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Comparison of Hybrid Composites with Different Filler Material

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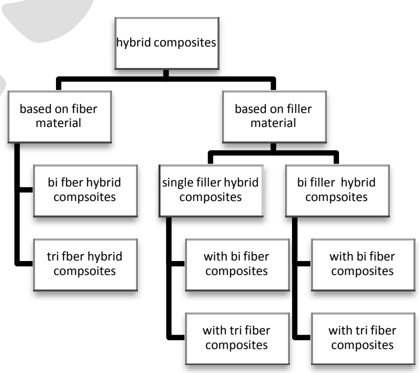
Abstract- Hybrid composites are those composites that are fabricated by combining different reinforcement materials to the combination of matrix material present in the reinforcement, sometimes may be filler or fibers or both. In the present study an effort is made to understand the behavior of different combination filler material to the epoxy resin matrix and test results are compared. The test results reveal that the hybrid composites with 2 different fiber materials and tungsten carbide as the filler material has higher tensile strength and hardness when compared to the material with 3 fiber material and Silicon carbide as the filler material. On the other side the hybrid composites with 3 fibers and Silicon carbide as the filler material showed higher strength than hybrid composites with 2 fibers and tungsten carbide in case of flexural strength and impact strength. Same trend is followed for the cold treated specimen also. Irrespective the material combination the cold treatment has reduced the strength of the material for tensile, flexural and impact strength but hardness of the material found to be increasing

Keywords— Impact, Flexural, Hybrid, Filler, Composites, Hardness, 2fiber hybrid, 3 fiber hybrid

INTRODUCTION

It is known that the combinations of several different materials have enhanced the mechanical properties in composites. This has led to the formation of Hybrid composites. The behavior of composites has improved characteristics than individual components or the composites with normal combination. The strength or performance of hybrid composites is always a sum of the strengths of individual components in which the weight due to their sum is compensated by their strength. The strength of one component can be used for overcoming the weakness of the other components. Hybrid composites have feather of less costly when compared to other composites with same strength and application. The different forms of hybrid composites are formed based on their combination. Metal matrix composites with different material combination and fiber are called metal matrix composites. With added fiber and filler material, they are called hybrid composites. In other different combination, the metal matrix composites are combined with 2 or more filler material to form hybrid composites. In case of polymer matrix composites hybrid composites are formed by combining two different fibers with filler material as bi fiber hybrid polymer composites. When three different fiber materials are used as the reinforcement with filler material, it is called as tri fiber hybrid polymer composites. The hybrid composites can be classified based on their matrix material, fiber present and filler used in it.



Generally composites are fabricated by using hand layup technique as it is most suitable and cheapest mode of fabrication and easily available. In this method the laminates are placed one above the other to obtain the desired thickness. The stacking sequence is sometimes varied in orientation so the strength in all direction remains same. In the present study the woven fabric is used as the reinforcement to bind the matrix, therefore the strength of the lamination in both directions is same. As the strength remains same in both directions the orientation angle need not be varied. The minimum required thickness of the hybrid composites can be obtained by just placing one laminate over the other in same order. The hybrid composites fabricated in present study are having fiber and matrix in the ratio of 60%: 40% of the weight ratio. The stacking sequence used for the two hybrid polymer composites fabricated in the present study is as follow for bi (two- fiber) hybrid composites the sequence is (G-A-G-A-G-A-G-A) where G- glass fiber and A is aramid fiber is used the reinforcement in of the laminates along with epoxy resin and tungsten carbide (WC) as the filler miller in proportion of (0, 5%, 7.5%&10) weight ratio. The other tri fiber hybrid composites the stacking order is (G-C-A-G-C-A-G-C-A) where C-carbon fiber is used the reinforcement in of the laminates along with epoxy resin and Silicon carbide (SiC) as the filler miller in proportion of (0, 5%, 7.5%&10) weight ratio.

REMAINING CONTENTS

Material testing

The different material testing conducted for the materials fabricated are tensile test flexural or 3 point bending test, impact test, hardness test for the specimen at normal temperature and cold treated specimen(cold treatment was done for -30^{0C} for 24 hours).

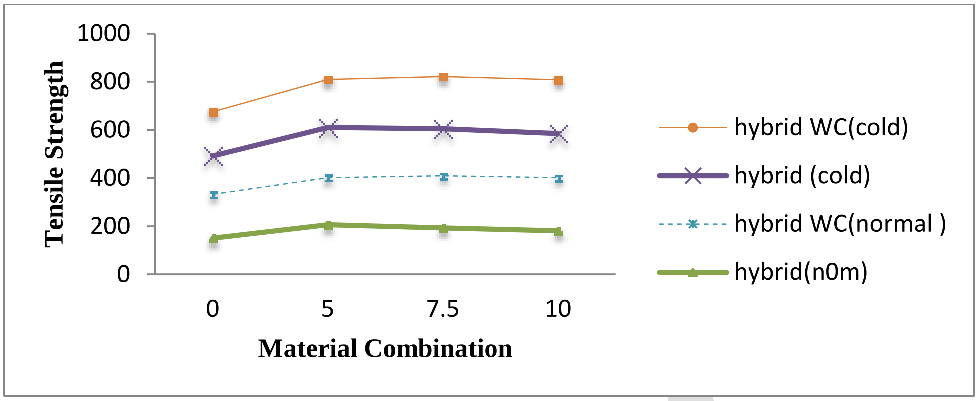
Tensile test

Tensile test is conducted according to the ASTM standard D3039 with the dimension of 250mm of length, 25.4mm of width and 3mm thickness.

Material composition	Tensile strength (MPa)	
	Normal	cold
Aramid-G-E	180.73	182.56
5WC-Aramid-G-E	196.26	199.35
7.5WC-Aramid-G-E	215.79	217.48
10WC-Aramid-G-E	220.36	222.89

Material composition	Tensile strength (MPa)	
	Normal	cold
Aramid-G-carbon -E	151.259	160.250
5SiC-Aramid-G-carbon-E	206.05	207.52
7.5SiC-Aramid-G-carbon-E	193.56	195.18
10SiC-Aramid-G-carbon-E	181.2	183.466

Plots of tensile stress



From comparison of tensile test result is evident that the tensile strength of the aramid glass fiber with tungsten carbide as the filler material shows increase in strength as the percentage of filler material increases. 10 % tungsten carbide filled aramid –glass composite shows higher strength for both normal and cold treated specimen. In case of SiC carbide filled aramid-glass-carbon fiber polymer composites shows increase in tensile strength up to 5% SiC. Any further increase in filler material, the strength found to be decreased but it was higher than the unfilled hybrid composites. When compared to both the hybrid polymer composites the glass –aramid hybrid composite filled with tungsten carbide shows higher strength.

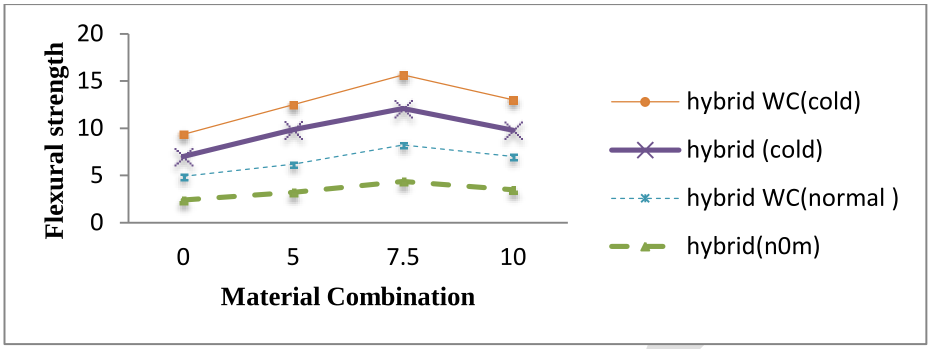
Flexural Test or 3- Point Bending Test

Flexural test is conducted according to the ASTM standard D790 of having the dimension of 125mm of length, 12.7mm of width and 3.2mm thickness

Material composition	Flexural strength (MPa)	
	Normal	cold
Aramid-G-E	9.32	9.07
5WC-Aramid-G-E	11.76	11.16
7.5WC-Aramid-G-E	13.91	12.98
10WC-Aramid-G-E	15.73	15.25

Material composition	Flexural strength (MPa)	
	Normal	cold
Aramid-G-carbon -E	10.2907	9.72
5SiC-Aramid-G-carbon-E	15.1074	11.43
7.5SiC-Aramid-G-carbon-E	12.36	10.24
10SiC-Aramid-G-carbon-E	9.7707	8.6328

Plots of Flexural Stress



From comparison of flexural test result is evident that the tensile strength of the aramid glass fiber with tungsten carbide as the filler material shows increase in its strength as the percentage of filler material increase and 10 % WC filled aramid –glass composite shows higher strength for both normal and cold treated specimen. In case of SiC carbide filled aramid-glass-carbon fiber polymer composites show the increase in flexural strength up to 5% SiC filled and any further increase in filled material the strength found to be decreased but it was even lesser than the unfilled hybrid composites. The flexural strength of the composite material will increases with the increasing tungsten carbide quantity. The increasing of filler material should be stopped where the flexural strength of the composite material start to decreases. The flexural strength of the given composite material cannot withstand the large amount of the filler/resin mixture. A right percentage of the filler material is decided earlier to get the maximum flexural strength of the composite material. The cold treated specimen will lose their flexural quality due to the hardness of the material after the cold treatment. So the cold treatment in case of flexural strength is not recommended.

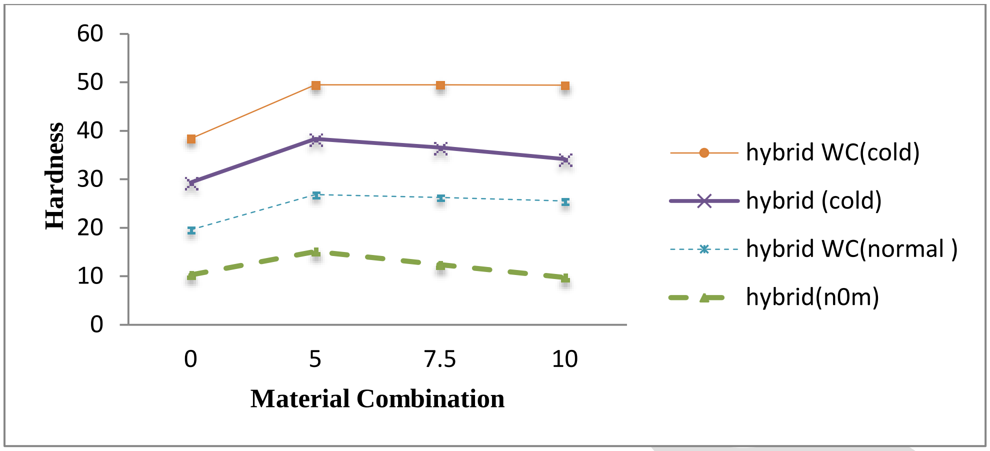
Hardness Test

To determine the hardness of the composites Rockwell hardness tester was used for both normal and cold treated specimen. The dimension of the components tested was 25*25mm with 3 mm thickness it does not have any standard dimension for harness test for convenience it is chosen as 25*25mm

Material composition	Hardness	
	Normal	cold
Aramid-G-E	59	62
5WC-Aramid-G-E	62	66
7.5WC-Aramid-G-E	65	68
10WC-Aramid-G-E	69	73

Material composition	Hardness	
	Normal	cold
Aramid-G-carbon -E	54	56
5SiC-Aramid-G-carbon-E	57	58
7.5SiC-Aramid-G-carbon-E	58	60
10SiC-Aramid-G-carbon-E	60	62

Plots of hardness



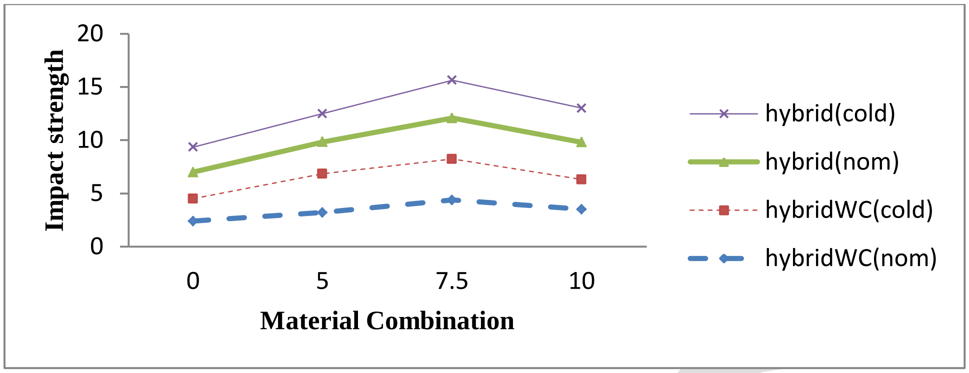
From comparison of hardness of both the composition components it is found that with increase in filler material percentage the hardness of the components was found to be increased and the material filled with 10 % filler showed higher hardness both in case of normal and cold treated specimen. The cold treatment has enhanced the hardness of the material irrespective of the filler used. Also it is observed that cold treatment has increased the brittleness of the composites. This may also be the one of the factor for higher hardness of the cold treated specimen.

Impact strength

Impact test is conducted according to the ASTM standard D256 of having the dimension of 69mm of length, 12.7mm of width and 3mm thickness

Material composition	Hardness	
	Normal	cold
Aramid-G-E	2.5	2.35
5WC-Aramid-G-E	2.99	2.65
7.5WC-Aramid-G-E	3.85	3.56
10WC-Aramid-G-E	3.5	3.2

Material composition	Hardness	
	Normal	cold
Aramid-G-carbon -E	2.40	2.1
5SiC-Aramid-G-carbon-E	3.2	3.65
7.5SiC-Aramid-G-carbon-E	4.38	3.85
10SiC-Aramid-G-carbon-E	3.5	2.8



From comparison of impact test of the given specimen shows the impact strength of the composites increased till 7.5% usage of filler material any further increase in the filer material has depleted the impact strength, for both normal and cold treated specimen. As compared to Aramid- glass fiber with WC, Aramid-glass and carbon fiber with SiC shows higher impact strength both in case of normal and cold treated specimens.

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If acknowledgement is there wishing thanks to the people who helped in work than it must come before the conclusion and must be same as other section like introduction and other sub section.

CONCLUSION

From the above result it is confirmed that material with two fiber and tungsten carbide filler shows higher strength when compared with a polymer composites with 3 fiber and SiC carbide as the filler material. The cold treatment has degraded material strength in all the mechanical characteristics except the hardness. The bonding between the materials may be the reason for decrease in the strength. Cold treatment has increased only the hardness of the material. This may due to increased brittleness. The hybrid material with aramid-glass-carbon fibers filled with SiC has showed higher strength than hybrid material with aramid and glass fiber filled with WC. This may be due to the resistance of the fibers or may be due to incorporation of SiC filler material.

REFERENCES:

1. RogérioLago Mazur São Paulo State University Guaratinguetá-Brazil Michelle Leali Costa São Paulo State University Guaratinguetá-Brazil. Journal of Aerospace Technology and Management dec-2009.
2. Zahra Riahi MASC in Earthquake Engineering, Energy and Infrastructure Division, Sandwell Engineering INC, Vancouver, BC. FarzadFaridafshin MASC in Structural Engineering, Concept and Technology Department, Aker Solutions, Bergen, Norway.
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11. R.Panneerdhassa , A.Gnanavelbabub*, K.Rajkumarc,Mechanical Properties of Luffa Fiber and Ground nut Reinforced Epoxy Polymer Hybrid Composites.
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