Waste-to-resource strategy to fabricate wearable Janus membrane derived from corn bracts for personal thermal management

Bin Gu, Tao Zhang * , Fengxian Qiu

School of Chemistry and Chemical Engineering, Jiangsu University, Zhenjiang 212013, China

优胜奖

Abstract

(1) Agricultural waste pollution, a worldwide problem faced by human society, has aroused global attention to environmental sustainability.

(2) Resource utilization of agricultural wastes is of great significance and challenge for the development of energy-saving and environmentally friendly materials due to the adverse impacts of agricultural wastes on environment.

(3) Waste corn bract as raw material was used to fabricate wearable Janus membrane for personal thermoregulation application.

(4) Wearable Janus membrane composed of ZnO nanosheets layer and Cu nanocoating was prepared by hydrothermal method and magnetron sputtering technique.

Graph abstract

ZnO-NSs/CBM side had a high infrared emissivity and a high visible reflectivity, which is conducive to the release of a large amount of human radiation and reducing the intrusion of sunlight. When ZnO-NSs/CBM side faces outwards, it can effectively achieve heat dissipation effect. Cu-NC/CBM side exhibited a lower infrared emissivity compared with the CBM, which helps to return radiation to the body. When Cu-NC/CBM side faces outwards, it can access radiation heat insulation effect.

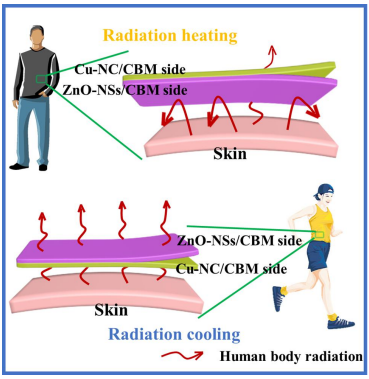

Figure 1. Schematic diagram of thermal management of Janus membrane.

Experiment

Experimental procedure:

1) Extraction of cellulose from corn bract;

2) Prepare fiber pulp and dry film (first layer);

3) ZnO nanosheets were grown in situ on the membrane surface;

4) ZnO nanosheets surface loaded cellulose layer (second layer);

5) Cellulose surface magnetron sputtering copper coating.

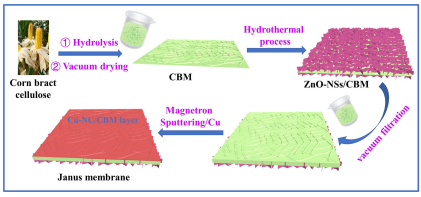

Figure 2. Illustration of the preparation process of Janus membrane.

Conclusion

1. SEM and AFM

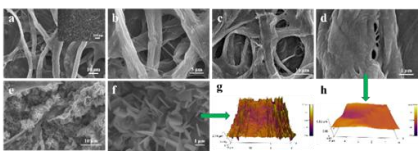

Figure 3. SEM images of (a, b) the CBM, (c, d) the Cu-NC/CBM side and (e, f) ZnO-NSs/CBM side of Janus membrane, respectively. The surface roughness of (g) ZnO-NSs/CBM side and (h) Cu-NC/CBM side of Janus membrane.

2. XRD

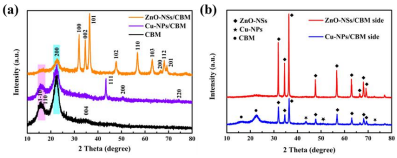

Figure 4. XRD patterns of (a) the CBM, Cu-NC/CBM and ZnO-NSs/CBM; (b) the two surfaces of Janus membrane, respectively.

3. XPS

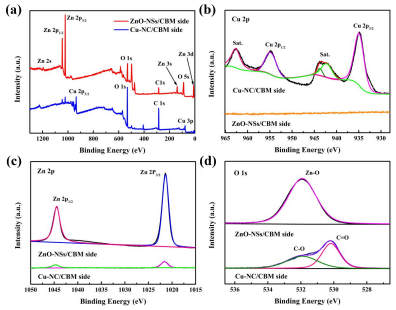

Figure 5. XPS spectra of Janus membrane; (a) the element survey spectra of the ZnO-NSs/CBM side and Cu-NC/CBM side, (b-d) the high-resolution XPS spectra of Cu 2p, Zn 2p and O 1s, respectively.

4. Thermal management properties

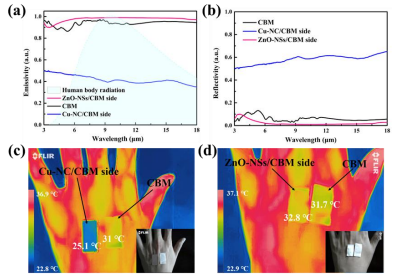

Figure 6. The thermal management properties of Janus membrane; (a) the infrared emissivity and (b) infrared reflectivity of the Cu-NC/CBM side and ZnO-NSs/CBM side of Janus membrane and CBM, respectively; the shaded area shows the human body radiation; (c) the thermal image with thermal insulation property of the Cu-NC/CBM side and CBM; (d) the thermal image with heat dispersion property of the ZnO-NSs/CBM side and CBM; the inset are the physical images.

5. Mechanical properties

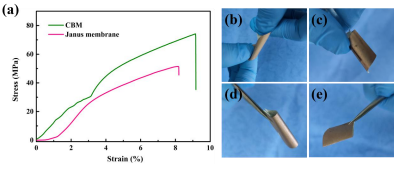

Figure 7. (a) the tensile stress–strain curves of the CBM and Janus membranes; (b-e) the flexibility images of Janus membrane.

References

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Personal information

Name: Bin Gu

Tell: 17826077636

E-mail: gb88773@163.com

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