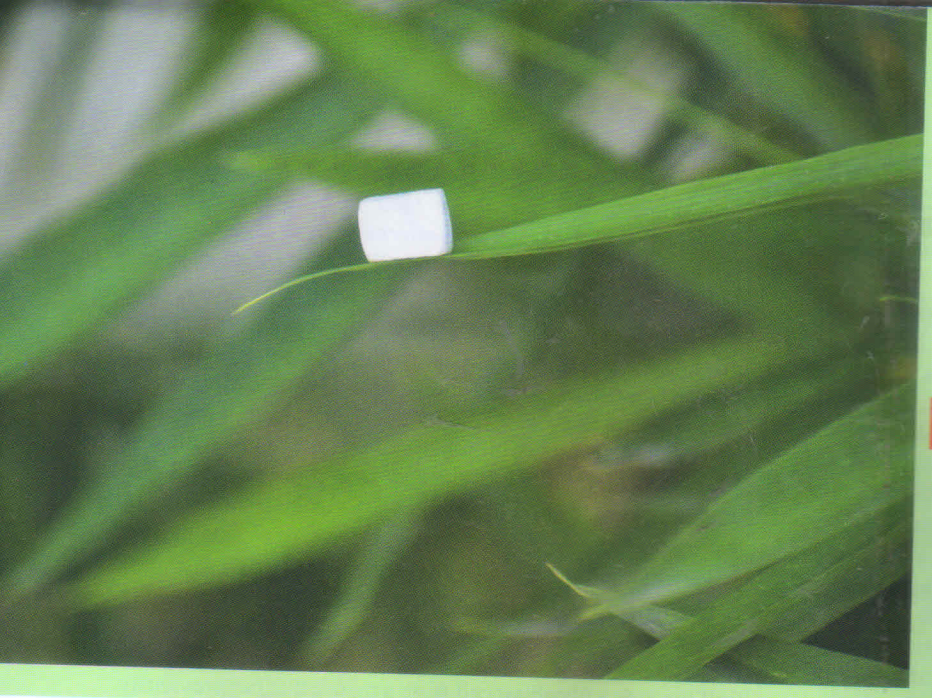

Harnessing Nature The Emergence of Wood-Based Aerogels

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MATERIAL scientists around the globe have been working to produce materials with porous structure, low density, and high strength for use in various applications. Aerogels are materials with large surface area, low density, high porosity, and excellent mechanical and thermal insulation properties. They are considered versatile materials that have the potential for application in various fields like oil-water separation, CO2 capture, electronics applications, and aerospace. Silica-based Aerogels were one of the first successfully commercialised aerogels, while cellulose, gelatine, agar and albumin-based aerogels have also been studied in the past. Aerogels are traditionally manufactured through the Sol-Gel processing method, where the colloidal solution of the reactants in a preferred solvent is allowed to crosslink with each other to form a gel through polymerisation. Finally, the solvent is exchanged and/or removed through different solvent removal methods such as ambient drying, supercritical drying and freeze drying, etc. Researchers have found that all the materials can be converted into aerogels, using the sol-gel method and dried using methods like the supercritical drying method. It is the speciality and uniqueness of the material that we use for the preparation of aerogels that makes them suitable for various special applications. An example to substantiate this is the application of silica aerogels (with 99% of empty space contributing to their high porosity) in space explorations. Silica-based aerogel grid was developed by the JPL (Jet Propulsion Laboratory) of NASA to collect cometary and extra-terrestrial particles from space for the historic Stardust spacecraft mission.

Cellulose Nano-Fibrils (CNFs), Cellulose Nano-Crystals (CNCs) are among the popular cellulose materials that are being explored in various fields, such as biomedical, bio-imaging and green electronics, in the form of aerogels and hydrogels. They are also used for producing nano-composites, such as incorporating cellulose into polymers. However, the bottom-up preparation of these materials involves a significant amount of mechanical, enzymatic, and chemical energy-intensive processes, thus reducing their possibilities for mass production and commercialisation.

Wood transformation for a promising sustainable future

Aerogel preparation using a top-down approach has recently become popular with wood as a starting material, transforming it into a promising product for advanced applications. Wood-based aerogels have impressive properties comparable to those of several bio-based aerogels and many synthetic inorganic aerogels. In recent years, around the globe, there has been a huge thirst among industrialists, researchers, and governments to replace existing materials with sustainable and environmentally friendly novel materials. It is the need of the hour to correct the polluted environment and encourage the introduction of renewable and sustainable products into the market that have the least detrimental effect towards the environment.

Wood, being a naturally abundant renewable material, can be used as a replacement for petroleum-based products, which can help reduce a considerable amount of pollution and greenhouse gas (GHG) emissions. Wood is a promising anisotropic material with innate properties, such as a hierarchical porous structure with high specific stiffness and strength. Conventionally, wood material is closely associated with humans for different applications like construction, furniture, handicraft production, as a fuel source, paper manufacture, etc. Wood is considered a lightweight construction material in the building industry due to its porous nature and remarkable mechanical qualities, acquired from anisotropic hierarchical organisation of the wood cells.

There are many studies that substantiate the importance of utilising wood in place of other materials of high embodied energy, like steel, plastic, concrete and other non-biodegradable materials like petrochemical products.

The majority of studies on native wood focus on its conventional areas of application, which include chemical modification procedures which have been developed over time to improve dimensional stability, deterioration resistance, and fire retardance in buildings. Wood material from the last few decades has been explored in innovative ways through novel approaches like biochemical production, densification,