NEGATIVE THERMAL COEFFICIENT OF NANOPOROUS BIOMATERIALS

by

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Materials change their sizes when subjected to a temperature change. Generally the coefficient of thermal expansion is positive, however, a negative coefficient in nanoporous biomaterials from enteromorpha is observed.

Key words: *thermal coefficient, biomaterials, microstructure, enteromorpha*

Introduction

Thermal expansion is the tendency of matter to change in *volume* in response to a change in *temperature* [1]. When a substance is heated, its particles begin moving more and thus usually maintain a greater average separation. Recently much attention is paid to various nanoporous biomaterials. To our knowledge, enteromorpha is a genus of green algae included in the kingdom Protista. Enteromorpha has long hair-like fronds that are from 8 to 16 inches long. It is bright green, though parts may become bleached white when exposed to sunlight. We investigate the microstructure of enteromorpha, and find its negative thermal coefficient, it contracts upon heating rather than expanding as most materials do. This effect is similar to negative Poisson's ratio [2, 3].

Experimental

In this work, scanning electron microscope (SEM) micrographs of nanoporous biomaterial in the enteromorpha are presented. In order to study the effect of temperature on biomaterials, SEM micrographs of enteromorpha after carbonization are studied.

Figure 1 shows the SEM images of the biomaterial microstructure with the amplification of 6000 from the enteromorpha. As can be seen, these nanopores are uniformly and symmetrically distributed on the surface. The sizes of nanopores are measured. Average length and width of rectangle nanopores in the surface of microstructure are found to be 485 nm and 46 nm, respectively.

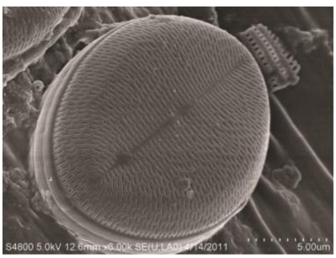

Figure 1. SEM micrographs of nanoporous biomaterial from enteromorpha at room temperature

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Table 1. The size of longitudinal and transverse direction of microstructure under different temperatures for 1 hour

Size	25 °C (Room temperature)	100 °C	200 °C	300 °C
Length (μm)	16	27	21	24
Width (μm)	14	9	7	12

Figure 2 shows SEM images of the biomaterial microstructure from the enteromorpha after nization with the temperature of 100 °C, fig. 2(a), 200 °C, fig. 2(b), and 300 °C, fig. 2(c) for 1 hour. When kept at 100 °C and 200 °C for 1 hour, respectively, the transverse direction of the microstructure curled inwards and contracted. However, when kept at 300 °C for 1 hour, the diameter of nanopores suddenly increased to 1.5 μm.

From figs. 1 and 2, the changes in longitudinal and transverse direction under different temperatures are listed in tab. 1.

Table 1 shows negative thermal expansion occurs, and it becomes much obvious after 100 °C.

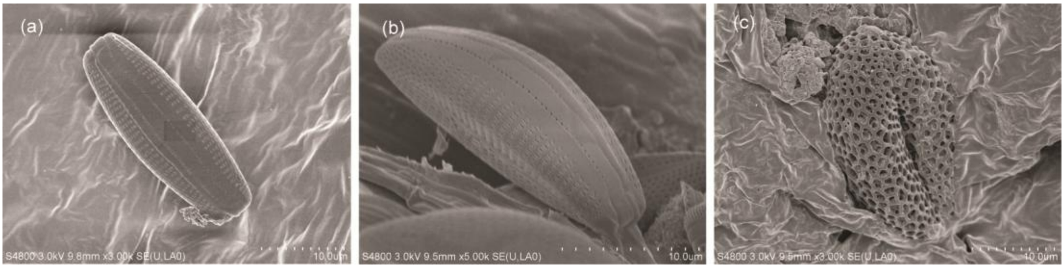

Figure 2. SEM micrographs of the biomaterial microstructure from the enteromorpha after carbonization with the temperature of (a) 100 °C, (b) 200 °C, and (c) 300 °C for 1 hour

Conclusions

The nanoporous biomaterials with negative thermal expansion provide us with many potential applications in biomimetic artificial materials.

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References

[1] Tipler, P. A., Mosca, G., *Physics for Scientists and Engineers*, Vol. 1 (6th ed.), Worth Publishers, New York, USA, 2008, pp. 666-670
[2] Greaves, G. N., *et al.*, Poisson's Ratio and Modern Materials, *Nature Materials*, *10* (2011), 11, pp. 823-837
[3] Lakes, R., Foam Structures with a Negative Poisson's Ratio, *Science*, *235* (1987), 4792, pp. 1038-1040

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