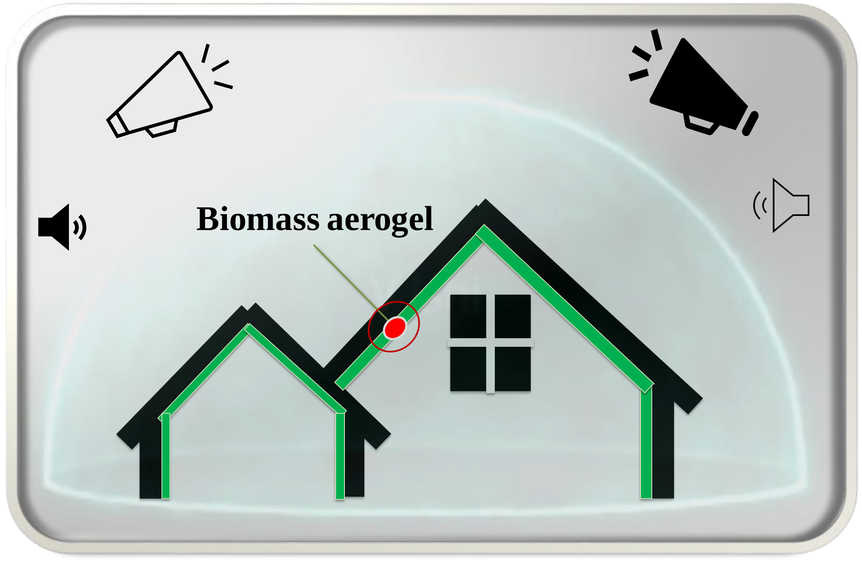
University of Nottingham
UK | CHINA | MALAYSIA

Sound Absorption Properties of Biomass Aerogels for Building Applications

Yixin Wang
Supervisors: Saffa Riffat, Yuehong Su



INTRODUCTION

Noise can cause negative health effects and has become to one of the three major pollution problems. Currently, there are many types of sound absorbing materials existing in the market. This study presents the preparation and property characterization of biomass aerogels as sound absorption building materials. As innovatively sustainable porous materials, four natural, degradable bio-polymers were selected to prepare biomass aerogels through the efficient freeze-drying method combined with sol-gel process.

METHODOLOGY

Raw materials of the studied biomass aerogel:

Konjac glucomannan (KGM). | Gelatin | Starch | Wheat straw

Fig. 1 Raw material of preparation.

Preparation procedure of biomass aerogels with freeze-drying method:

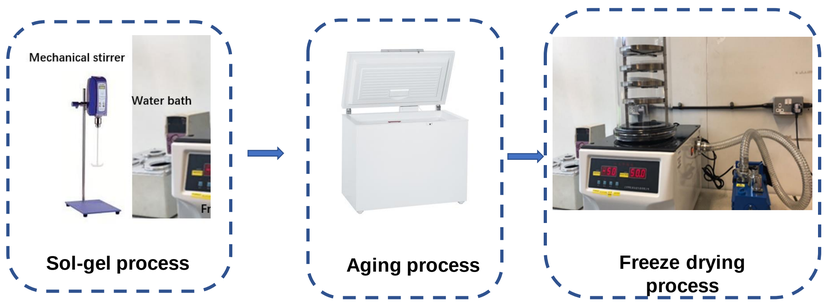


Fig. 2 Preparation machine.

Characterization methods:

- Microstructure morphology was observed with a scanning electron microscope (SEM) at a magnification of 50X, 100X and 1000X using an accelerated voltage of 30kV.
- Sound absorption coefficient at the frequency of 125, 250, 500, 1000, 2000 and 4000 Hz was measured at room temperature using an Impedance Tube AWA6122A (Hangzhou Aihua Instruments, China).

RESULTS & ANALYSIS

Our preliminary results revealed that biomass aerogels display three-dimensional network structure (Fig.3). For biomass aerogels, the KGM molecules act as a skeleton, and the pores are relatively big, spherical and uniform. It has been certificated that the existence of gelatin contributes to the amount of open pore structure with large size. These results are consistent in SEM images in Fig. 3.

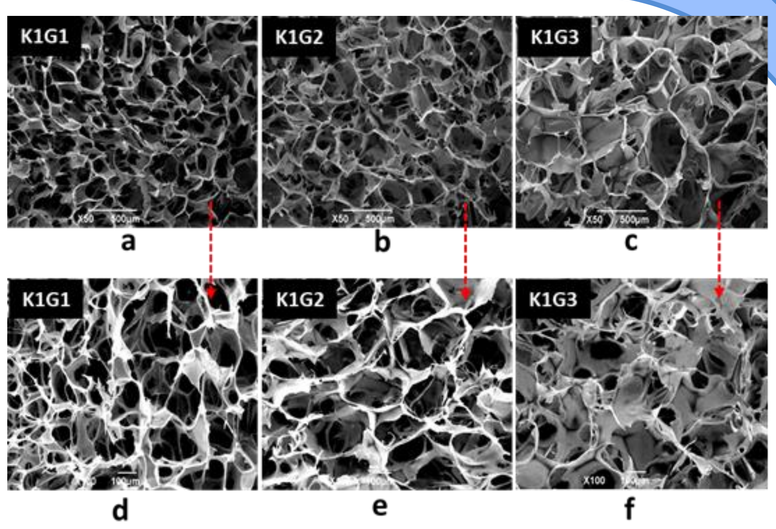


Fig. 3 SEM observations of KGM/Gelatin aerogels.

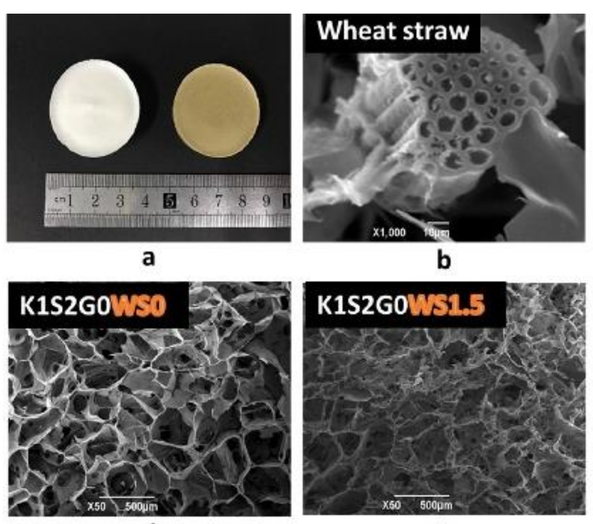


Fig.4 Biomass aerogels with/without wheat straw.

The presence of wheat straw causes the shape changes of ice crystal formed during freezing, which could affect the distribution of pore size, shape and the connectivity of the porous network. The pure KGM aerogels shape is relative spherical and uniform and after wheat straw addition, the biomass aerogel pore was changed from polygons into irregular shape. Besides, wheat straw can also provide many micron-scale pores due to their multi-cavities as shown in Fig. 4.

The sound absorption coefficient curves of three biomass aerogels are consistent in the property of porous materials, which has excellent sound absorption performance in medium-high frequency. As Fig. 5, the sound absorption coefficient of biomass aerogels was about 0.1 at 500 Hz, while sound absorption coefficient was about 0.8 at 4000 Hz. Compared with traditional fiber cotton sound absorbing board (the average sound absorption coefficient 0.225), the biomass aerogels showed significant excellent characteristics.

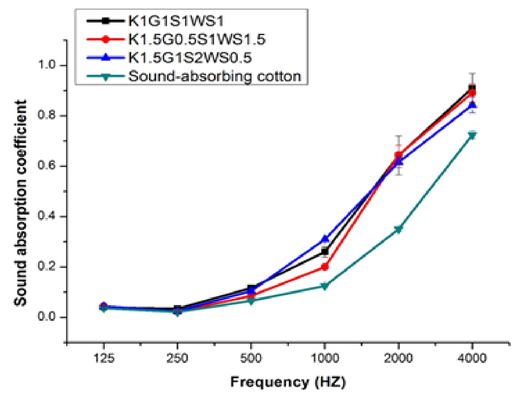
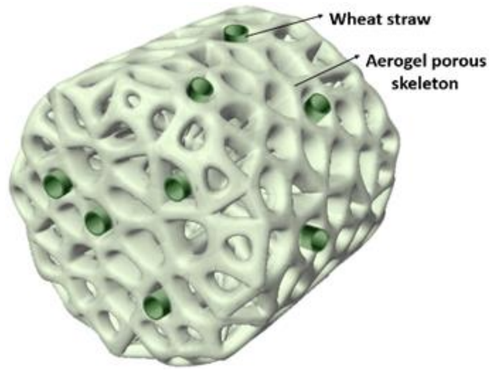


Fig.5 Sound absorption efficiency of composite aerogels.

CONCLUSIONS

- Using freeze-drying method combined with sol-gel process, the novel and sustainable biomass aerogel has been produced.
- The SEM images showed the appropriate addition of gelatin and starch could improve the performance of sound absorption with the specific pore structure in biomass aerogels.
- The optimized biomass aerogel sample for sound absorption was determined to be K1S2G1WS1.5, with its average sound absorption coefficient 0.352, density 0.047 g/cm3 and porosity 94.46±0.04%.
- This study demonstrates the possibility of biomass aerogels as sound absorption material in building applications.



* K： KGM; G: Gelatin; S: Starch; WS: Wheat straw.

Paper authors: Yixin Wang, Fei Xiang, Wei Wang, Weiling Wang, Yuehong Su, Fatang Jiang, Sheng Chen and Saffa Riffat

Buildings, Energy and Environment (BEE) Research Group