

## Finite Element Model Analysis of Nanopaper Enabled Composite Materials

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**Abstract.** The software PROE 5.0 is used for 3D modeling of composites reinforced by pulse bending nanopaper. And the modeling process of composites reinforced by pulse bending nanopaper is described in detail. The finite element software FLUENT is used to analyze the temperature difference of the maximum and minimum temperature of composites reinforced by pulse bending nanopaper with calculation area. The temperature distribution of the nanocomposites is more uniform with the increase of the bending cycles of nanopaper. The heat source of the unit volume of the nanopaper changes with the calculated area under the same total heating power. The more the bending period of the nanopaper, the smaller the heat source of the unit volume. At the same time, with the increase of calculation area, the heat dissipation area of polymer matrix material per unit volume decreases. The average heat flux distribution on the outer surface of nanocomposites under different heating power decrease as the bending cycles increase.

### 1. Introduction

CNTs have been regarded as reinforcement materials or functional agents in high performance structural and multifunctional nanocomposites [1-6] as CNTs have excellent electrical and thermal properties [7-10]. The polymer composites reinforced by the nanopaper have excellent thermal conductivity.

The software PROE 5.0 is used for 3D modeling of composites reinforced by pulse bending nanopaper. The finite element software FLUENT is used to analyze the temperature difference of the maximum and minimum temperature of composites reinforced by pulse bending nanopaper with calculation area.

### 2. 3D modeling

Taking composites reinforced by pulse bending nanopaper as an example, the software PROE 5.0 is used for 3D modeling. When the software PROE 5.0 is working, a new part model is created. The model names need to be defined and the modeling unit is set as mm. Then the sketch plane tool is opened and the sketch plane is selected as the front plane. The original point of the coordinate system is set at the center of the model, drawing the tensile cross section on the interface, and modifying the corresponding dimensions as shown in Figure 1.

When the section is drawn, the drawing entity is created using the sketched features drawn, and the model obtained is shown in Figure 2.

Then we need to complete the drawing of the stretch section of the pulse bending heating sheet. The sketch is still the front plane, and the corresponding size is modified. The effect after the completion is shown in Figure 3.

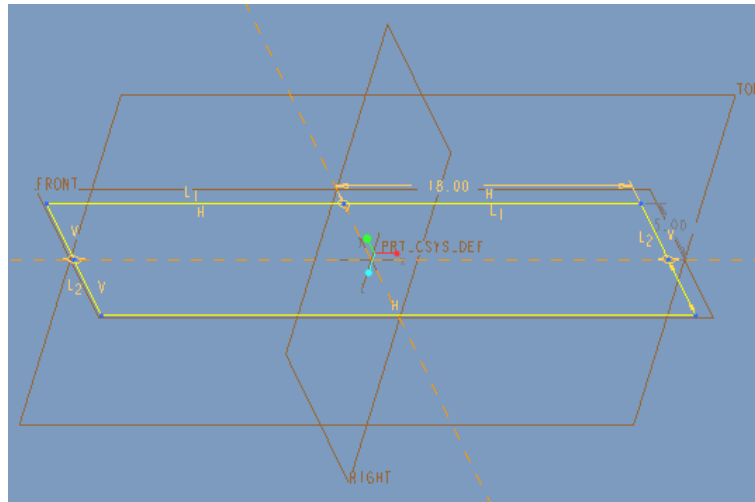


Fig. 1. Drawing tensile cross section

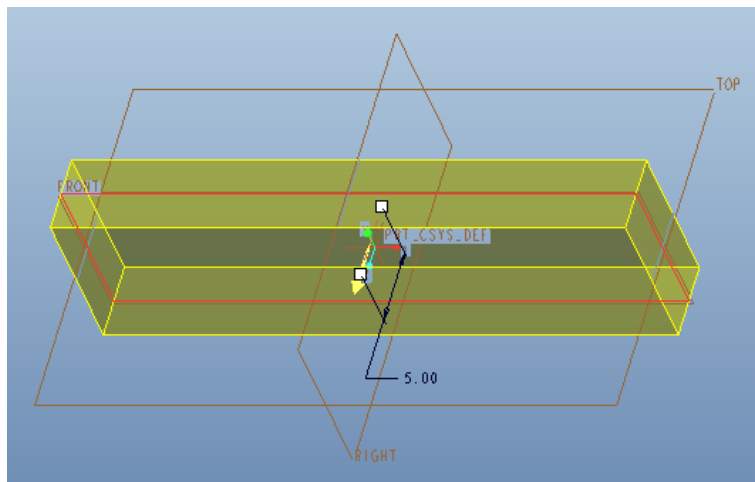


Fig. 2. Preliminary creation of overall shape

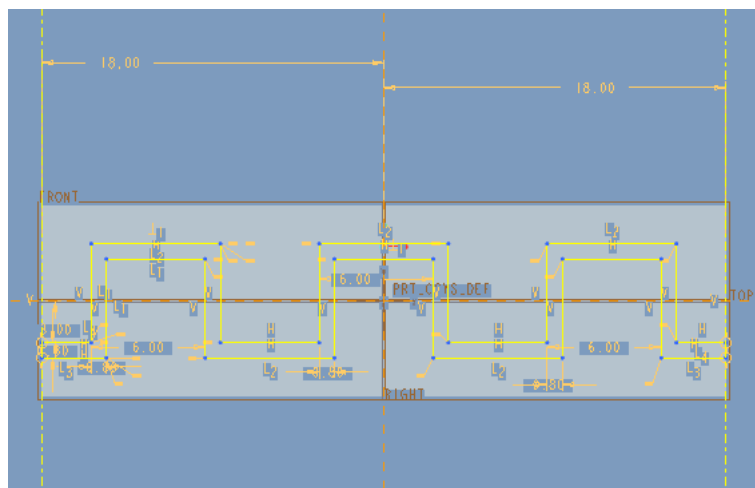


Fig. 3. Drawing tensile cross section of pulse heating sheet

After that, the final modeling is completed using the material removal function in the drawing command, and the final model is shown in Figure 4. After the modeling is completed, we need to transform the model into the .Stp file format of ICEM, which is easy to import.

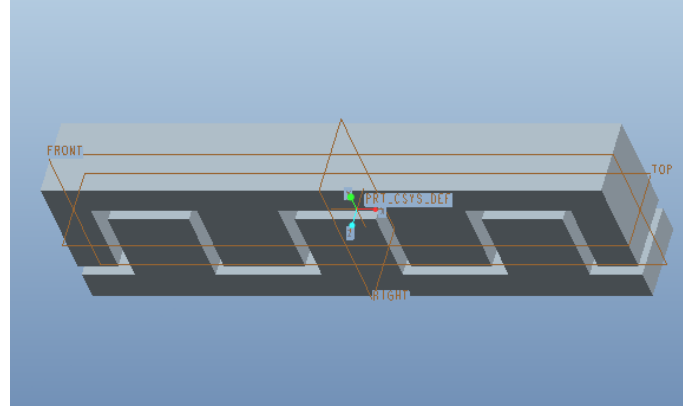


Fig. 4. Nanocomposite model with pulse heating sheet

### 3. Results and discussion

As shown in Figure 1 to Figure 4, the length, width, and the thickness of the nanocomposites are 36 mm, 5 mm, and 10 mm respectively. The thicknesses of the nanopaper are 0.4 mm. The bending height and bending period (A) of the bending nanopaper are 6 mm and 12 mm.

Figure 5 shows the curve of temperature difference of the maximum and minimum temperature of composites reinforced by pulse bending nanopaper with calculation area. Figure 5 indicates that the temperature distribution of the nanocomposites is more uniform with the increase of the bending cycles of nanopaper.

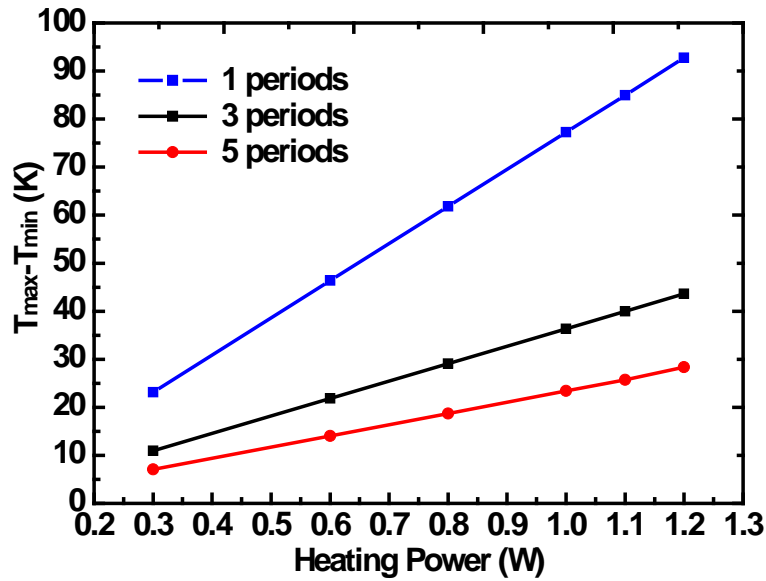


Fig. 5. Curve of temperature difference of composites reinforced by pulse bending nanopaper with different calculation area

When the calculation area changes, the heat source of the unit volume of the nanopaper also changes under the same total heating power. The more the bending period of the nanopaper, the smaller the heat source of the unit volume. At the same time, with the increase of calculation area, the heat dissipation area of polymer matrix material per unit volume decreases.

Table 1 show that the average heat flux distribution on the outer surface of nanocomposites under different heating power. As shown in Table 1, the average heat flux decrease as the bending cycles increase.

Table 1 The average heat flux distribution on the outer surface of nanocomposites

Bending cycles	0.3w		0.6w	
	Buckypaper	Resin	Buckypaper	Resin
1	748.1280	641.8596	1496.6510	1284.0580
3	287.8816	250.7003	501.0782	575.3829
5	178.0979	155.7694	356.3322	311.6775

#### 4. Summary

The software PROE 5.0 is used for 3D modeling of composites reinforced by pulse bending nanopaper. And the modeling process of composites reinforced by pulse bending nanopaper is described in detail.

The finite element software FLUENT is used to analyze the temperature difference of the maximum and minimum temperature of composites reinforced by pulse bending nanopaper with calculation area. The temperature distribution of the nanocomposites is more uniform with the increase of the bending cycles of nanopaper.

The heat source of the unit volume of the nanopaper changes with the calculated area under the same total heating power. The more the bending period of the nanopaper, the smaller the heat source of the unit volume. At the same time, with the increase of calculation area, the heat dissipation area of polymer matrix material per unit volume decreases.

The average heat flux distribution on the outer surface of nanocomposites under different heating power decrease as the bending cycles increase.

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