ANALYSIS

17(48), 2020

ISSN 2319–7757 EISSN 2319–7765

Indian Journal of Engineering

Strength analysis of value added composite materials from shells of crabs

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Article History

Received: 25 April 2020

Accepted: 30 May 2020

Published: June 2020

Citation

Raghuram KS, Pavani Moyya. Strength analysis of value added composite materials from shells of crabs. *Indian Journal of Engineering*, 2020, 17(48), 351-356

ABSTRACT

The external skeletons of crabs contain chitin fibers in excess quantity. The chitin powder can be manufactured by mechanical treatment with several purification processes. Chitin powders are manufactured by grinders and water jets. The acidic treatment is done to fibrillation. Surface modification is done to mechanical fibrillation. The surface modification is done to change the surface property. After grinding the crab powder is used to manufacture functionally graded material.

Keywords: laminates; chemical properties; chitin; chitosan; grinding of crab powder

1. INTRODUCTION

The present work is to invent a novel material from the shells of the crabs. The powder thus made is called chitin. As this research work triggers towards the usage of biological waste, the work is expected to get the good reputation among the evolution of novel materials. There was discontinuity in their tensile stress-strain curves. The crab cuticle fails in an entirely brittle manner. Chitin is widely and freely in nature and its annual production is very high. This study demonstrated the suitability of copper-cross-linked chitosan scaffolds [1]. The powders made from the shell material of crabs can be used to fabricate functionally graded materials. The novel method of expelling micro powders from the bio wastes serves two purposes like giving a value addition to biological waste and secondly to evolve a functionally graded material to the nation. The material structural properties differ due to the low porosity and phenolic dark tanning material and this tanning resulted the dark color and porosity filling [2]. The electro-grinding process helps for the artificial micro powders evolution of waste shell materials. The shell of the body (the carapace) *is* less mineralized and more elastic [3]. These shell materials can be widely used for the manufacturing of a wide range of polymers. Modern practices resulted in large volume of waste material, i.e., skin, eyes, head, tails, body shells, scales on bodies, backbones, etc [4]. The dynamic motion of fluids, charged electrical surfaces, charged liquids etc are some of the procedural steps involved in the present research. The biopolymers are generally biodegradable, compatible, reusable and sustainable many researchers are looking towards these materials. The powders chitin and chitosan contain cellulose analogues having an *N*-acetyl glycosamine repeat unit and the deacetylate derivative.

Chitin is one of the most abundant biopolymer present in the outer skeletons of crabs, insects, shells of prawns and the fungi walls. The chitin is produced at a high rate of 10E10 to 10E11 tons yearly. A high amount of chitin shell material is thrown away as low cost waste. Chitosan occupied a dide range of applications because of its biodegradable nature, compatible nature, antimicrobiality, nontoxic quality and versatile chemical property and physical properties [5].This is because of the low workable nature of chitin, the biopolymer. The commercially available chitin powder is insoluble in any solvent and precipitates. Chitin is having linear crystalline structure. Chitin powders can be prepared by disintegration of shell materials to powder. The author made a simple method to prepare chitin powder by electro grinding. Response surface method was designed the culture media considering demineralization [6]. Finally the chitin-glucan formulations are verified correct [7]. These results suggest that removing the protein from shrimp waste by A2 protease can be used to the chitin production [8].

Chitin is made by the process of an oil-in-water emulsification/evaporation method. A structure of parallel poly-*N*-acetyl glucosamine chains with no inter sheet hydrogen bonds were existing [9]. This method evolves a facile and flexible compatible chitin and dibutyryl chitin sub-micron sized particles. The usual behavior of chitin's hydrophilic surface and chitosan turned to hydrophobic with water contact [10]. In this method hydro-phobicization of chitin by the addition of labile butyryl groups to disrupt intermolecular hydrogen bonds and enabling solubility in the organic solvent used as the oil phase during fabrication. Chitin is translucent in nature. Chitin is exhibiting the property of resilient and tough. Plied composites can be made using chitin powder. They were completely soluble in acids [11]. The sponge scaffold was a potential skin tissue with appropriate physical nature and compatible [12]. The shells of micelles can be made cross-linked [13]. The experimental isotherm data was analyzed for each sample of chitosan powder [14]. The present bioactivities of chitin derivatives are completely correlated with biomedical properties [15].

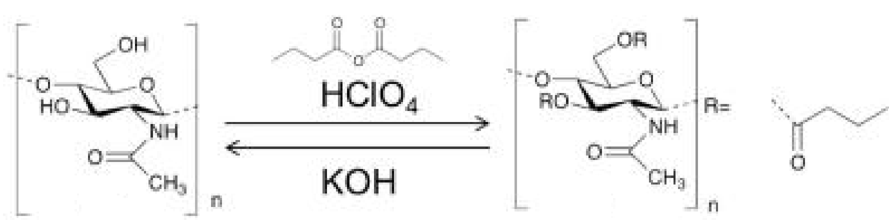

Figure 1 showing the chemical formula of chitin particles and dibutyrylchitin particles

Table 1 showing the contents of chitin powder used in the present work	
Parameters of chitin	Properties
Powder color	White Powder
Size of the powder particles	80 mesh
Moisture content	< 10%
Ash content	< 1.0%
Pb material	< 2 ppm
As	< 0.5 ppm

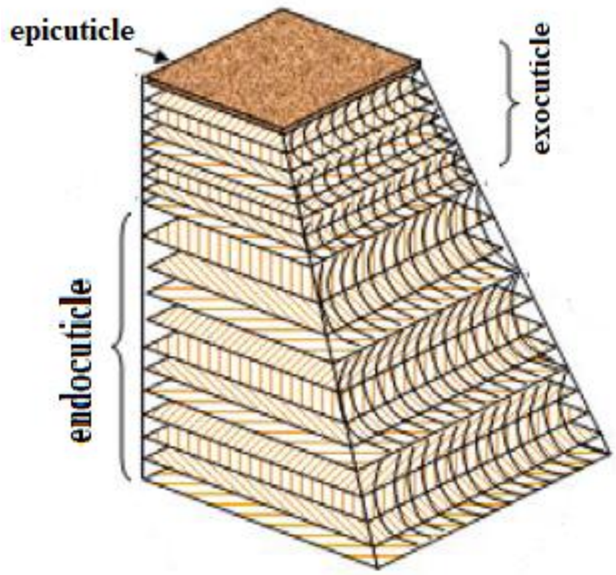

Figure 2 Showing the schematic sectional view of the crabs external skeleton

Figure 3 showing the image of a crab shells

Figure 4 showing primary cleaning of crab shells

Cleaning process of Crab shells:

Figure 5 showing the 1) collection of shells of crabs 2) Thorough cleaning of shells

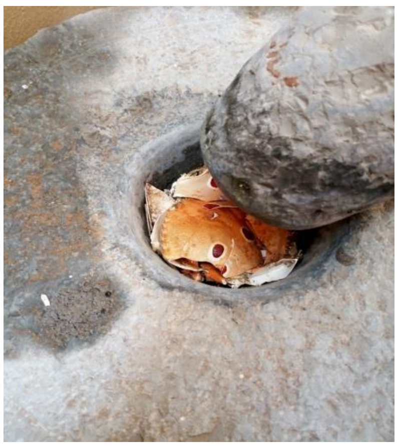

Figure 6 a) the crab shells are put in the stone grinder

Figure 6 b) the crab shells are hand grinded

Figure 6 c) the crab shells after hand grinding

Figure 7) the crab shells after grinded in the electric grinder

Figure 8) the electrically grinded crab shell powder for filtration

Figure 9) the remained crab shell powder for further grinding

The crab shells collected from the waste garbage of fish markets is brought to cleaning. They are thoroughly cleaned from the adhered flesh particles. Then the grab shells are dried for 7-8 hours in deep sunlight such that no water particle rest on the shell material. Then these shell materials are grinded by 5-8 times until the particles of the shell powder get filtered through 30 micron filter. The grinding and filtering are shown in the following figures.

Synthesis and characterization

The residual proteins and calcium carbonate lumps are removed to form pure chitin. The proteins were cleaned by adding 1 M NaOH and the rest of the minerals were removed by adding 3 M HCl. Neutral chitin then is separated by the action of centrifugal force and then cleaned a number of times with water, it is then dried and powdered. The pH value is checked for neutral value of the chitin. The chitin particle of sub-micron size was analyzed under Scanning Electron Microscopy.

2. METHODOLOGY

The crab powder thus prepared is brought to the workshop and is allowed to mix with the matrix material. The crab powder is used as reinforcement material as it possesses good mechanical properties. The matrix material used for the present research is flux, E-glass and jute. The polymer matrix composites are made of hand layup process. They are pressed with roller placed on the high density poly ethylene sheet to remove the residual stresses and air bubbles in the composite plate. The plates are allowed to settle for 2 hours. The plates are then removed off their loads and are machined to prepare the specimens with E8 specifications.

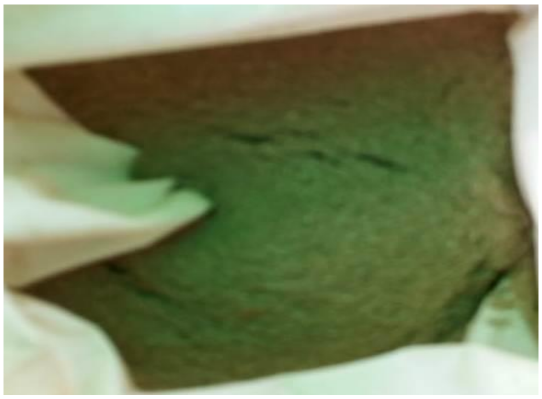

Figure 10) Crab powder ready to use in the fabrication of the present material

Figure 11) the materials used for the matrix material the flux, E glass, Aluminum powder

Figure 12) the composite plates made by hand layup method.

Figure 13) the specimens after tensile test

3. RESULTS AND DISCUSSION

The chitin is synthesized and residual proteins and calcium carbonate were removed. The viscometer measures the molecular weight of the chitin as 81.7 KDa. The testing results shows that this material withstands a load carrying capacity of 3KN and this is comparatively more than other fillers such as shell powder of coconut, powder taken tamarind seeds.

Water Test result

The composite specimens are placed in water for about 48 hours continuously and it is clearly observed that there is no absorption of water by the specimens. The weight of water is measured. The specimens are soaked in this water and kept for 48 hours and taken from the water and water's weight is again weighed. The weight of water remained same after the specimens are removed from water. Hence it is concluded that there is no water absorption and these Polymer Matrix Composite materials are undoubtedly used for exposition to water.

Table 2 showing the properties of various combinations of composite materials

Property (unit)	Flax	E glass	Flax +E glass	Flax + Eglass+ 5g crab powder	Flax + E glass+10g crab powder
Load at yield (KN)	5.48	6.36	5.62	7.66	8.74
Elongation at yield (mm)	0.060	0.020	0.040	2.200	2.670
Yield stress (N/mm$^{2)}$	182.667	212	187.33	255.333	291.33
Load at peak (KN)	7.100	14.160	10.880	9.580	10.940
Elongation at peak (mm)	2.580	4.620	4.490	3.820	4.330
Tensile strength (N/mm$^{2)}$	236.667	472.00	362.667	319.333	364.667
Load at break (KN)	5.240	14.080	0.820	5.220	5.060
Elongation at break (mm)	2.460	4.630	1.580	3.530	4.110

4. CONCLUSION

On thorough observation through experimentation with various combinations of composite specimens made with E glass, chitin powder, Flux it is notified that the functionally graded materials can be manufactured from the combination of 10% Crab material called chitin powder mixed with flux and E-glass. It was also observed that the polymer matrix composite material is exhibiting high water resisting property. The tension test on the various combinations showed a clear authenticity that 10% chitin powder combination with Flux and E-glass is having good mechanical properties.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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