menunjukkan penurunan berbanding nilai yang dikira menggunakan hukum campuran yang telah diubahsuai. Sifat mekanikal dan morfologi rekahan permukaan bahan ini turut dikaji terhadap sifat regangan dan impak bagi keadaan kering dan juga basah. Kajian membuktikan bahawa morfologi rekahan permukaan bagi bahan ini bergantung kepada kekuatan perlekatan antara gentian dan matrik.

LIST OF SYMBOLS

V_f	Volume fraction of fibre
V_m	Volume fraction of matrix
V_{ft}	Total volume fraction
M_f	Weight of fibre
M_m	Weight of matrix
δ_f	Density of fibre
δ_m	Density of matrix
σ_c	Stress in the composite
σ_f	Stress in the fibre
$\overline{\sigma_f}$	Average stress in the fibre
$\overline{\sigma_m}$	Average stress in the matrix
$\sigma_m^{'}$	Stress in the matrix at fibre breaking strain
$\sigma_{\max}$	Maximum stress
σ_y	Yield strength
ε_c	Strain in the composite
E_c	Young's modulus of composite
E_f	Young's modulus of fibre
E_m	Young's modulus of matrix
τ_f	Shear flow stress
P	Total force on a cross section
A	Area of cross section
η_o	Correction factor for fibre orientation
η_l	Correction factor for fibre length
R	Rate of crosshead motion
l	Fibre length
l_c	Critical fibre length
L	Original length of material
ΔL	Amount of extension

L_n	Number average fibre length
L_w	Weight average fibre length
a	Crack length
B	Thickness of specimen
D	Depth of specimen
a/D	Notch to depth ratio
S	Specimens’ support span
C	Compliance of the specimen
W	Fracture energy
U	Total strain energy
G	Strain energy release rate
K	Stress intensity factor
G_c	Critical strain energy release rate
K_c	Critical stress intensity factor
P	Peak load
ω	Angular frequency of oscillation
E'	Storage modulus
E''	Loss modulus
$\tan\delta$	Damping factor
T_g	Glass transition temperature
T_m	Melting temperature
T_c	Crystalline peak temperature
ΔH_m	The enthalpy
$-\Delta H_m$	Crystalline enthalpy

LIST OF TABLES

Table 3.1: Specimens' abbreviation and formulation

Table 3.2: Temperature settings on automatic injection moulding machine model Boy® 50M

Table 4.1: Determination of fibre volume fraction

Table 4.2: Thermal properties (from DSC measurements) of glass fibre composite at dry condition

Table 4.3: Thermal properties (from DSC measurements) of glass fibre composite at 50% relative humidity condition

Table 4.4: Thermal properties (from DSC measurements) of glass fibre composite at wet condition

Table 4.5: Thermal properties (from DSC measurements) of glass fibre composite at various conditions

Table 4.6: Thermal properties (from DSC measurements) of carbon fibre composite at various conditions

Table 4.7: Thermal properties of hybrid composite at dry condition

Table 4.8: Thermal properties of hybrid composite at 50% relative humidity condition

Table 4.9: Thermal properties of hybrid composite at wet condition

Table 4.10: Thermal properties of hybrid composite at various conditions

Table 4.11: Thermomechanical data of glass fibre composite at dry condition

Table 4.12: Thermomechanical data of glass fibre composite at 50% relative humidity condition

Table 4.13: Thermomechanical data of glass fibre composite at wet condition

Table 4.14: Thermomechanical data of glass fibre composite at various conditions

Table 4.15: Thermomechanical data of carbon fibre composite at various conditions

Table 4.16: Thermomechanical data of hybrid composite at dry condition

Table 4.17: Thermomechanical data of hybrid composite at 50% relative humidity condition

Table 4.18: Thermomechanical data of hybrid composite at wet condition

Table 4.19: Thermomechanical data of hybrid composite at various conditions

Table 4.20: The fibre characteristics of glass fibre composites

Table 4.21: Tensile properties of glass fibre composites at different condition

Table 4.22: Tensile properties of carbon fibre composites at different condition

Table 4.23: Tensile properties of glass/carbon hybrid fibre composites at different condition

Table 4.24: Tensile properties of glass/carbon hybrid fibre composites at different condition

Table 4.25: Tensile properties of glass/carbon hybrid fibre composites at different condition

Table 4.26: Flexural properties of glass fibre composites at different condition

Table 4.27: Flexural properties of carbon fibre composites at different condition

Table 4.28: The experimental and calculated flexural strength of hybrid fibre composites

Table 4.29: The experimental and calculated flexural modulus of hybrid fibre composites

Table 4.30: The experimental and calculated flexural displacement of hybrid fibre composites

Table 4.31: The average values of fracture energy, peak load and notch to depth ratio of glass fibre composites at dry condition

Table 4.32: The average values of fracture energy, peak load and notch to depth ratio of glass fibre composites at 50% relative humidity condition

Table 4.33: The average values of fracture energy, peak load and notch to depth ratio of glass fibre composites at wet condition

Table 4.34: The critical strain energy release rate, G_c and the critical stress intensity factor, K_c values of glass fibre composites at dry condition

Table 4.35: The critical strain energy release rate, G_c and the critical stress intensity factor, K_c values of glass fibre composites at 50% relative humidity condition

Table 4.36: The critical strain energy release rate, G_c and the critical stress intensity factor, K_c values of glass fibre

Table 4.37: The average values of fracture energy, peak load and notch to depth ratio of carbon fibre composites at various conditions

Table 4.38: The critical strain energy release rate, G_c and the critical stress intensity factor, K_c values of carbon fibre composites at various condition

Table 4.39: The average values of fracture energy, peak load and notch to depth ratio of hybrid composites at dry condition

Table 4.40: The average values of fracture energy, peak load and notch to depth ratio of hybrid composites at 50% relative humidity condition

Table 4.41: The average values of fracture energy, peak load and notch to depth ratio of hybrid composites at wet condition

Table 4.42: The critical strain energy release rate, G_c and the critical stress intensity factor, K_c values of hybrid composites at dry condition

Table 4.43: The critical strain energy release rate, G_c and the critical stress intensity factor, K_c values of hybrid composites at 50% relative humidity condition

Table 4.44: The critical strain energy release rate, G_c and the critical stress intensity factor, K_c values of hybrid composites at wet condition

LIST OF FIGURES

Figure 1.1: Schematic diagrams of hybrid types-all end view

Figure 2.1: Stress distribution usually assumed for a given fibre in a discontinuous, aligned fibre composite subjected to a tensile stress, σ_c and at the point of failure

Figure 2.2: Variation of fibre stress with length

Figure 2.3: Specimens and loading configurations for (a) Charpy V-notch and (b) Izod tests

Figure 2.4: An edge crack of length, a in the material

Figure 3.1: Dimensions of the tensile specimen

Figure 3.2: Specimen arrangement during the flexural test

Figure 3.3: Single edge notch impact specimen

Figure 4.1: TGA thermographs of unreinforced polyamide 6,6 at different conditions

Figure 4.2: TGA thermographs of glass fibre composite (4% V_f) at different conditions

Figure 4.3: TGA thermographs of glass fibre composite (8% V_f) at different conditions

Figure 4.4: TGA thermographs of glass fibre composite (13% V_f) at different conditions

Figure 4.5: TGA thermographs of glass fibre composite (16% V_f) at different conditions

Figure 4.6: TGA thermographs of glass fibre composite at various fibre volume fractions under dry condition

Figure 4.7: TGA thermographs of glass fibre composite (18% V_f) at different conditions

Figure 4.8: TGA thermographs of carbon fibre composite (33% V_f) at different conditions

Figure 4.9: TGA thermographs of glass/carbon hybrid fibre composite (SG75/C25) at different conditions

Figure 4.10: TGA thermographs of glass/carbon hybrid fibre composite (SG50/C50) at different conditions

Figure 4.11: TGA thermographs of glass/carbon hybrid fibre composite (SG25/C75) at different conditions

Figure 4.12: TGA thermographs of hybrid composites at different carbon fibre content

Figure 4.13: DSC results of glass fibre composites with various volume fractions at dry condition

Figure 4.14: DSC results of glass fibre composites with various volume fractions at 50% RH condition

Figure 4.15: DSC results of glass fibre composites with various volume fractions at wet condition

Figure 4.16: DSC results of single carbon fibre composites at various conditions

Figure 4.17: DSC results of hybrid fibre composites with different carbon fibre content at dry condition

Figure 4.18: DSC results of hybrid fibre composites with different carbon fibre content at 50% RH condition

Figure 4.19: DSC results of hybrid fibre composites with different carbon fibre content at wet condition

Figure 4.20: The tan delta–temperature behaviour of injection-moulded short glass fibre composites at dry condition

Figure 4.21: The storage modulus–temperature behaviour of injection-moulded short glass fibre composites at dry condition

Figure 4.22: The tan delta–temperature behaviour of injection-moulded short glass fibre composites at 50% RH condition

Figure 4.23: The storage modulus–temperature behaviour of injection-moulded short glass fibre composites at 50% RH condition

Figure 4.24: The tan delta–temperature behaviour of injection-moulded short glass fibre composites at wet condition

Figure 4.25: The storage modulus–temperature behaviour of injection-moulded short glass fibre composites at wet condition

Figure 4.26: The tan delta–temperature behaviour of unreinforced polyamide 6,6 matrix at different conditions

Figure 4.27: The storage modulus–temperature behaviour of unreinforced polyamide 6,6 matrix at different conditions

Figure 4.28: The tan delta–temperature behaviour of 4% V_f glass fibre composites at different conditions

Figure 4.29: The storage modulus–temperature behaviour of 4% V_f glass fibre composites at different conditions

Figure 4.30: The tan delta–temperature behaviour of 8% V_f glass fibre composites at different conditions

Figure 4.31: The storage modulus–temperature behaviour of 8% V_f glass fibre composites at different conditions

Figure 4.32: The tan delta–temperature behaviour of 13% V_f glass fibre composites at different conditions

Figure 4.33: The storage modulus–temperature behaviour of 13% V_f glass fibre composites at different conditions

Figure 4.34: The tan delta–temperature behaviour of 16% V_f glass fibre composites at different conditions

Figure 4.35: The storage modulus–temperature behaviour of 16% V_f glass fibre composites at different conditions

Figure 4.36: The tan delta–temperature behaviour of 18% V_f glass fibre composites at different conditions

Figure 4.37: The storage modulus–temperature behaviour of 18% V_f glass fibre composites at different conditions

Figure 4.38: The tan delta–temperature behaviour of carbon fibre composites at different conditions

Figure 4.39: The storage modulus–temperature behaviour of carbon fibre composites at different conditions

Figure 4.40: The tan delta–temperature behaviour of injection-moulded hybrid fibre composites at dry condition

Figure 4.41: The storage modulus–temperature behaviour of injection-moulded hybrid fibre composites at dry condition

Figure 4.42: The tan delta–temperature behaviour of injection-moulded hybrid fibre composites at 50% RH condition

Figure 4.43: The storage modulus–temperature behaviour of injection-moulded hybrid fibre composites at 50% RH condition

Figure 4.44: The tan delta–temperature behaviour of injection-moulded hybrid fibre composites at wet condition

Figure 4.45: The storage modulus–temperature behaviour of injection-moulded hybrid fibre composites at wet condition

Figure 4.46: The tan delta–temperature behaviour of injection-moulded (SG75/C25) hybrid fibre composites at different conditions

Figure 4.47: The storage modulus–temperature behaviour of injection-moulded (SG75/C25) hybrid fibre composites at different conditions

Figure 4.48: The tan delta–temperature behaviour of injection-moulded (SG50/C50) hybrid fibre composites at different conditions

Figure 4.49: The storage modulus–temperature behaviour of injection-moulded (SG50/C50) hybrid fibre composites at different conditions

Figure 4.50: The tan delta–temperature behaviour of injection-moulded (SG25/C75) hybrid fibre composites at different conditions

Figure 4.51: The storage modulus–temperature behaviour of injection-moulded (SG25/C75) hybrid fibre composites at different conditions

Figure 4.52: Fibre length distribution of short glass fibre composites for 18% V_f before and after moulding

Figure 4.53: Fibre length distribution of short carbon fibre composites for 33% V_f before and after moulding

Figure 4.54: Fibre length distribution of short glass fibre composite (4% V_f)

Figure 4.55: Fibre length distribution of short glass fibre composite (8% V_f)

Figure 4.56: Fibre length distribution of short glass fibre composite (13% V_f)

Figure 4.57: Fibre length distribution of short glass fibre composite (16% V_f)

Figure 4.58: Fibre length distribution of short glass fibre composite (18% V_f)

Figure 4.59: Fibre length distribution of short carbon fibre composite (33% V_f)

Figure 4.60: Fibre length distribution of short glass fibre composites

Figure 4.61: Cumulative fibre frequency of short glass fibre composites

Figure 4.62: Average residual fibre length versus fibre volume fraction

Figure 4.63: The tensile strength of injection-moulded short glass fibre composites for various fibre volume fractions at different conditions

Figure 4.64: The tensile modulus of injection-moulded short glass fibre composites for various fibre volume fractions at different conditions

Figure 4.65: The fracture strain of injection-moulded short glass fibre composites for various fibre volume fractions at different conditions

Figure 4.66: The tensile strength of injection-moulded short glass fibre composites at dry, 50% RH and wet condition for various fibre volume fractions

Figure 4.67: The tensile modulus of injection-moulded short glass fibre composite at dry, 50% RH and wet condition for various fibre volume fractions

Figure 4.68: The fracture strain of injection-moulded short glass fibre composite at dry, 50% RH and wet condition for various fibre volume fractions

Figure 4.69: Tensile strength of carbon fibre composites at various conditions

Figure 4.70: Tensile modulus of carbon fibre composites at various conditions

Figure 4.71: Fracture strain of carbon fibre composites at various conditions

Figure 4.72: Tensile strength of hybrid fibre composites subjected to dry condition

Figure 4.73: Tensile strength of hybrid fibre composites subjected to 50% RH condition

Figure 4.74: Tensile strength of hybrid fibre composites subjected to wet condition

Figure 4.75: Tensile modulus of hybrid fibre composites subjected to dry condition

Figure 4.76: Tensile modulus of hybrid fibre composites subjected to 50% RH condition

Figure 4.77: Tensile modulus of hybrid fibre composites subjected to wet condition

Figure 4.78: Fracture strain of hybrid fibre composites subjected to dry condition

Figure 4.79: Fracture strain of hybrid fibre composites subjected to 50% RH condition

Figure 4.80: Fracture strain of hybrid fibre composites subjected to wet condition

Figure 4.81: The flexural strength of injection-moulded short glass fibre composites for various fibre volume fractions at different conditions

Figure 4.82: The flexural modulus of injection-moulded short glass fibre composites for various fibre volume fractions at different conditions

Figure 4.83: The flexural displacement of injection-moulded short glass fibre composites for various fibre volume fractions at different conditions

Figure 4.84: The flexural strength of injection-moulded short glass fibre composites at dry, 50% RH and wet condition for various fibre volume fractions

Figure 4.85: The flexural modulus of injection-moulded short glass fibre composites at dry, 50% RH and wet condition for various fibre volume fractions

Figure 4.86: The flexural displacement of injection-moulded short glass fibre composites at dry, 50% RH and wet condition for various fibre volume fractions

Figure 4.87: Flexural strength of carbon fibre composites at various conditions

Figure 4.88: Flexural modulus of carbon fibre composites at various conditions

Figure 4.89: Flexural displacement of carbon fibre composites at various conditions

Figure 4.90: Flexural strength of composites subjected to dry condition

Figure 4.91: Flexural strength of composites subjected to 50% RH condition

Figure 4.92: Flexural strength of composites subjected to wet condition

Figure 4.93: Flexural modulus of composites subjected to dry condition

Figure 4.94: Flexural modulus of composites subjected to 50% RH condition

Figure 4.95: Flexural modulus of composites subjected to wet condition

Figure 4.96: Flexural displacement of composites subjected to dry condition

Figure 4.97: Flexural displacement of composites subjected to 50% RH condition

Figure 4.98: Flexural displacement of composites subjected to wet condition

Figure 4.99: Variation of fracture energy with notch to depth ratio of composites subjected to dry condition

Figure 4.100: Variation of peak load with notch to depth ratio of composites subjected to dry condition

Figure 4.101: Variation of fracture energy with notch to depth ratio of composites subjected to 50% RH condition

Figure 4.102: Variation of peak load with notch to depth ratio of composites subjected to 50% RH condition

Figure 4.103: Variation of fracture energy with notch to depth ratio of composites subjected to wet condition

Figure 4.104: Variation of peak load with notch to depth ratio of composites subjected to wet condition

Figure 4.105: Variation of fracture energy with notch to depth ratio of unreinforced polyamide 6,6 matrix at different conditions

Figure 4.106: Variation of peak load with notch to depth ratio of unreinforced polyamide 6,6 matrix at different conditions

Figure 4.107: Variation of fracture energy with notch to depth ratio of glass fibre composites, V_f 4% at different conditions

Figure 4.108: Variation of peak load with notch to depth ratio of glass fibre composites, V_f 4% at different conditions

Figure 4.109: Variation of fracture energy with notch to depth ratio of glass fibre composites, V_f 8% at different conditions

Figure 4.110: Variation of peak load with notch to depth ratio of glass fibre composites, V_f 8% at different conditions

Figure 4.111: Variation of fracture energy with notch to depth ratio of glass fibre composites, V_f 13% at different conditions

Figure 4.112: Variation of peak load with notch to depth ratio of glass fibre composites, V_f 13% at different conditions

Figure 4.113: Variation of fracture energy with notch to depth ratio of glass fibre composites, V_f 16% at different conditions

Figure 4.114: Variation of fracture energy with notch to depth ratio of glass fibre composites, V_f 16% at different conditions

Figure 4.115: Variation of fracture energy of glass fibre composites with fibre volume fraction at various notches to depth ratio at dry condition

Figure 4.116: Variation of peak load of glass fibre composites with fibre volume fraction at various notches to depth ratio at dry condition

Figure 4.117: Variation of fracture energy of glass fibre composites with fibre volume fraction at various notches to depth ratio at 50% RH condition

Figure 4.118: Variation of peak load of glass fibre composites with fibre volume fraction at various notches to depth ratio at 50% RH condition

Figure 4.119: Variation of fracture energy of glass fibre composites with fibre volume fraction at various notches to depth ratio at wet condition

Figure 4.120: Variation of peak load of glass fibre composites with fibre volume fraction at various notches to depth ratio at wet condition

Figure 4.121: Variation of fracture energy with specimen geometry function of glass fibre composites at dry condition

Figure 4.122: Variation of fracture energy with specimen geometry function of glass fibre composites at 50% RH condition

Figure 4.123: Variation of fracture energy with specimen geometry function of glass fibre composites at wet condition

Figure 4.124: G_c values of glass fibre composites for various fibre volume fractions at different conditions

Figure 4.125: G_c values of glass fibre composites at dry, 50% RH and wet condition for various fibre volume fractions

Figure 4.126: Variation of σY with $a^{-1/2}$ of glass fibre composites at dry condition

Figure 4.127: Variation of σY with $a^{-1/2}$ of glass fibre composites at 50% RH condition

Figure 4.128: Variation of σY with $a^{-1/2}$ of glass fibre composites at wet condition

Figure 4.129: K_c values of glass fibre composites for various fibre volume fractions at different conditions

Figure 4.130: K_c values of glass fibre composites at dry, 50% RH and wet condition for various fibre volume fractions

Figure 4.131: Variation of fracture energy with notch to depth ratio of carbon fibre composite at different conditions

Figure 4.132: Variation of peak load with notch to depth ratio of carbon fibre composite at different conditions

Figure 4.133: Variation of fracture energy with notch to depth ratio of carbon fibre composite at different conditions

Figure 4.134: Variation of peak load with notch to depth ratio of carbon fibre composite at different conditions

Figure 4.135: Variation of fracture energy with specimen geometry function of carbon fibre composites at dry condition

Figure 4.136: G_c values of carbon fibre composites at different conditions

Figure 4.137: Variation of σY with $a^{-1/2}$ of carbon fibre composites at various conditions

Figure 4.138: K_c values of carbon fibre composites at different conditions

Figure 4.139: Variation of fracture energy with notch to depth ratio of hybrid fibre composite at dry condition

Figure 4.140: Variation of peak load with notch to depth ratio of hybrid fibre composite at dry condition

Figure 4.141: Variation of fracture energy with notch to depth ratio of hybrid fibre composite at 50% RH condition

Figure 4.142: Variation of peak load with notch to depth ratio of hybrid fibre composite at 50% RH condition

Figure 4.143: Variation of fracture energy with notch to depth ratio of hybrid fibre composite at wet condition

Figure 4.144: Variation of peak load with notch to depth ratio of hybrid fibre composite at wet condition

Figure 4.145: Variation of fracture energy with notch to depth ratio of 18% fibre volume fraction glass fibre composites at different conditions

Figure 4.146: Variation of peak load with notch to depth ratio of 18% fibre volume fraction glass fibre composites at different conditions

Figure 4.147: Variation of fracture energy with notch to depth ratio of SG75/C25 hybrid composites at different conditions

Figure 4.148: Variation of peak load with notch to depth ratio of SG75/C25 hybrid composites at different conditions

Figure 4.149: Variation of fracture energy with notch to depth ratio of SG50/C50 hybrid composites at different conditions

Figure 4.150: Variation of peak load with notch to depth ratio of SG50/C50 hybrid composites at different conditions

Figure 4.151: Variation of fracture energy with notch to depth ratio of SG25/C75 hybrid composites at different conditions

Figure 4.152: Variation of peak load with notch to depth ratio of SG25/C75 hybrid composites at different conditions

Figure 4.153: Variation of fracture energy with notch to depth ratio of carbon fibre composites at different conditions

Figure 4.154: Variation of peak load with notch to depth ratio of carbon fibre composites at different conditions

Figure 4.155: Variation of fracture energy of hybrid fibre composites with carbon fibre composite contents and a/D ratios at dry condition

Figure 4.156: Variation of peak load of hybrid fibre composites with carbon fibre composite contents and a/D ratios at dry condition

Figure 4.157: Variation of fracture energy of hybrid fibre composites with carbon fibre composite contents and a/D ratios at 50% RH condition

Figure 4.158: Variation of peak load of hybrid fibre composites with carbon fibre composite contents and a/D ratios at 50% RH condition

Figure 4.159: Variation of fracture energy of hybrid fibre composites with carbon fibre composite contents and a/D ratios at wet condition

Figure 4.160: Variation of peak load of hybrid fibre composites with carbon fibre composite contents and a/D ratios at wet condition

Figure 4.161: Variation of fracture energy with specimen geometry function of hybrid fibre composites at dry condition

Figure 4.162: Variation of fracture energy with specimen geometry function of hybrid fibre composites at 50% RH condition

Figure 4.163: Variation of fracture energy with specimen geometry function of hybrid fibre composites at wet condition

Figure 4.164: G_c values of hybrid fibre composites for various carbon fibre content at different conditions

Figure 4.165: G_c values of hybrid fibre composites at dry, 50% RH and wet condition

Figure 4.166: Variation of σY with $a^{-1/2}$ of hybrid fibre composites at dry condition

Figure 4.167: Variation of σY with $a^{-1/2}$ of hybrid fibre composites at 50% RH condition

Figure 4.168: Variation of σY with $a^{-1/2}$ of hybrid fibre composites at wet condition

Figure 4.169: K_c values of hybrid composites for various carbon fibre content at different conditions

Figure 4.170: K_c values of hybrid composites at dry, 50% RH and wet condition

Figure 4.171: SEM micrographs of the fracture surfaces of the composites which shows fibre-matrix interfaces at (a) low fibre loading, V_f 4 % (b) high fibre loading, V_f 8 %

Figure 4.172: SEM micrographs of the fracture surfaces of the composites at various magnifications show the misalignment of the fibres

Figure 4.173: SEM micrographs taken from tensile fracture surface of glass fibre composite at dry as moulded condition

Figure 4.174: SEM micrographs taken from tensile fracture surface of glass fibre composite at wet condition

Figure 4.175: SEM micrographs taken from tensile fracture surface of carbon fibre composite at dry as moulded condition

Figure 4.176: SEM micrographs taken from tensile fracture surface of carbon fibre composite at wet condition

Figure 4.177: SEM micrographs taken from impact fracture surface of glass fibre composite at dry as moulded condition

Figure 4.178: SEM micrographs taken from impact fracture surface of glass fibre composite after water immersion

Figure 4.179: SEM micrographs taken from impact fracture surface of carbon fibre composite at dry as moulded condition

Figure 4.180: SEM micrographs taken from impact fracture surface of carbon fibre composite after immersed in water

TABLE OF CONTENTS

TITLE PAGE…………………………………………………………………………i

ACKNOWLEDGEMENTS………………………………………………………………ii

ABSTRACT…………………………………………………………………………..iii

ABSTRAK…………………………………………………………………………iv

LIST OF SYMBOLS……………………………………………………………………v

LIST OF TABLES…………………………………………………………………..vii

LIST OF FIGURES…………………………………………………………………..x

TABLE OF CONTENTS………………………………………………………………xx

CHAPTER 1: INTRODUCTION

1.1. Composites materials……………………………………………………………1

1.2. Fibre Reinforced Plastics………………………………………………………...1

1.2.1 Matrix Phase………………………………………………………………3

1.2.2 Reinforcing Phase…………………………………………………………4

1.2.2.1 Carbon fibre reinforced polymer composites (CFRP)……………4

1.2.2.2 Glass fibre reinforced polymer composites (GFRP)……………...6

1.2.2.3 Aramid fibre reinforced polymer composites……………………6

1.2.3 Interfaces……………………………………………………………………7

1.3 Hybrid fibre composites…………………………………………………………..8

1.4 Short fibre reinforced composites………………………………………………10

1.5 Processing of fibre reinforced composite………………………………………..11

1.6 Objectives………………………………………………………………………..12

Figure

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction…………………………………………………………………..13

2.2. Tensile and flexural properties…………………………………………………13

2.2.1. Reinforcement theory of discontinuous fibre composites……………….15

2.2.2. Tensile and flexural properties of single fibre composites………………21

2.2.3. Tensile and flexural properties of hybrid fibre composites……………...21

2.3. Impact properties…………………………………………………………….22

2.3.1. Fracture toughness……………………………………………………23

2.3.2. Impact properties of single fibre composites……………………………26

2.3.3. Impact properties of hybrid fibre composites……………………………28

2.4. Dynamic mechanical properties…………………………………………...28

2.4.1. Analysis of dynamic mechanical properties……………………………..29

2.4.2. Dynamic mechanical properties of composites......……………………...30

Figures

CHAPTER 3: EXPERIMENTAL

3.1. Materials……………………………………………………………………...32

3.2. Sample preparation…………………………………………………………...32

3.2.1. Glass fibre composites…………………………………………………...32

3.2.2. Carbon fibre composites…………………………………………………33

3.2.3. Short glass/short carbon hybrid fibre composites……………………….33

3.3. Preparations of moulded specimens…………………………………………33

3.4. Determination of fibre volume fraction in composites…………………………34

3.4.1. Fibre extraction…………………………………………………………..34

3.4.1.1.Carbon fibre composites……………………………………………..34

3.4.1.2.Glass fibre composites………………………………………………34

3.4.1.3.Short glass/short carbon hybrid fibre composites…………………...35

3.4.2. Calculations…………………………………………………………...35

3.4.2.1.Single glass and carbon fibre composites……………………………35

3.4.2.2.Short glass/short carbon hybrid fibre composites…………………...35

3.5. Specimens conditioning……………………………………………………...36

3.5.1. Dry……………………………………………………………………36

3.5.2. 50% Relative Humidity (RH)…………………………………………36

3.5.3. Wet……………………………………………………………………36

3.6. Determination of fibre length distribution……………………………………...37

3.7. Determination of thermal properties……………………………………………37

3.7.1 Thermogravimetric analysis (TGA)………………………………………….37

3.7.2 Differential scanning calorimetry (DSC)…………………………………….38

3.7.3 Dynamic mechanical analysis (DMA)……………………………………….38

3.8. Determination of mechanical properties………………………………………..39

3.8.1. Tensile testing…………………………………………………………39

3.8.2. Flexural testing………………………………………………………..39

3.8.3. Impact testing…………………………………………………………40

3.9. Microscopic study………………………………………………………………41

Tables

Figures

CHAPTER 4: RESULTS AND DISCUSSION

4.1. Determination of physical and thermal properties…………………………...42

4.1.1 Fibre volume fraction, V_f...42

4.1.2 Termogravimetric analysis (TGA)……………………………………...43

4.1.3 Differential scanning calorimetry (DSC)……………………………….44

4.1.3.1 Reinforced polyamide 6,6………………………………………44

4.1.3.2 Carbon fibre composite……………………………………………46

4.1.3.3 Hybrid fibre composite……………………………………………..46

4.1.4 Dynamic mechanical analysis (DMA)…………………………………..47

4.1.4.1 Glass fibre composites……………………………………………...47

4.1.4.2 Carbon fibre composites…………………………………………50

4.1.4.3 Short carbon/short glass hybrid fibre composites……………….51

4.2 Fibre length characteristics……………………………………………………..53

4.2.1 Effect of processing on fibre length distribution………………………...53

4.2.2 Effect of fibre volume fraction on fibre length distribution……………..53

4.2.3 The statistical analysis of fibre length distribution……………………...54

4.3 Tensile properties………………………………………………………………55

4.3.1 Single fibre composites…………………………………………………55

4.3.1.1 Glass fibre composites……………………………………………...55

4.3.1.2 Carbon fibre composites…………………………………………62

4.3.2 General comparison between single and hybrid fibre composites………63

4.4 Flexural properties……………………………………………………………...65

4.4.1 Single fibre composites…………………………………………………65

4.4.1.1 Glass fibre composites……………………………………………...65

4.4.1.2 Carbon fibre composites…………………………………………69

4.4.2 General comparison between single and hybrid fibre composites………69

4.5 Impact properties………………………………………………………………70

4.5.1 Single fibre composites…………………………………………………70

4.5.1.1 Glass fibre composites……………………………………………...70

4.5.1.2 Carbon fibre composites…………………………………………75

4.5.2 General comparison between single and hybrid fibre composites………76

4.6 Fractographic studies……………………………………………………..78

4.6.1 Effect of moisture on tensile fracture surfaces………………………….78

4.6.2 Effect of moisture on impact fracture surfaces…………………..............79

Tables

Figures

CHAPTER 5: CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

5.1 Conclusions……………………………………………………………….81

5.2 Suggestions for further work…………………………………………….....82

References…………………………………………………………………………….83

APPENDICES