UNIVERSITY OF CALIFORNIA SANTA CRUZ OFFICE OF RESEARCH

A Bio-Based Manufacturing Process To Create Foam Using Chitin Sourced From Shellfish Waste

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BACKGROUND

A bio-based closed-cell foam created using chitin derived from shellfish waste. Chitin is the second most abundant polysaccharide after cellulose and acts as the structural component of the exoskeleton of arthropods. Chitin has mechanical properties that can be processed into a foam. Such a foam can be used for biodegradeable packaging as well as other uses.

TECHNOLOGY DESCRIPTION

The foam is made using chitin extracted from shellfish waste as well as other sources of chitin. Chitin is the second most abundant polysaccharide after cellulose and acts as the structural component of the exoskeleton of arthropods. Currently the most widely produced foams, polyurethane and polystyrene, are created from nonrenewable petroleum based sources. Manufacturing and working with petroleum based foams is very toxic to workers and damaging to the environment. Chitin based foams have neither of these drawbacks. Chitin extracted from shellfish waste can be a powder, flake, granule, or combination thereof. The chitin is then dissolved in an eco-friendly, water-based ionic liquid solution such as a solution of sodium hydroxide and urea. The chitin is then foamed either by mechanical, chemical, or physical blowing of the solution.

Surfactants, stabilizers, and/or cross-linking agents may be added to the dissolved chitin solution to facilitate the foaming process, stabilize the foamed product, and/or tailor the mechanical properties of the dried foam. The surfactants can be anionic, cationic, or nonionic. These surfactants, stabilizers, and cross-linkers may include but are not limited to sodium dodecyl sulfate, ammonium lauryl sulfate, sodium stearate, polysorbate 20/40/60, dodecyldimethylamine oxide, glycols, ethers, sulfates, carboxylates, xanthan gum, or glyoxal.

The foamed chitin solution can then be washed with water, or an organic solvent (e.g. ethyl alcohol), to allow the chitin to self-assemble while simultaneously removing excess salt from the ionic solution. The foamed chitin solution is then dried by a method including but not limited to air, oven, steam, vacuum, or pressure to result in a cellular, closed-cell, chitin polymer foam material.

The foamed chitin can be tailored to have a variety of different mechanical and physical properties dependent on the desired application. Foams manufactured with a 2% chitin composition by weight

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OTHER INFORMATION

KEYWORDS

chitin foam, biodegradable foam, chitin packaging, biodegradable packaging, environmentally friendly materials, chitin surfboard, biodegradable surfboard, shrimp, lobster, crab

CATEGORIZED AS

- **Materials & Chemicals**
  - Electronics Packaging
  - Polymers

RELATED CASES

2016-854-0

resulted in densities ranging from 80 to 200 kg/m^3 depending on the different types and amounts of additives used (surfactant, stabilizer, cross-linking agent) and the washing and drying methods

Foams with 2% beta chitin by weight exhibited compression elastic modulus’ ranging from 3 to 8 MPa and yield strengths ranging from 0.2 to 0.46 MPa. These results match the mechanical properties of competing polyurethane foams at comparable densities. Foams made with 4% beta chitin by weight resulted in densities ranging from 700 to 800 kg/m^3 and compression elastic moduli ranging from 100 to 175 MPa, and yield strengths ranging from 4.65 to 6.13 MPa.

One example of making a chitin based foam is as follows: A solution of 8% by weight sodium hydroxide and 4% by weight urea is dissolved in deionized water. After dissolving the NaOH and urea the solution is cooled to approximately 5º C. The NaOH/urea solution is placed at room temperature and 2% by weight beta chitin is added. The chitin is stirred into the solution and is then placed at -20 C for 24 to 48 hours. Over the 24 to 48 hours the NaOH/urea/chitin solution is removed from the freezer and allowed to thaw to between 0º C and 5º C when the mixture becomes a viscous gel. The gel is stirred and again placed at -20 ºC. This freeze/thaw/stir cycle is repeated an additional one to two times over the 24 to 48 hour period. The solution is removed and allowed to thaw to between 0º C and 5º C when a surfactant, stabilizer, and/or cross-linker can be added to the solution. In this example the added surfactant is typically between 0.02% by weight to 1% by weight of the solution. The NaOH/urea/chitin gel with surfactant is mechanically foamed until a consistent liquid foamed state is achieved. The foam is then washed with water until all the excess NaOH and urea is removed and the wash reads close to a pH of 7. The foam is then transferred to a drying container or bed and allowed to air-dry or oven-dry.

APPLICATIONS

- Replacement for petroleum based (polystyrene) and/or corn based foam products
- Packaging
- Protection during shipping
- Coolers
- Surfboards

ADVANTAGES

- World’s first 100% biodegradable and 100% bio-based foam made out of chitin.
- Low-cost manufacturing: inexpensive raw materials and cost-effective processing methods.
- Faster manufacturing process.
- Highly versitile - can be used in a range of products from packaging to surfboards

INTELLECTUAL PROPERTY INFORMATION

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	12,024,625	07/02/2024	2016-854
United States Of America	Issued Patent	11,667,770	06/06/2023	2016-854
Germany	Issued Patent	3487922	05/05/2021	2016-854
European Patent Office	Issued Patent	3487922	05/05/2021	2016-854
France	Issued Patent	3487922	05/05/2021	2016-854
United Kingdom	Issued Patent	3487922	05/05/2021	2016-854

Additional Patents Pending

RELATED MATERIALS

- US20200239670 - Naturally Sourced Chitin Foam - 07/30/2020

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Wearable Bioelectronics for Programmable Delivery of Therapy
- Bioelectronic Smart Bandage For Controlling Wound pH through Proton Delivery

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