Finite Element Analysis of the Geometric Design of Composites Reinforced by Nanopaper

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Abstract: The finite element software FLUENT is used to analyze the influence of calculation areas and thickness of nanopaper on the thermal conductivity and the temperature distribution on the composites reinforced by pulse bending nanopaper during the heating process. The average temperature of composites reinforced with different calculation areas during heating process along the section z=0 was analyzed. The temperature distribution of composites reinforced with pulse bending nanopaper in the process of reaches the steady state. The research shows three temperature distributions at each heating time, corresponding to one, three, and five bending cycles of the sheet. With the increase of heating time, the heat generated by the nanoscale paper heating sheet gradually diffused into the surrounding area, and the temperature in the region increased gradually. After a certain time, the change of temperature gradually stabilized.

1. Introduction

The preformed nanotube network or nanotube mat often has been called nanopaper. When the resin reinforced by with nanopaper, the nanocomposites is produced as the bulk polymeric with a uniform CNT dispersion, well-controlled nanostructures and high CNT loading capability [1]. Since in nanopapers and composites reinforced by nanopaper, singlewalled CNTs (SWCNTs) can form dense networks, therefore a high thermal conductivity could be achieved [2]. Since the buckypaper may exhibit a better thermal conducting performance not only in the plane but also more importantly along the direction perpendicular to the plane of nanopaper, i.e., along the thickness direction. The results shows that the in-plane thermal conductivity of nanopaper with CNTs aligned in the plane could be higher than 300 W/(m•K) [3]. The nanopaper expected to exhibit excellent electrical and thermal properties in view of the exceptionally high electrical (～10^{-6} mΩ•cm) and thermal (～3000 W/(m•K)) conducting properties of individual MWCNTs [4,5].

The finite element software FLUENT is used to analyze the influence of calculation areas and thickness of nanopaper on the thermal conductivity and the temperature distribution of the composites reinforced by pulse bending nanopaper during the heating process.

2. Results and discussion

Figure 1 shows the curve of average temperature of composites reinforced with different calculation areas during heating process along the section z=0.

Figure 2 shows the temperature distribution of composites reinforced with pulse bending nanopaper in the process of reaches the steady state. Figure 2 shows three temperature distributions at each heating time, corresponding to one, three, and five bending cycles of the sheet. With the increase of heating time, the heat generated by the nanoscale paper heating sheet gradually diffused into the surrounding area, and the temperature in the region increased gradually. After a certain time, the change of temperature gradually stabilized.

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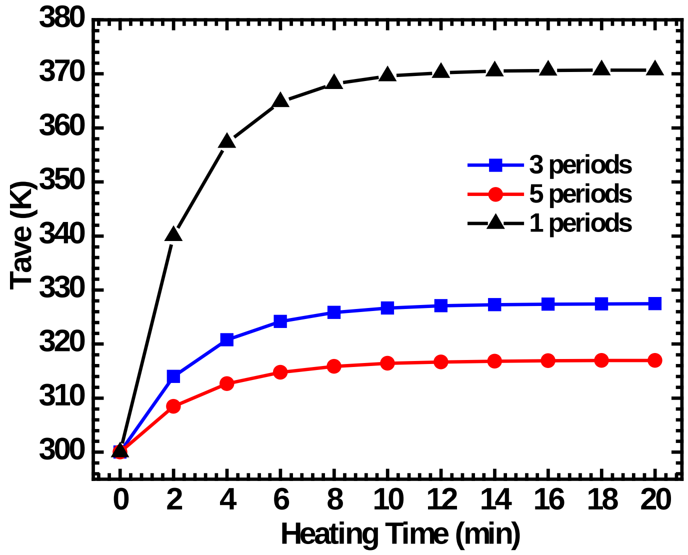
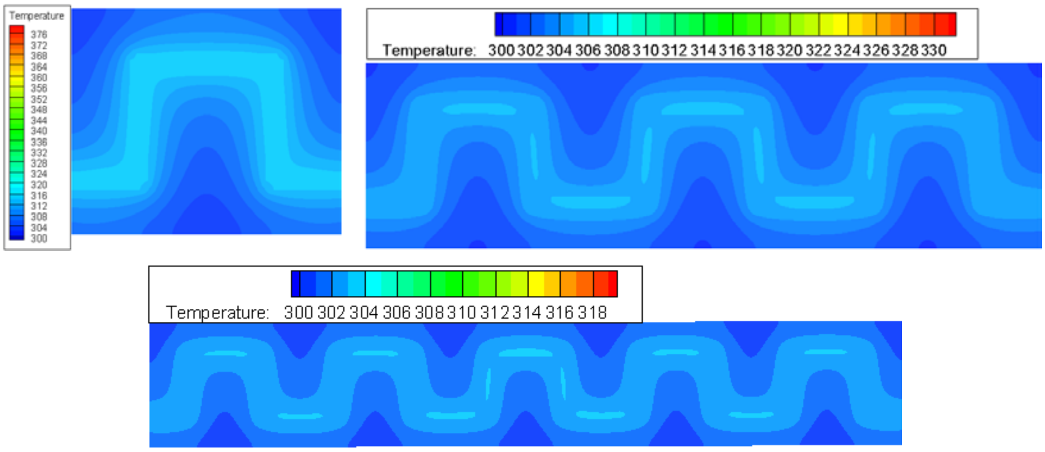


Fig. 1. Curve of average temperature of composites reinforced with different calculation areas during heating process



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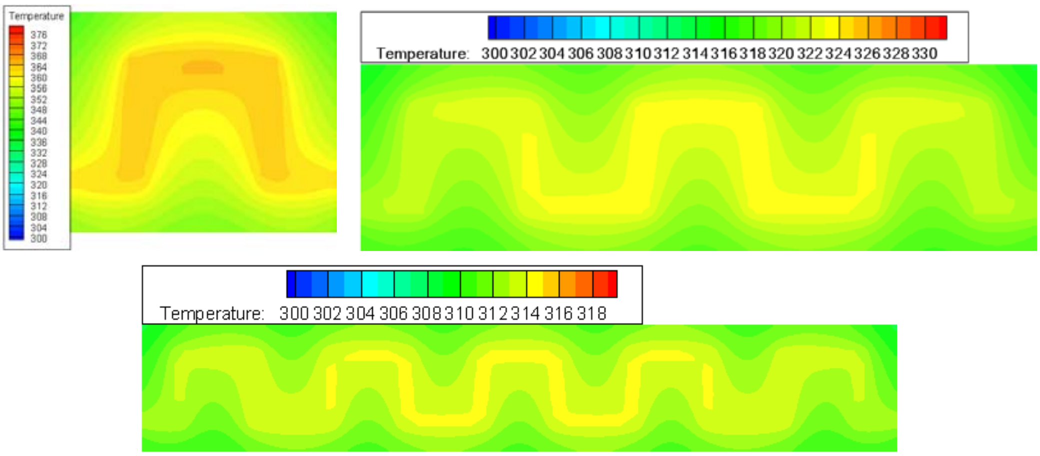

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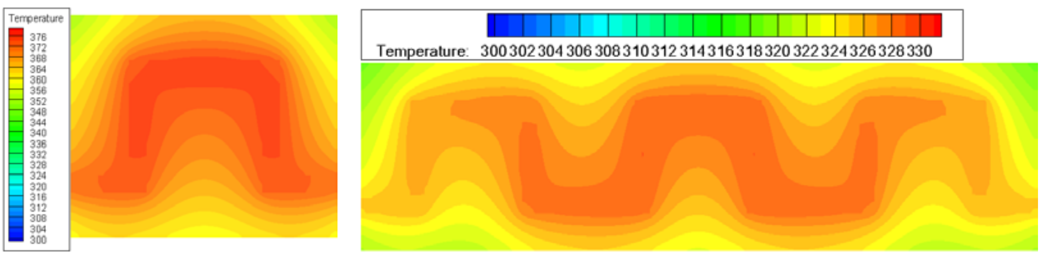

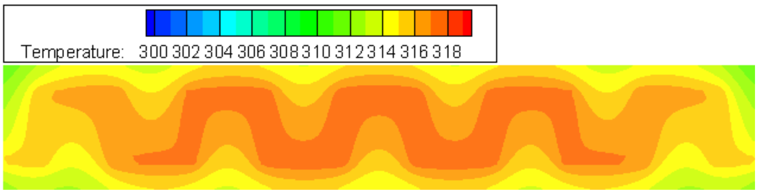

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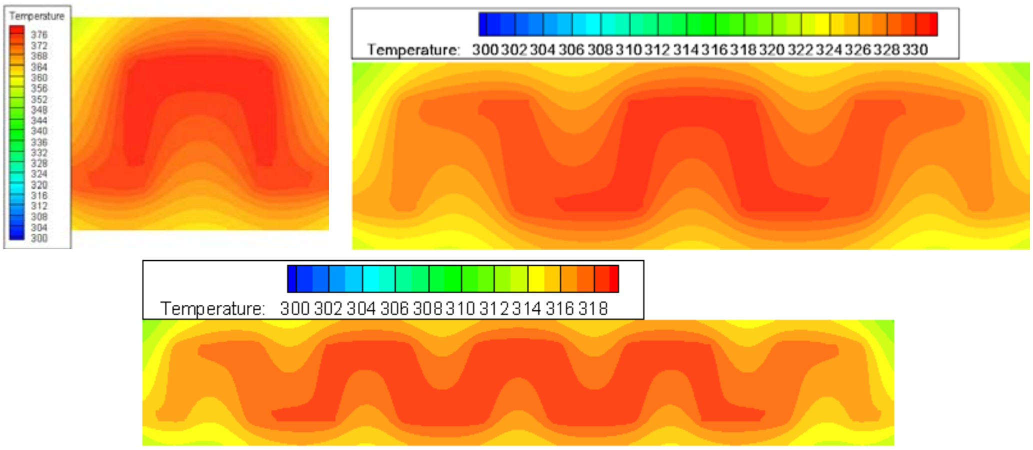
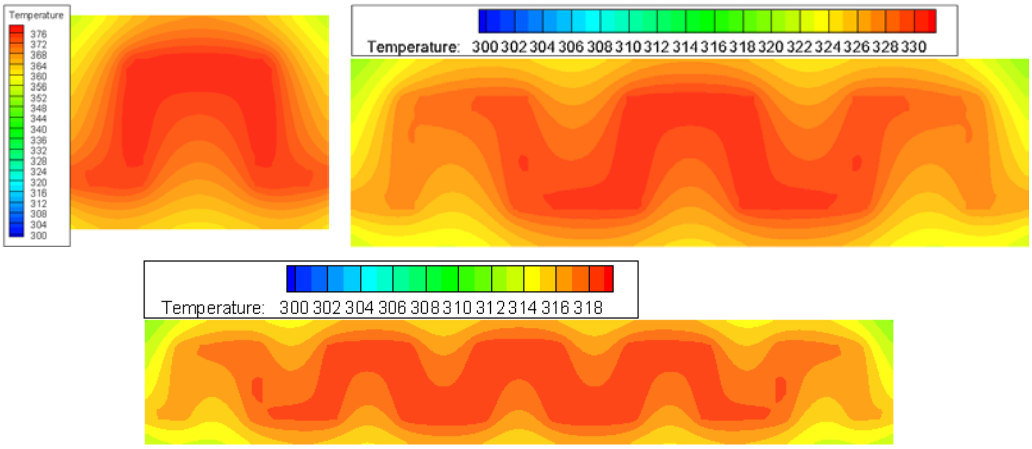
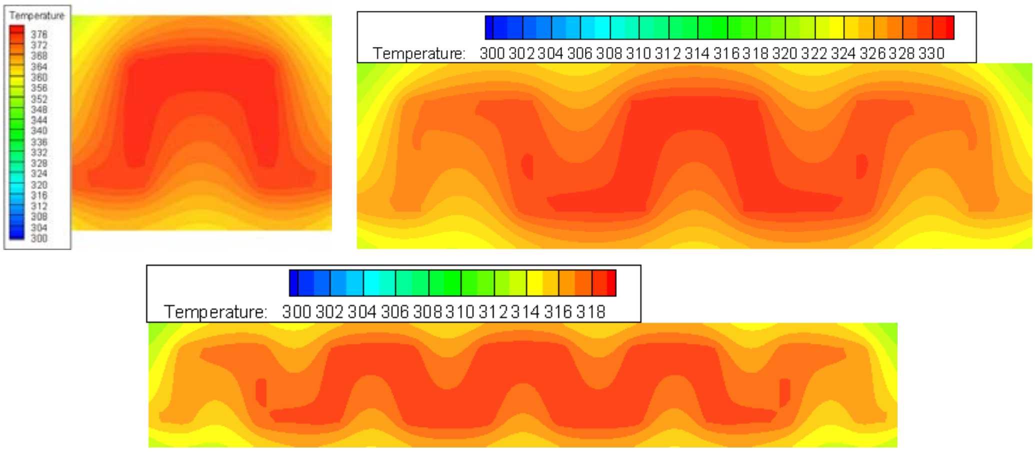


(d) 960s



(e) 1200s



(f) 1400s

Fig. 2. Temperature distribution of nanocomposite with pulse shape heating sheet versus time under different pulse cycles along the section z=0

Table 1 shows that the typical temperature of composites reinforced with pulse bending nanopaper of the thickness of 0.4 mm during the heating process along the section z=0

Table 1 Typical temperature of composites with pulse bending nanopaper during the heating process

Time/s	Tmax/K	Tmin/K	Tave/K
0	300	300	300
60	310.07	304.42	307.83
120	315.83	308.86	313.37
240	323.23	314.18	320.23
360	327.14	316.87	323.79
480	329.19	318.26	325.64
720	330.81	319.35	327.10
840	331.10	319.54	327.36
960	331.25	319.64	327.49
1080	331.33	319.69	327.56
1200	331.37	319.72	327.60
1440	331.40	319.74	327.63

3. Summary

The finite element software FLUENT is used to analyze the influence of calculation areas and thickness of nanopaper on the thermal conductivity and the temperature distribution on the composites reinforced by pulse bending nanopaper during the heating process.

The average temperature of composites reinforced with different calculation areas during heating process along the section z=0 was analyzed. The temperature distribution of composites reinforced with pulse bending nanopaper in the process of reaches the steady state. The research shows three temperature distributions at each heating time, corresponding to one, three, and five bending cycles of the sheet. With the increase of heating time, the heat generated by the nanoscale paper heating sheet gradually diffused into the surrounding area, and the temperature in the region increased gradually. After a certain time, the change of temperature gradually stabilized.

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