

Experimental Study of Biopolymer Nano Composite for Engineering Applications

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ABSTRACT: In recent years, bio based biodegradable products have raised great interest to apply in the engineering applications. The bio-polymer that is developed from living beings. The materials prepared from single biopolymer are shown under performance properties towards numerous engineering applications. It is worthwhile to explore the biopolymer composites to acquire desired qualities by blending the chosen biopolymers with required additives. Moreover, the biopolymers have efficiency in conjugation with numerous additives, it is easy to obtain the properties of engineering materials in the composites.

It is easy to obtain the properties of engineering materials in these composites. The series of biopolymer composites are prepared by blending of nano composites like carboxy methyl cellulose (CMC), and chitin. The mechanical properties of these composites are studied for engineering applications.

KEYWORDS: Nano composites, Mechanical properties

I. INTRODUCTION

Chitin is a natural, renewable and biodegradable polymer, the second most abundant natural polymer after cellulose [1]. Large amounts of this structural material can be found in animals, in exoskeleton shells of arthropods (crabs, shrimps and beetles), internal flexible backbone of cephalopods, worms, webs of spiders, cell walls of fungi and yeasts [2-4]. Despite its easy accessibility, chitin is still an underutilized resource because of its bulk structure and insolubility in water and common organic solvents [5].

Chitin is considered to be the main biomass resource [6], with more than 1011 tons per year production in nature [5]. The shellfish processing industry (shrimp or crab shells) generates great amounts of waste from shells, which contain about 30% in chitin [4]. Chitin is non-toxic, odorless, bio compatible with living tissues, biodegradable [2], and presenting antibacterial, moisture retaining and healing characteristics [7]. Chitin and chitosan (partially deacetylated chitin) can be utilized in water purification [8], additives in cosmetics [9, 10], antibacterial agents [11, 12].

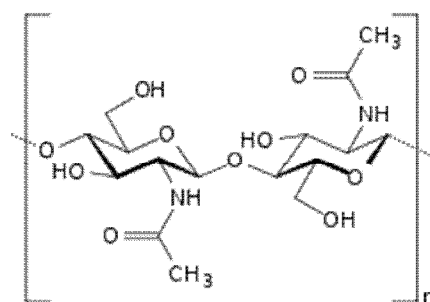


Fig. 1. Structure of the chitin molecule, showing two of the *N*-acetylglucosamine units that repeat to form long chains in β -1, 4 linkage.

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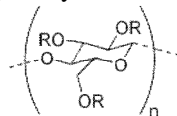
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Naturally-derived carbohydrate polymers have unique physical and biochemical properties advantageous for bioengineering applications. For example, agarose and alginate have enjoyed a long history of use in the molecular biology and cell encapsulation fields, respectively. Additionally, glycosaminoglycans such as heparin, chondroitin sulfate and hyaluronic acid have been selected to impart biological activity in tissue engineering scaffolds and can also function alone as active pharmaceutical agents. Cellulose derivatives such as carboxymethylcellulose (CMC) and hydroxyl propyl cellulose are biocompatible.

It is synthesized by the alkali-catalyzed reaction of cellulose with chloroacetic acid. The polar (organic acid) carboxyl groups render the cellulose soluble and chemically reactive.

The functional properties of CMC depend on the degree of substitution of the cellulose structure (i.e., how many of the hydroxyl groups have taken part in the substitution reaction), as well as the chain length of the cellulose backbone structure and the degree of clustering of the carboxymethyl substituents.



R = H or CH₂CO₂H

Fig. 2. Structure of carboxymethylcellulose

II. MATERIALS AND METHODS

Chitin and CMC are purchased from chemical agent. The hardness of the composites is evaluated by Rockwell hardness tester. The tensile strength of the prepared materials are tested by using Universal testing machine (UTM). The test film is cut into uniform shaped according to ASTM D882-02. The five samples were tested for each formulation at both with and without moistures.

$$\rho = m/v \quad (1)$$

Where ρ = density, m = mass, v = volume of sample.

$$\% \text{ Weight gained} = \frac{\text{Final Weight} - \text{Initial weight}}{\text{Initial weight}} \times 100 \quad (2)$$

III. SAMPLE PREPARATION

The Chitin and CMC are dried in oven for 24 hours at 80°C before pre-mixing and compounding to remove moistures. The compounding of Chitin/CMC at different blend ratios was done with addition of palm cooking oil. The compositions are stirred uniformly at rate of 60 rpm. Then, resultant composites are molded as products. The samples were prepared by using Chitin as base and CMC is propositioned as indicated in the table-I. The compounds are tested for physical and mechanical properties.

Table1 Composite Compositions in %

S No	Samples	CMC (%)	Chitin (%)
1	Chitin	0	100
2	Chitin/CMC-I	80	20
3	Chitin/CMC-II	60	40
4	Chitin/CMC-III	50	50
5	CMC	100	0

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IV. RESULT AND DISCUSSIONS

4.1 Mechanical Properties of nano composites

Tensile test

The tensile property of different products were measured and shown in fig.1 It is observed that the composite products of Chitin/CMC-I breaks at 16.9kN. The individual Chitin and CMC are breaks at 11.7 kN and CMC has 8.2 kN respectively. The high viscosity characters of CMC get brittle when it used at 100%.

It is noticed that the addition of 20% Chitin into CMC has improved the elongation properties of the products.

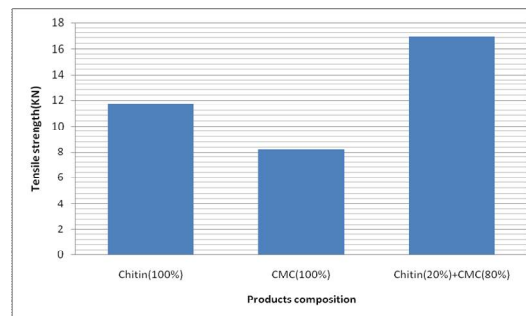


Fig. 1. Graph of tensile properties of composites Vs Compositions

Hardness

The hardness of the composites chitin and CMC-I, chitin and CMC by Rockwell hardness tester and results are plotted in graph (fig.2). A constant load of 150Kgf is applied on the products, as specification of ASTM. The Chitin has gained the hardness of 20.33, whereas CMC for 23.67 in B scale. The 80% blended CMC/Chitin performed very low hardness of 17.2 against the applied load.

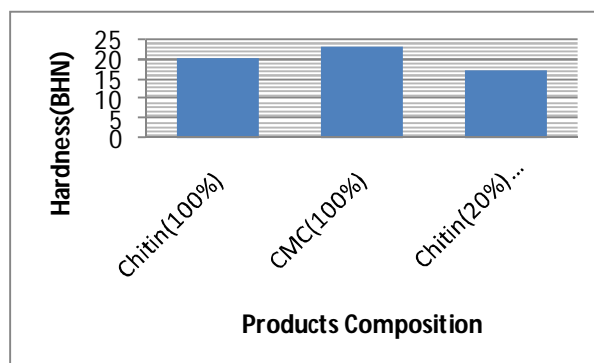


Fig. 2. Graph of hardness properties of composites Vs Compositions

V. CONCLUSION

After conducted the mechanical tests for our prepared biopolymer composites of Chitin (20%) + CMC (80%) having an increase in tensile value of 16.9kN and for the same above composition the hardness value decreased to 17.2 BHN.

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