A young Chinese scholar, with "cow manure," issued a district TOP paper!

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Environmental Challenges and Resource Opportunities of Cow Waste

Cellulose is one of the most widely used industrial materials in the world, naturally occurring in plant cell walls。Since they were first used in the mid-19th century to make synthetic materials, including celluloid, an early photographic film material, they are now widely used in areas such as protective film, surgical masks, paper products, textiles, food and pharmaceuticals.Although it can be extracted organically, toxic chemicals are often used in industrial production to synthesize it.

The production of livestock **cow manure** is a global **environmental problem** , its improper disposal will release greenhouse gases such as methane, pollute water and spread pathogens, threatening public health。Traditional disposal methods such as composting or landfilling are limited in efficiency, and this study takes a different approach by treating cow manure as a "resource bank" - **The**

undigested plant fiber in cow manure contains about 1.6 % ~ 23.5 % of cellulose , which can be converted into high value-added nanocellulose by chemical and mechanical treatment .

Recently, **University College London Mohan EdirisingheProfessor and TISS University Senthilarasu SundaramProfessor Collaborators** at ***the Journal of Cleaner Production*** published a groundbreaking study . **They extract nanocellulose from cow manure through innovative technology and use improved Nozzle-Pressurized Spinning （NPS） technology to create a variety of products such as films, ribbons and fibers** 。 This result not only provides a new path for the high value utilization of agricultural waste, but also sets a benchmark for sustainable materials development and circular economy practices.The first author of this paper is **Yanqi Dai （graduated from Xiamen University）** .

Yanqi Dai

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Harnessing cow manure waste for nanocellulose extraction and sustainable small-structure manufacturing

Yanqi Dai [a 1], Dongyang Sun [b 1], Dominic O'Rourke [b], Sasireka Velusamy [c], Senthilarasu Sundaram [c], Mohan Edirisinghe [a]

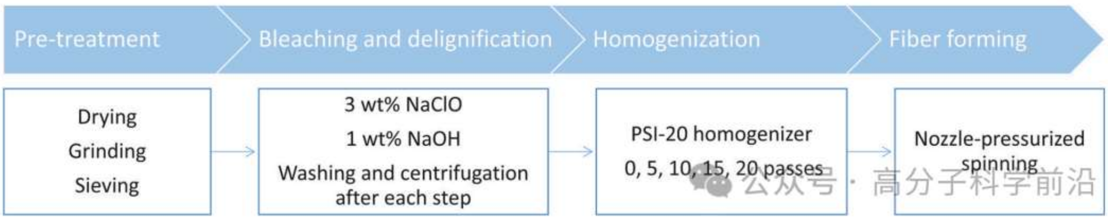
Pressed rotating filament spinning technology

The spinning technology was invented in 2013 by a team led by Professor Mohan Edirisinghe of the Department of Mechanical Engineering at University College London . **The technology can spin liquid soft matter into fibers , microspheres , ribbons , webs and films by simultaneously applying pressure and rotational force .**

Breakthroughs in technology: From waste to high-performance materials

The research team developed a highly efficient low energy process:

1. Extraction of nanocellulose : After drying and grinding of cow dung , Step-by-step defoliation and purification by sodium hypochlorite and sodium hydroxide solution, followed by high pressure homogenization, resulted in type I cellulose nanofibers with a diameter of only 12.8 ± 4.1 nanometers (Figure 1).X-ray diffraction （XRD） and Fourier transform infrared spectroscopy （FTIR） analyses confirmed its crystalline structure and chemical integrity.



2. Improvement of Nozzle Pulsed Spinning Technology （NPS） : Traditional NPS relies on vertical rotating axis. This study innovatively introduces horizontal rotating device and integrates water bath system to solve the problem of solvent detachment caused by strong hydrogen bond in cellulose solution。By adjusting the concentration of the solution （2% ~ 10%）, flexible films, ribbons or micron-scale fibers can be prepared （Fig. 7）. **The technology does not need high voltage field and is suitable for continuous production with low energy consumption .**

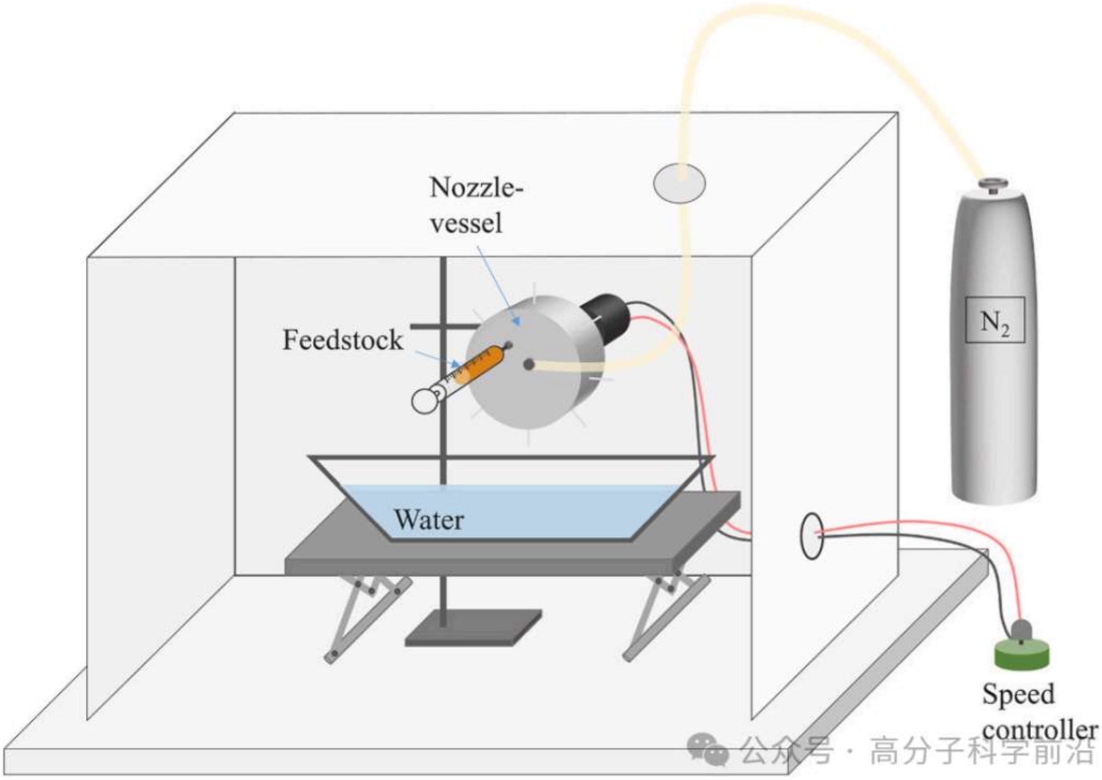


FIG. 2. An illustrative diagram of an improved nozzle pressurized spinning that contains a water bath. The rotation revolves around a horizontal axis.

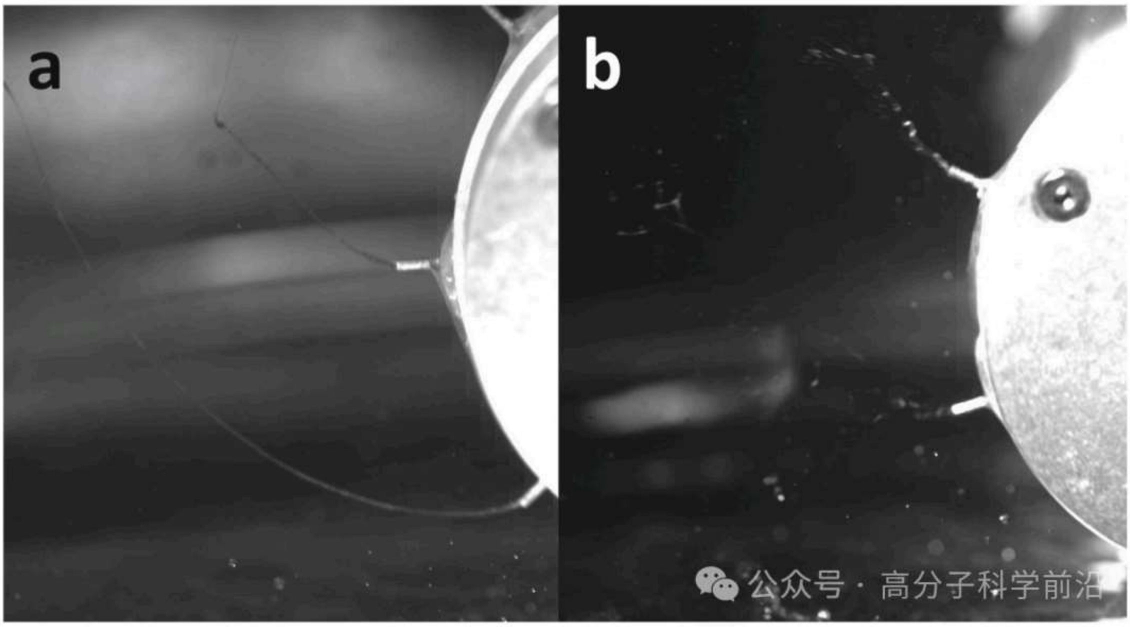


Figure 3. A digital photograph of (a) the rotating jet and (b) the jet rupture taken by a high-speed camera.

Potential for application: multi-sectoral enabling of sustainable development

The extracted nanocellulose has shown application prospects in a number of fields due to its high surface area, degradable properties and excellent mechanical properties:

• **Packaging** : Develop transparent , high barrier , eco-friendly materials instead of plastic ;

• **Energy storage** : lightweight components as batteries or supercapacitors ;

• **Biomedical** : biocompatible scaffolds for wound dressings or drug delivery systems ;

• **Electronic devices** : as a flexible substrate or dielectric layer material .

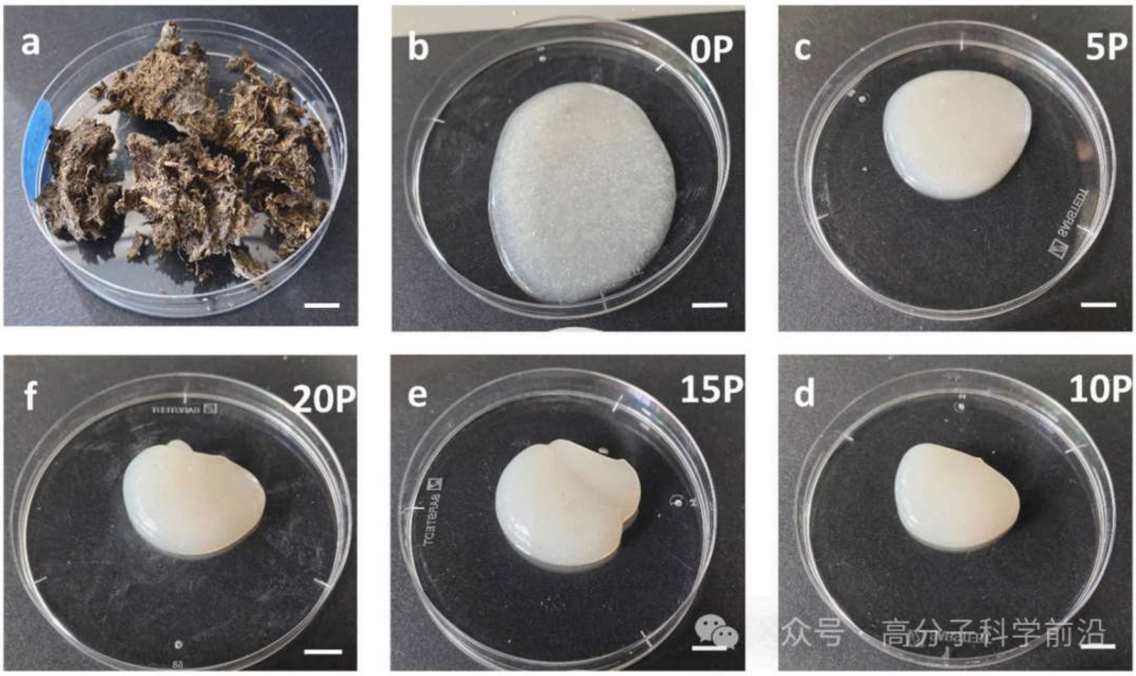


FIGURE 4. (a) dried cow dung skins, (b) extracted cellulose plasma, and (c-f) photographs of cellulose material obtained using 5, 10, 15 and 20 homogenization processes, respectively.(Scale = 10 mm).

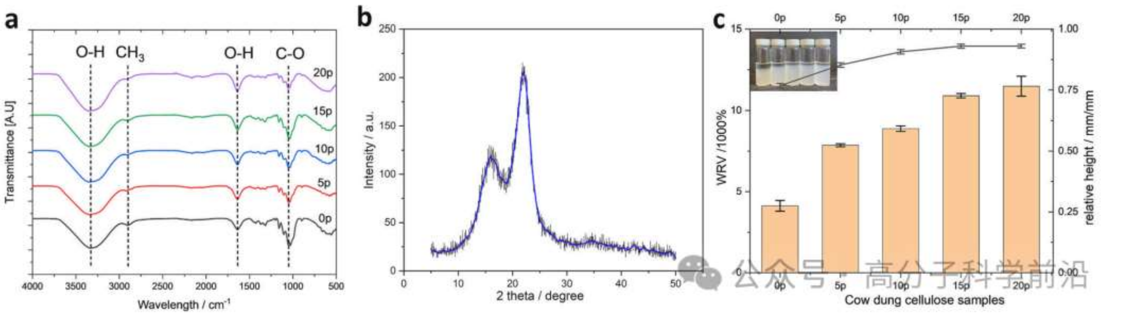


FIG. 5. (a) FTIR spectra of cow faecal ciliomycin homogenized at 0, 5, 10, 15, and 20 passes, assigned with characteristic peaks. (b) XRD profiles of nanocellulose extracted from cow manure after 20 homogenizations were used. (c) The effect of increasing the number of channels on water retention values and sediment characteristics.

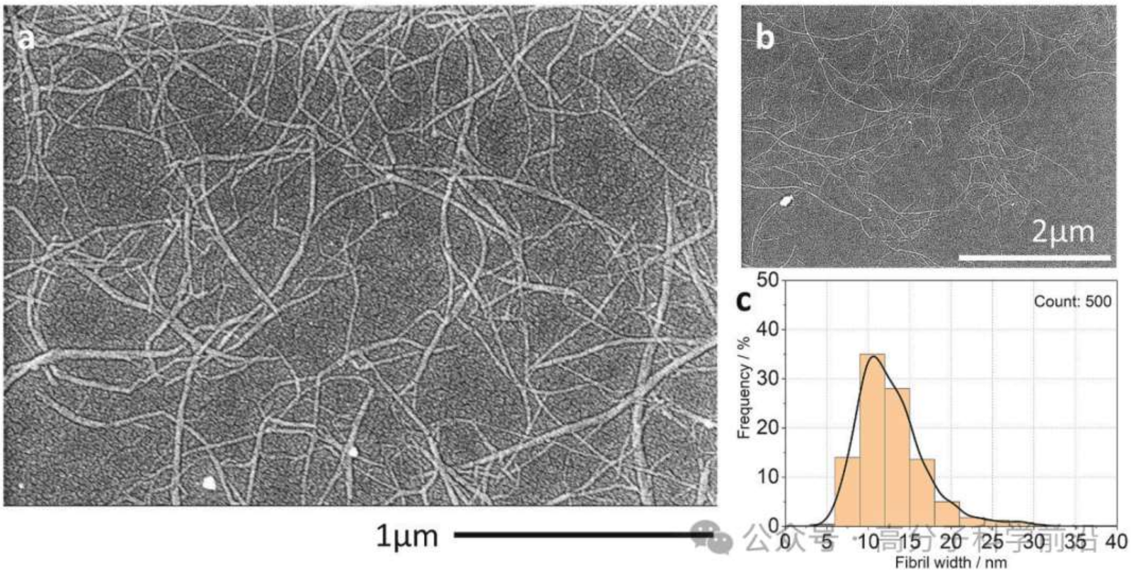


FIG. 7. (a) Modified NPS from concentrations of (b) 2wt%, (c) 4wt%, (d) 8wt%, (e) 10wt% SEM images of dried nanocellulose and (b-e) cilium samples were prepared in the solution. (f) the diameter distribution of the cilium fibers produced from a 10 wt% solution.(Rule = 100 μm).

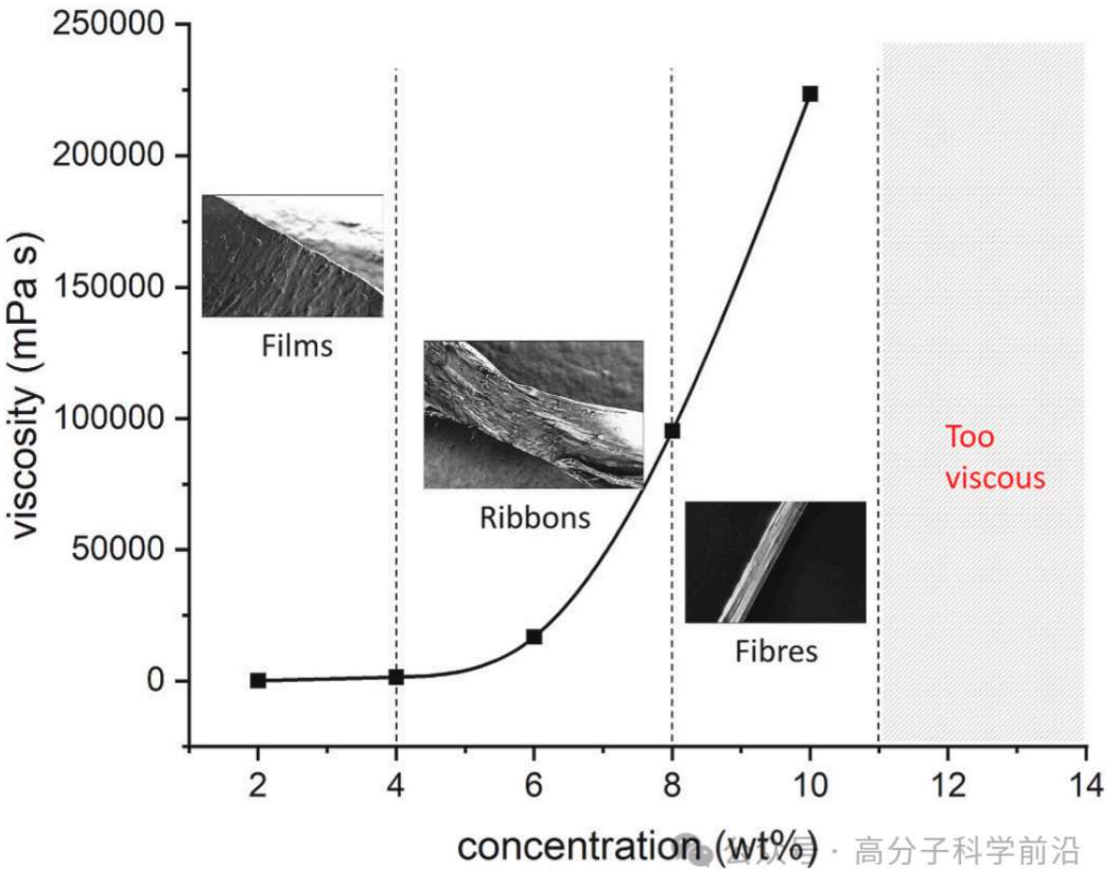


Figure 8. Viscosity distribution of ciliomycin solution and structure of related products.. (Solutions with concentrations above 11 wt% are too viscous to handle.)

Environmental and Economic Benefits

The whole process avoids the use of harmful chemicals, and solvents (such as extrinsic liquid EMMIOAc) can be recycled, in line with the concept of "waste to wealth." The research team notes that if scaled up, the technology is expected to reduce the cost of nanocellulose production, while relieving the pressure of animal waste disposal, creating environmental and economic benefits.

Looking ahead

Despite the remarkable results, the research is still in its early stages. The next step will be to optimize the process efficiency, increase the cellulose yield, and explore in depth the functional properties of the material. The team called for greater cross-cutting collaboration to move the technology from laboratory to industrialization.

Source: Frontiers in Polymer Science

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