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# The Fabrication and Characterization of a Honeycomb Ceramic Electric Heater with a Conductive Coating

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**Abstract :** Porous electric heaters, compared to conventional electric heaters, exhibit excellent heating performance due to their large specific surface area. Porous electric heaters employ porous metallic materials or conductive porous ceramics as the heating element. The former attains a low heating power with a fixed current due to the low electrical resistivity of metal. Although the latter can bypass the inherent challenges of porous metallic materials, the fabrication process of the conductive porous ceramics is complicated and high cost. This work proposed a porous ceramic electric heater with dielectric honeycomb ceramic as a substrate and surface conductive coating as a heating element. The conductive coating was prepared by the sol-gel method using silica sol and methyl trimethoxysilane as raw materials and graphite powder as conductive fillers. The conductive mechanism and degradation reason of the conductive coating was studied by electrical resistivity and thermal stability analysis. The heating performance of the proposed heater was experimentally investigated by heating air and deionized water. The results indicate that the electron transfer is achieved by forming the conductive network through the contact of the graphite flakes. With 30 wt% of graphite, the electrical resistivity of the conductive coating can be as low as 0.88 Ω•cm. The conductive coating exhibits good electrical stability up to 500°C but degrades beyond 600°C due to the formation of many cracks in the coating caused by the weight loss and thermal expansion. The results also show that the working medium has a great influence on the volume power density of the heater. With air under natural convection as the working medium, the volume power density attains 640.85 kW/m3, which can be increased by 5 times when using deionized water as the working medium. The proposed honeycomb ceramic electric heater has the advantages of the simple fabrication method, low cost, and high volume power density, demonstrating great potential in the fluid heating field.

**Keywords :** conductive coating, honeycomb ceramic electric heater, high specific surface area, high volume power density
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