Factorial Design of Thermally Conductive Composite Materials for Fuel Cell Bipolar Plate Applications

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The thermal conductivity of insulating polymers can be increased by adding conductive fillers. One potential market for these thermally conductive resins is for fuel cell bipolar plates. In this study varying amounts of three different carbon fillers (carbon black, synthetic graphite particles, and carbon fiber) were added to Vectra A950RX Liquid Crystal Polymer. The resulting composites were tested for both through-plane and in-plane thermal conductivity. The effects of single fillers and combinations of the different fillers were studied via two different factorial designs (4 wt% carbon black, 40 wt% synthetic graphite, and 10 wt% carbon fiber in the first factorial design and 2.5 wt% carbon black, 65 wt% synthetic graphite, and 5 wt% carbon fiber in the second factorial design).

In the first design of experiments, all of the single fillers caused a statistically significant increase in composite through-plane and in-plane thermal conductivity at the 95% confidence level. Composites containing synthetic graphite/carbon black and synthetic graphite/carbon fiber caused a statistically significant increase in through plane and in plane thermal conductivity.

In the second design of experiments, all of the single fillers caused a statistically significant increase in composite through-plane and in-plane thermal conductivity at the 95% confidence level. Furthermore, all of the composites containing combinations of the different fillers caused a statistically significant increase in composite through-plane and in-plane thermal conductivity.