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Influence of graphene oxide on mechanical properties

Basalt fabric reinforced phenolic resin

Yan yiwu[1] , Cao hailin*[1] , [2] , Gan zhou[1]

[1] Shenzhen Key Laboratory of composite materials,Shenzhen Academic of aerospace Technology,shenzhen 518057,

[2] School of chemical Engineeringand Technology,Harbin Institute of Technology,Harbin 150001, Today

Abstract: The coupling agent modified graphene oxide (go) is added into phenolic resin to prepare basalt fabric</b 12>

Reinforced phenolic composites. The influence of graphene oxide mass fraction on the mechanical and impact properties of basalt fabric reinforced Phenoli C Composites was investigated. The results show, the addition of Go in

creases The flexural strength , The modulus and Interlaminar strength (LSS) of the basalt fabric reinforced phenolic. The maximum flexural strength and modulus areobtained at the go mass fraction of 2WT%<b 14>, which s M

creased by nearly 39% and % , respectively. The Maximu mimpact load and damage absorbed energy increase by 40% and /b17>60%,respectively, after adding 1wt% go.

Keywords: Graphene oxide (go) ; Surface Modification ; Basalt Fiber mechanical Properties ; Composite

phenolic resin is a high-performance ablative resin , has a High carbon rate , Low density uniformity and ablation rate of carbonized layer . but because of the ITS brittleness big , Toughness difference low Shear Strength , usually need to pass modified to improve its mechanical properties [1] . oxidation of graphene (gra-pheneoxide , Go is a graphene oxide , relative to graphite allyl ,go not only has excellent mechanical properties , Its surface also has Large number of active groups , like hydroxyl , carboxyl etc ,to increase its clustering

compatibility between objects , to make it a modifier in the resin or compound material fields have important application value [2-5].

Chiang - beep wait [6] Prepare 1% for Go doped Go / cyanate ester resin composite , its tensile strength , flexural Strength and impact strength the cyanate ester resins with less than doping go are increased by the 14%,50% and 53%. Cai etc [7] the is prepared by in-situ aggregation Go / polyurethane composite , when go The is added to 1wt%when , composite

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Newsletter Author : Cao Hai Lin , Professor , Research direction for composite material performance design and development E - Mail: caohl@hit.edu . CN

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Has improved the toughness of 50%, When the amount of graphene oxide reaches 4wt% when , composite elastic modulus increased 4 times .

Basalt Fiber is a new inorganic green high-performance fiber Dimension Material , due to its excellent price/performance ratio and thermal insulation , becomes The focus of many scholars at home and abroad [8 9].

with basalt fiber enhance material , resin [ ], WPC [ ] and] Concrete [ ]] materials Composite applications for the base system are very extensive. , where , basaltic Rock fiber reinforced phenolic resin composite can be applied to rocket and missile thermal protection field for engine nozzle material[1314] . current , about go modified basalt fabric / Research report of Phenolic composites still not very much . This article will study go/ Phenolic modification technology , toprepare Performance-engineered basalt fabric composites . through research go content to composite bending , Effects of interlaminar shear and impact performance Law ,clarifying Go Enhanced hardening mechanism for composites , is a composite The Material Performance design provides the basis for .

1. Experimental materials and methods

1.1 Raw Material

barium phenolic resin , Solid Content 58% , Beijing FRP Research House , basalt fabric , face density (400±20) g/m^2, Sichuan Aerospace xinlong Basalt Fiber Co., Ltd. ; graphite flakes , mansion door Kay Graphite Technology Co., Ltd. ; KH560 silane coupling agent , South Jing ao City Chemical Co., Ltd. .

1.2 oxidized graphene (Go) prepare

with improved Humm er s To prepare Go ; To take the appropriate amount of stone Ink micro-flakes in three flasks , in ice bath conditions , slowly add strong sulfuric acid with mechanical search min , joins the slowly at the same time $Kmno_7$, The reaction temperature is no higher than 5 C , After the item is added , Normal temperature reaction2h , again C thermostatic reaction 2h , and then slowly add the deionized Water , and control temperature to 9 5 ~ 9 8 C , To keep the 3 0 min after cooling , Last add deionized water dilution , drop plus 30wt% for H 2 O 2 to anti-change from brown to yellow . silence 12h after , with 5wt% hydrochloride and proper deionized water for centrifugal washing to no so4- , Sample Collection To be used .

1.3 GC - Basalt Fabric / Phenolic resin composite preparation

calls the appropriate Go Ultrasonic dispersion in water , To take the appropriate amount of coupling agent for mixed modification , adjust reaction PH is between 3. 5~45between , thermostatic Water bath reaction 12h , and then centrifuge , After spray drying Get modified go powder . will be modified go on a certain scale dispersed in phenolic resin , Preparation of modified phenolic resin .

basalt fabric prepared by hot pressing process / Phenolic resin composite Material Sheet . First will contain go phenolic resin with basalt fiber fabric is fully impregnated ,then dry remove solvent get prepreg

Material ; Finally, the prepared prepreg is paved in the stencil , to progress in hot press line heating pressure curing . Optimizing curing process , get qualified Xuanwu Rock fabric / phenolic resin composite products . For comparison , take Basalt fabric prepared by same process / phenolic resin composite . -Test and representations

A Japanese science company produces D / Max - RB type X Ray diffractometer , for prepared Go to represent , diffraction rake to CuK_a , Pipe current is MA , The tube voltage is KV , scan speed is 5 /min, incident wavelength is 0. 154 nm

Basalt Fabric / flexural Properties of phenolic resin composites , Inter-layer shear performance according to GB/t 1449- ???? [a] and jc/t 773 - [a] to test , each test Ten sample ,test on CMT7054 Electronic Universal Experimental Machine progressive line . basalt fabric / impact performance of phenolic resin composites press ASTM D3763[P] To test , test on Instron- CEAST9340 Drop Hammer Impact tester Carry on .

using the United States Nicolet Company's Nicolet - 380 -type Fourier transform IR spectrometer , Go to represent , with dry KBr powder to matrix , thin slices , To measure its transmission Spectrum , measurement range is 370 ~ 4 cm - \

using Hitachi s^47 (8) type sweep electron microscope to basalt fiber surface and basalt fabric / phenolic resin composite fracture form appearance Description , test acceleration voltage is KV .

2. Results and discussions

2.1 Go representations of

diagram 1 is Go Microscopic form of . can see ,go not is a flattened layer , but has a crimp structure , This could be because The oxygen-containing functional groups introduced by oxidation of graphite have weakened the Force of the graphite layer's .. combined with EDS analysis shows , go main contains carbon and oxygen elements ,calculated ,C /O element quality ratio 2. , The indicates a certain amount of oxygen-containing functional groups on the graphene surface . from Chart 1 (b) visible , preparedGo sample has a thin layer structure , Edge margin with curly or wrinkled miniature structure , indicates product layer less , up to nanometer level .

diagram 2 is graphite and Go for X X-ray diffraction map . can See, Graphite flakes in is is a strong diffraction peak , This peak corresponds to Graphite's (002) feature diffraction peak , layer spacing is 0. nm . graphite after oxidation the ,on ten no . Chang peak , corresponds to graphite oxide (001) feature diffraction peak , and only on The diffraction peak strength of the weakens , indicates graphite is oxidized after , Crystal corrupted , Reduced order degree . via Bragg equation count, graphite oxide after layer spacing from 0. nm increases to 0.,

nm . This is because the surface of the go, has a hydroxyl , carboxyl group , make graphite crystal lattice in C axis increases .

diagram 3 is Go infrared spectra before and after modification . from Diagram 3 (a) Visible , 3 384 cm ^{1} and 3 175 cm ^{1} corresponds to Go associating in hydroxyl and adsorbed water molecule free hydroxyl group ,1 723 cm^{-1} for carboxyl base C = O flex Shock absorption peak ,1618 cm^{-1} corresponding C#c telescopic Vibration absorption Peak , also , on 1 399 cm1 Premises

corresponds to C - O Peak Enhancement , at the same time 1 066 C m -^{1} also appears at C -O Single-touch peak , description go contains a lot one OH,-COOH and C-O -C etc oxygen-containing functional groups ; in diagram 3 (b) , by KH 5 Modified Go in 3 380 C m - ^{1} To Place now one OH Absorption Peaks , 2 8 7 2 C m - ^{1} corresponds to the alkyl C -H absorption Peaks , 1 726 cm - ^{1} The still retains the Go to in carboxyl groups C = O Vibration absorption Peak , 1 4 0 3 C m - ^{1} at C - O weakens , may be in dry process go partially restored , on 1 201 cm-1 ,1 1 0 8 C m - ^{1} 1 042 C m - ^{1} at the S I - OH and Asymmetric S I - O - S I absorption Peaks , The department partially snaps to IJ hydrolysis condensation forms , and 1 066 C m - ^{1} The epoxy group absorption peaks at are move to 914 cm ^{1},, This indicates the coupling agent successfully grafted to go surface . Z 2 GC- Basalt Fabric / Phenolic resin bending performance

diagram 4 is basalt fabric / bending of phenolic resin composites performance . knowable , basalt fabric / Phenolic resin composite bend The curvature strength and bending modulus all follow Go The increase in content increases first reduce ,go content is less than 2wt% , Add Go after , Complex The flexural properties of a material reaches maximum , Bend strength and bend modulus increased by approximately 39% and 25%; followed by the Go In – Step increase , Bending strength and bending modulus drop . from Diagram 4 Middle

can also see the , with Go increased content , Basalt Fabric / The standard deviation of the flexural properties of phenolic resin composites is also gradually increase .

Z 3 Basalt Fabric / Phenolic layer shear performance

diagram 5 gives the basalt fabric / Phenolic resin composite layer between shear strength (ilss) with go content change relationship . can See, Similar to flexural strength ,basalt fabric / phenolic resin complex all Material's ilss with go increase first before minus Small . when go content to 2w t% when , Basalt fabric / phenolic

15 -0 0.5 1 0 1.5 [* * * * [] 2.0 2.5 3.0

Mass Fraction of go/%

diagram 5 Go content to basalt fabric / phenolic resin composites

ILSS Effects of

Fig. 5 Effect of Go mass fraction on the Interlaminar shear

STRENGTHC ilss) of basalt fabric reinforced phenolic composites

resin composites ILSS Maximum Value , larger than blank sample approximately 43%. follows The go further increase ilss appear down , when go content to 3wt% when ,ilssbetter than blank sample increase approximately ? %.

diagram 6 is basalt fabric / Phenolic resin composite interlayer shears cut mouth shape . from the diagram 6 (a) can see , not added go , Basalt Fabric / cross section fiber of phenolic resin composite pull-out grave , and unplug fiber surface almost without resin , fibers and resins

diagram 6 different Go basalt fabric with content / Phenolic resin composite fracture morphology Fig. 6 SEM micrographs of basalt fabric rein.forced phenolic composites with different mass ractions o f go

large gap between ; and add 0 5wt% go after , basalt weave objects / Phenolic resin composite fracture fiber pull-out reduction , and Unplug fiber surface contains resin (Chart 6 (b)); when Go Add amount to _ Step increases , Basalt Fabric prepared by / Phenolic resin composite material material fractures are more homogeneous , binding between fibers and resin matrix tight (Chart 6 (c) and Diagram 6 (d)).

will Go Introducing Basalt fabrics / phenolic resin composites resin Matrix , improving interfacial bonding strength of composites , makes the The stress is better delivered at the two-phase interface , Fiber in composite the matrix resins Share the destructive stress . go with oxygen functional groups Can react with phenolic resin matrix , make fiber and resin pass over Go micro-slices are connected , To increase the basalt fabric / Phenolic properties of resin composites .

Z 4 Basalt Fabric / Phenolic resin impact Performance

diagram 7 is a basalt fabric / the loading of phenolic resin composites and energy-time curves . can see , basalt fabric / phenol formaldehyde resin composites are damaged in small loads (A point); as the test continues , load up to maximum (B Point), sample starts to crack ; increases with time , crack propagation causes load to drop . until sample is flushed , load should down to 0(**Figure 7** with dotted line , but due to flush after , header vs. sample frictional effect , causes the actual measured force after punching is not to 0[a].

Table 1 is different Go Basalt fabric prepared by content / Phenolic Peak strength of resin composite in impact test , peak power Amount and peak force offset data . Energy response of peak Force in table test specimen resistance to damage , when Go content is 1w T % , basalt fabric / Peak strength of phenolic resin composites , peak position Energy and peak Force displacement parameter values highest , Impact performance Most Excellent , and relative to basalt fabric without go / phenolic resin complex

Composite Material , The impact damage load of the composite is increased by 40% , Break bad absorption energy increase 60%.

composite impact damage forms including fiber breakage , resin crack , Interface Hierarchy etc . Go add basalt fabric / phenolic tree lipid composites , interacting with resins and fibers , can to more effectively deliver stress , make basalt fabric / Phenolic resin composite resistance to impact load enhanced . at the same time , go the presence of the increases the path of the crack extension . so ,go The addition effectively resists the basalt fabric. / phenolic composite delamination of materials and formation and expansion of matrix cracks , make basalt fabric / phenolic resin composites absorb more in the impact process Energy .

3. Conclusion

(1) X X-ray diffraction , Scanning electron microscope and transmission electron microscope analysis results show , prepared graphene oxide (Go With has a nano-layered structure . ir spectroscopic results show , coupling agent KH560 successfully grafted to go surface .

(2) Go can significantly improve basalt fabric / phenolic resin complex Mechanical properties of materials . when go content 2wt% time ,G& Basalt fabric / phenolic resin composite Properties most high , Increasing bending strength and bending modulus by 39% and 25% , Layer between shear strength (ilss) increase 43%.

(3) Go can increase basalt fabric / Phenolic resin composite material impact performance for material . with go

Increase content , G& basalt Fabric / anti-shock performance of phenolic resin composites increase first after minus small . go content 1wt% ,G& Basalt Fabric / phenolic tree Grease composite impact damage Load increase40%, destroy absorbing energy Add 60%.

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