

Supporting Information for

Application of Graphene-polymer Composite Heaters in Gas-assisted Micro-Hot-Embossing

Dip coating method

The dip coating method is shown in Figure S1. First, the PI substrate was fixed on the slider. In addition, parts of the PI substrate that do not need to be coated were covered with tape. Then, the slider was moved down, letting the PI substrate be soaked in the graphene-polymer composite. The graphene-polymer composite adhered to the PI substrate owing to viscous force, and the slider was then moved up. Lastly, the tape was removed to complete the dip coating method.

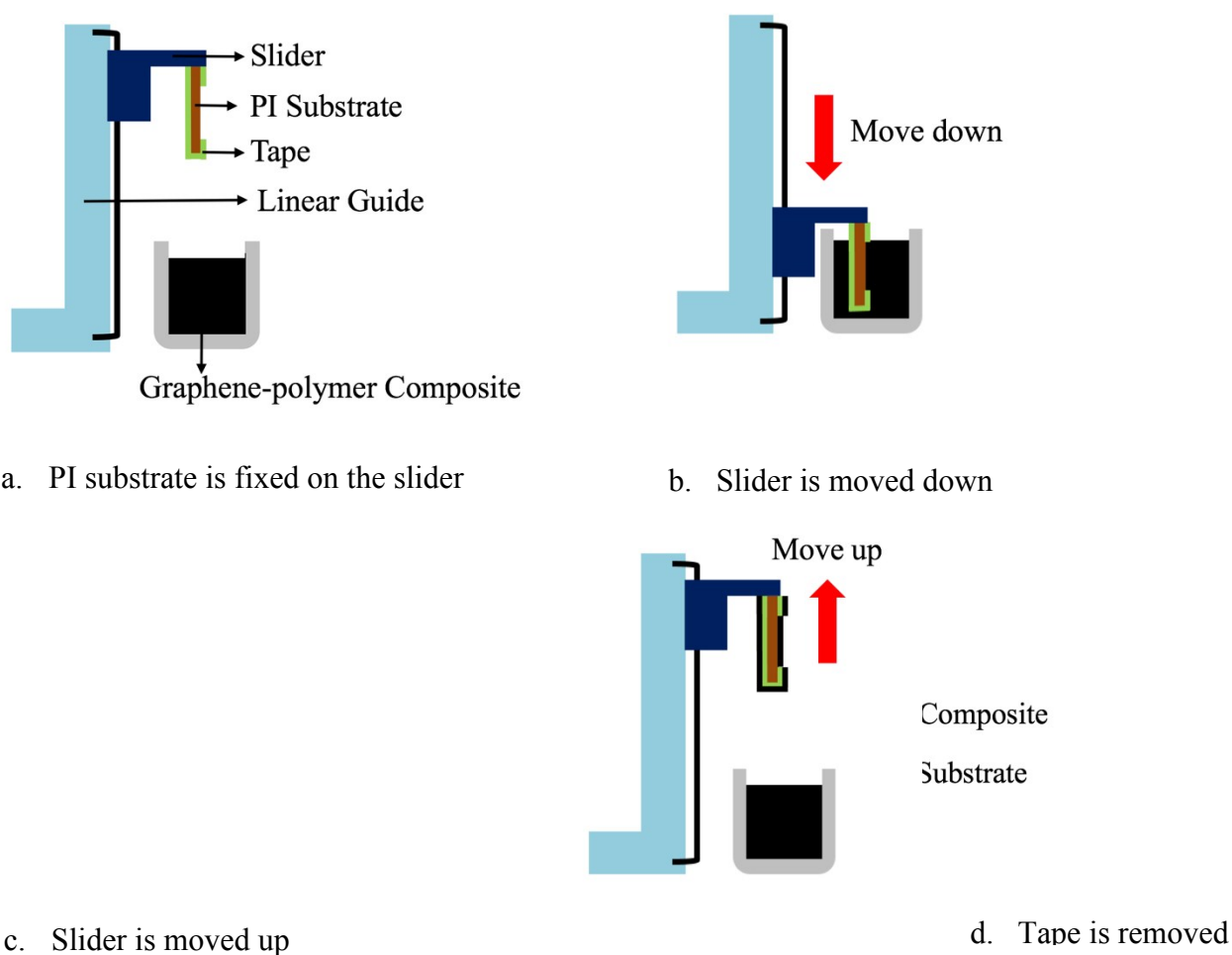


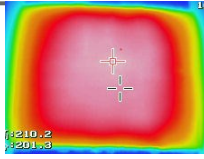
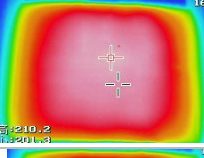
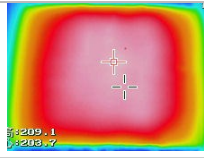
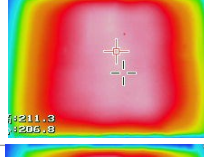
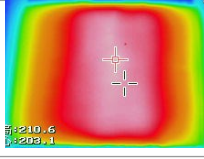
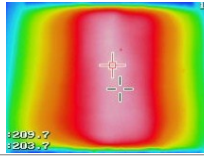
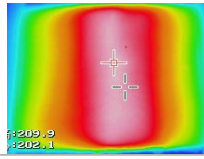
Figure S1. Schematic of the dip coating method to coat the PI substrate with the graphene-polymer composite.

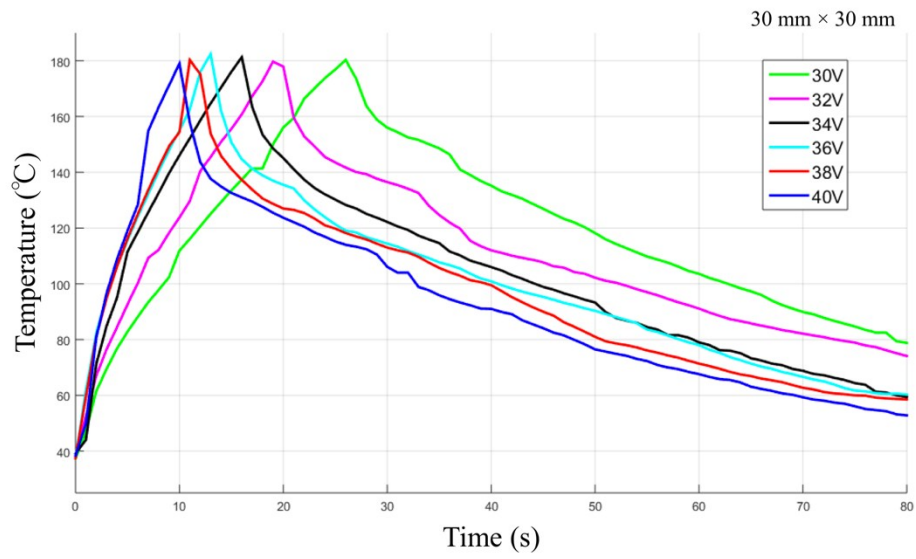
Heating Performance degradation

Generally, the graphene-polymer composite layer is pressed by the mold during the hot embossing process. A direct contact between composite layer and mold conduces to a rapid heat transfer. However, the heating performance of the heater would gradually decline by

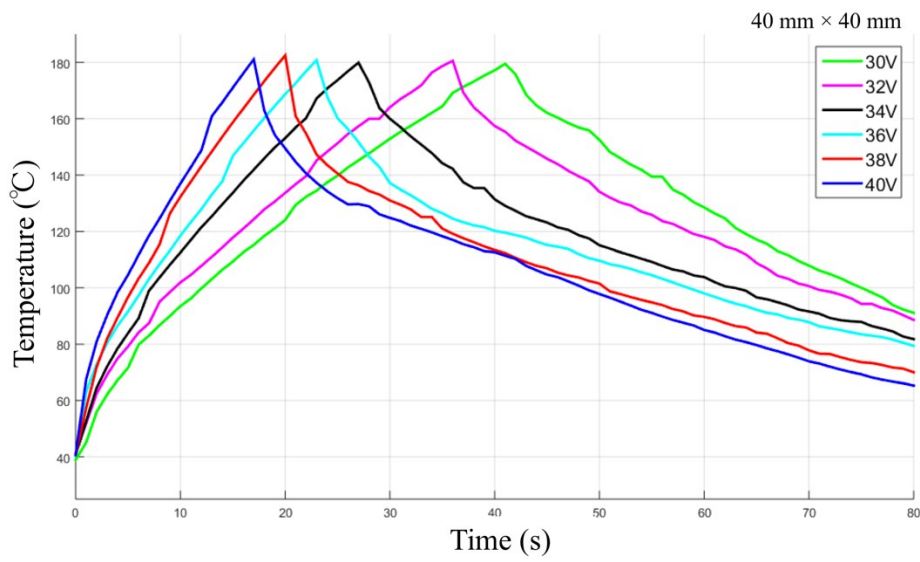
observation after pressing several times. To test the pressure endurance of the graphene-polymer composite layer, the coating layer was pressed under a pressure of 0.6 MPa for 30 s. The pressing test was repeated six times, and the heater was initiated after each pressing. The heating performance of the heater was observed with an infrared camera. Furthermore, the effective heating area was calculated via MATLAB. The results are shown in Table S1. The dramatic decline of the heating performance implies that the graphene-polymer composite layer was damaged during the embossing process.

Table S1. Heating performance and effective heating area after each pressing test

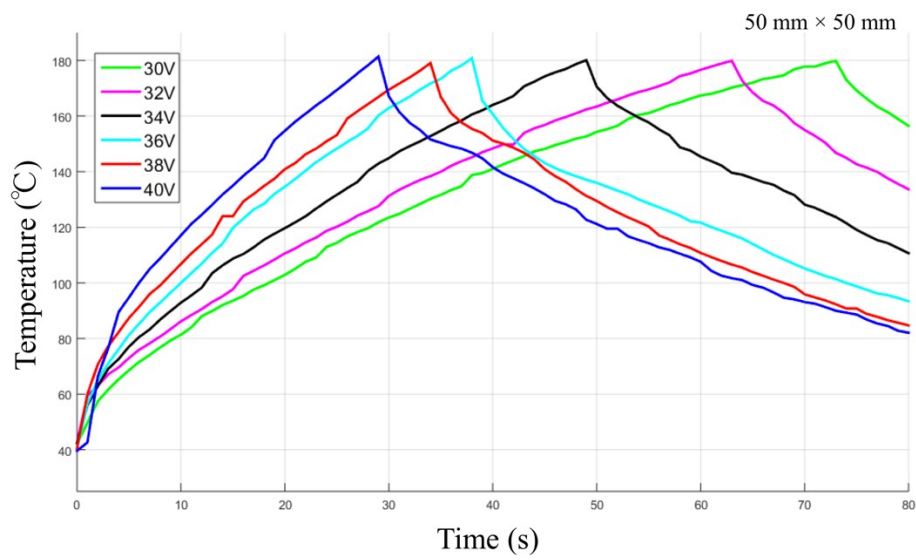
Number of times the graphene-polymer composite layer was pressed	Proportion of the heating area (above 150 °C)	Infrared image
0	80.6%	
1	79.8%	
2	74.8%	
3	66.7%	
4	61.2%	
5	55.9%	
6	49.4%	



(a)



(b)



(c)

Figure S2. Heating response of the heaters with size of (a) 30 mm × 30 mm (b) 40 mm × 40 mm (c) 50 mm × 50 mm under various driving voltages.