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Method for lignin-based carbon fibre production

Summary

Two patent-pending technologies for the creation of sustainably produced lignin-based carbon fibres

Current issue

Carbon fibres (CFs) are strong materials that can be used to produce carbon fibre-reinforced composites, which are desirable lightweight construction materials. Carbon fibres are produced by pyrolysis of precursor fibres made from polyacrylonitrile (PAN) and mesophase petroleum pitch. However, the two major precursors are derived from petroleum and are, therefore, non-renewable. For PAN, the use of the expensive spinning solvents DMSO and DMF makes precursor manufacture expensive, while toxic chemicals such as HCN, DMF and acrylonitrile raise environmental and health concerns. The high cost associated with precursor fabrication limits carbon fibre composite use to high-end markets and is an obstacle to fast market growth.

Proposed solution

Lignin is a low-cost and renewable alternative precursor, as it is a readily available by-product of paper making and biorefining. Lignin is attractive for its sustainable origin, low cost and relatively high fibre yield after carbonisation. Over 70 million tonnes of lignin are extracted each year during paper and pulp manufacture. Extracted lignin is currently mostly burned for generating heat and electricity rather than value-added products.

Carbon nanotubes are cylindrical molecules that consist of rolled-up sheets of single-layer carbon atoms. They have a vast range of potential commercial applications.

Commercial lignin-based carbon fibres could reduce the cost of carbon fibres and support the developing renewable chemical industry by providing additional revenues to wood-processing biorefineries by offering a route to creating value-added lignin products.

Benefits

- Step-change in solvent cost for lignin fibre spinning
- Compatible with up to 90% bio-derived waste lignin from a variety of industrial sources
- Sustainable low-cost spinning aid
- Good carbon fibre yield (›35%)

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Technology reference: **10915**, **11332**

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The Inventions

10915: Fibre spinning dope comprising lignin and non-toxic polymer

This invention relates to a method for making fibres, using a dope solvent, a commercial lignin dissolved in the dope solvent and a carbon nanomaterial (in particular carbon nanotubes) dispersed in the dope solvent. The dope solvent comprises a low-cost ionic liquid (less ¼ of the cost of DMF and DMSO) and a small amount of water; the spinning dope is extruded into water to obtain a fibre or fibre bundle. The lignin content of the fibres is ›90% and the carbon yield after pyrolysis is › 50%, making the lignin CNT fibres cost-effective carbon fibre precursors. The fibres have the potential to produce lignin carbon fibres with improved graphitic structure and with reduced energy requirements

11332: Method for making fibres

This invention relates to a method for making fibres, using a dope solvent, a commercial lignin dissolved in the dope solvent and a carbon nanomaterial (in particular carbon nanotubes) dispersed in the dope solvent. The dope solvent comprises a low-cost ionic liquid (less ¼ of the cost of DMF and DMSO) and a small amount of water; the spinning dope is extruded into water to obtain a fibre or fibre bundle. The lignin content of the fibres is ›90% and the carbon yield after pyrolysis is › 50%, making the lignin CTN fibres cost-effective carbon fibre precursors. The fibres have the potential to produce lignin carbon fibres with improved graphitic structure and with reduced energy requirements.

Application

There is a need for low-cost sustainably produced carbon fibres in applications such as automotive construction to reduce the weight of vehicles and increase fuel efficiency and driving range. Other applications are aircraft parts, wind turbine blades and hydrogen fuel tanks. More graphitic carbon fibres can be used in higher performance applications.

Intellectual Property Information

10915: Method for Making Fibres is protected by PCT application: EP2023/064615

11332: Method for Making Fibres is protected by PCT application: EP2023/064612.

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