Research on Finite Element Calculation of Heating Conditions of Nanocomposites

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Abstract. The finite element software FLUENT was used to analysis the influence of the thermal conductivity of the polymer matrix, calculation area of nanopaper and different heating power on the thermal property of the polymer composites reinforced by pulse bending nanopaper. The typical temperature of composites reinforced by pulse bending nanopaper during the heating process under different thermal coffecient has been analyzed. The research shows that as the thermal conductivity of the polymer matrix increases, the maximum and average temperature of nanocomposites decrease, while the minimum temperature increases. With the increase of thermal conductivity of the polymer matrix, the temperature difference between the maximum and minimum temperature of the polymer matrix composite with a pulse bending nanopaper is significantly reduced in the process of reaching steady state.

1. Introduction

Carbon nanotubes (CNTs) have been researched for their excellent electrical, chemical, thermal and mechanical properties [1-4]. With their excellent thermal conductivity, the polymer composites reinforced by the buckypaper can be used to solve the heat problems associated with advanced electronic equipment, radiators, connectors and printed circuit boards. Nanopaper and its reinforced polymer composite materials have extra functions of fire proof, lightening protection and electromagnetic interference shielding. With the effective control of nanopaper of carbon nanotubes, they can be used as good sensor and functional material.

2. Numerical model

As shown in Figure 1, the heating model of the polymer composites reinforced by pulse bending nanopaper under different heating conditions were developed by the finite element software FLUENT.

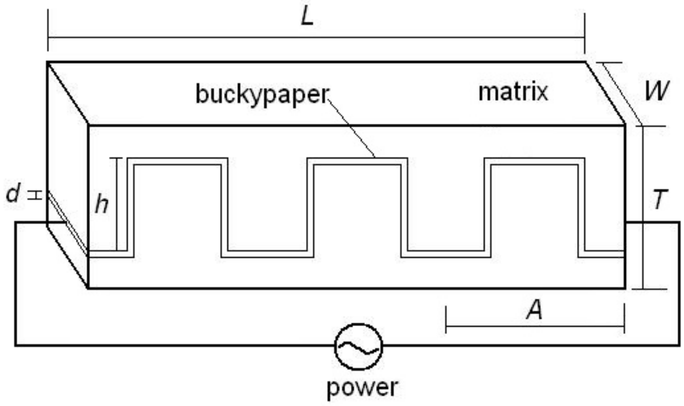

Fig. 1. Heating model of nanocomposites

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3. Results and discussion

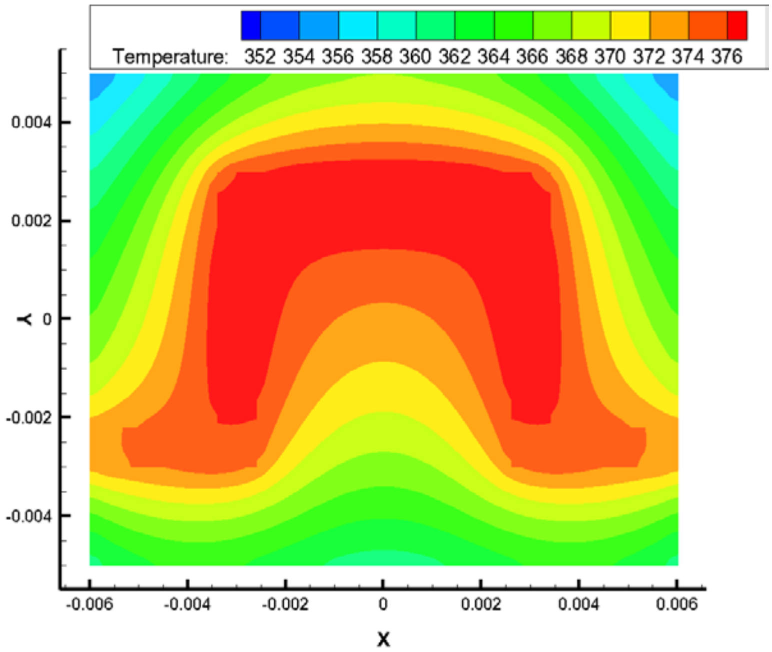
Table 1 show typical temperature of composites reinforced by pulse bending nanopaper during the heating process under different thermal coffecient of resin along the section z=0.

Table 1 Typical temperature of composites reinforced by pulse bending nanopaper under different thermal coffecient

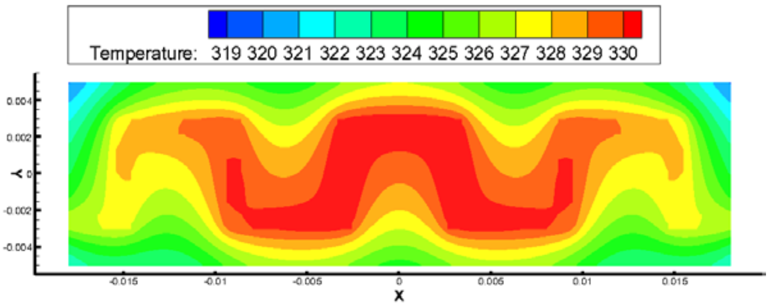
Time/s	1.5/0.1			1.5/0.15		
	Tmax/K	Tmin/K	Tave/K	Tmax/K	Tmin/K	Tave/K
0	300	300	300	300	300	300
20	306.46	300.33	303.44	305.55	300.64	303.31
40	309.62	301.54	306.21	308.50	302.30	306.03
60	312.23	303.06	308.66	311.01	304.10	308.44
120	318.40	307.13	314.54	317.01	308.53	314.19
240	326.07	312.01	321.72	324.44	313.72	321.12
360	330.07	314.40	325.37	328.21	316.24	324.59
480	332.13	315.60	327.23	330.12	317.50	326.32
600	333.19	316.21	328.18	331.07	318.12	327.19
720	333.73	316.51	328.66	331.55	318.43	327.63
840	334.00	316.67	328.91	331.79	318.59	327.85
960	334.14	316.75	329.04	331.91	318.67	327.96
1100	334.22	316.79	329.10	331.98	318.71	328.02
Time/s	1.5/0.2			1.5/0.25		
	Tmax/K	Tmin/K	Tave/K	Tmax/K	Tmin/K	Tave/K
0	300	300	300	300	300	300
20	305.04	300.90	303.24	304.70	301.12	303.19
40	307.89	302.84	305.93	307.50	303.23	305.86
60	310.35	304.77	308.31	309.93	305.23	308.24
120	316.28	309.38	313.99	317.01	308.53	314.19
240	323.54	314.74	320.80	322.97	315.44	320.59
360	327.19	317.35	324.17	326.52	318.11	323.91
480	329.00	318.64	325.84	328.28	319.42	325.54
600	329.90	319.28	326.67	329.14	320.06	326.34
720	330.35	319.59	327.08	329.57	320.38	326.73
840	330.57	319.75	327.28	329.78	320.54	326.93
960	330.68	319.82	327.38	329.88	320.61	327.03
1100	330.74	319.87	327.44	329.94	320.65	327.08

Table 1 shows the maximum, minimum and average temperature of the polymer composite with a pulse bending nanopaper along the z=0 section in the process of reaching steady state. As can be seen from Table 1, as the thermal conductivity of the polymer matrix increases, the maximum and average temperature of nanocomposites decrease along the z=0 section, while the minimum temperature increases. With the increase of thermal conductivity of the polymer matrix, the temperature difference between the maximum and minimum temperature of the polymer matrix composite with a pulse bending nanopaper is significantly reduced in the process of reaching steady state.

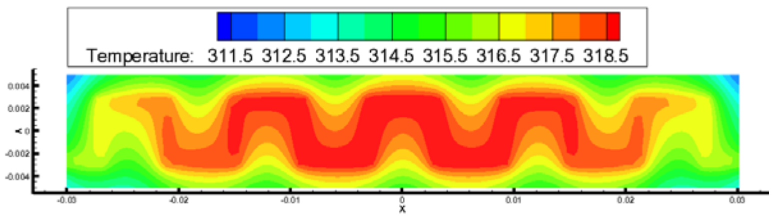
Figure 2 shows the temperature distribution of the polymer composite with a pulse bending nanopaper with different calculation area along the section z=0 under the heating power of 0.3w.



(a) 1A



(b) 3A



(c) 5A

Fig. 2. Temperature distribution of composite with different bending cycles along the section z=0 under the heating power of 0.3w

Figure 3 shows the curve of average temperature of composites with pulse bending nanopaper during heating process with different heating power along the section z=0.

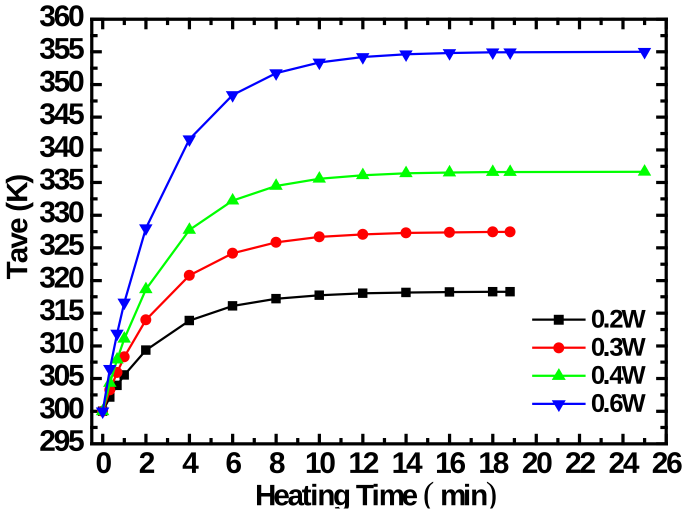


Fig. 3. Curve of average temperature of composites with pulse bending nanopaper during heating process with different heating power along the section z=0

4. Summary

The finite element software FLUENT was used to analysis the influence of the thermal conductivity of the polymer matrix, calculation area of nanopaper and different heating power on the thermal property of the polymer composites reinforced by pulse bending nanopaper.

The typical temperature of composites reinforced by pulse bending nanopaper during the heating process under different thermal coffecient along the section z=0 have been analyzed. The research shows as the thermal conductivity of the polymer matrix increases, the maximum and average temperature of nanocomposites decrease along the z=0 section, while the minimum temperature increases. With the increase of thermal conductivity of the polymer matrix, the temperature difference between the maximum and minimum temperature of the polymer matrix composite with a pulse bending nanopaper is significantly reduced in the process of reaching steady state.

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References

[1] R. S. Ruoff and D. C. Lorents: Carbon Vol. 33(1995), p. 925

[2] J. Hone and J. E. Fischer: Science, Vol. 289(2000), p. 1730

[3] S. Berber, Y. K. Kwon and D. Tomanek: Physical Review Letters, Vol. 84(2000), p. 4613

[4] M. A. Osman and D. Srivastava: Nanotechnolgy, Vol. 12(2001), p. 21