Heat Transfer Performance of Double-layer Porous Copper Produced by Tape Casting with Lost Carbonate Sintering

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Abstract

Porous copper tapes with high surface area to thickness ratio are attractive for thermal management in portable electronics where good heat transfer performance is required. In this study, the porous sheets of thickness down to *1350μm* were investigated for heat transfer performance. The porous copper samples were produced by a novel process combining lost carbonate sintering (LCS) and tape casting. This process allows the flexibility to produce copper double-layer structure consisting of a porous section with a wide range of porosities on a dense substrate. Here double-layer structures consisting of a porous layer of porosities ranging from *30-70%* were investigated. Their suitability for heat sink applications were investigated with simple assessments of the thermal properties under forced convection using air as a coolant. Through experiments, the heat transfer performance of the thin porous tapes was systematically studied under two different heating system; a cylindrical and a flat heating systems. The heat generated within the heating systems was controlled by AC/DC power supply. Also the flow rate of air passing through the samples was varied between the ranges of 0 – 0.5 kg/s. T-type thermometers and an Infrared thermography sensor were installed in the system to track in and out and surface temperatures of the system. This allowed behaviour of heat dissipation by porous copper tapes to be effectively studied. The initial experimental results showed that, from the thermal viewpoint, the porous copper heat sinks investigated here have an excellent heat transfer performance. The outcome of this study is fully discussed in the presentation.

Image

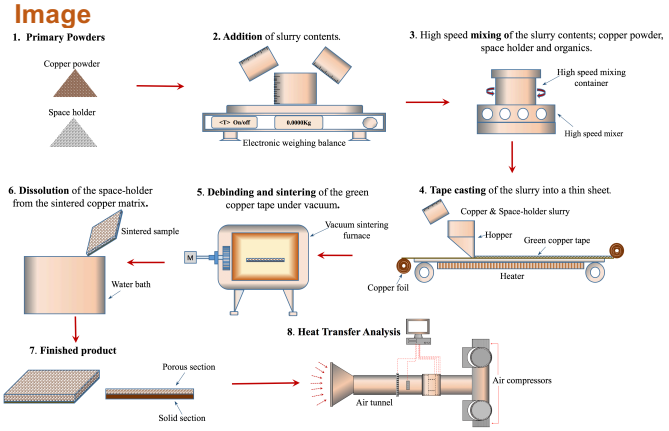


Figure 1: *Schematic diagram showing processing and heat transfer analysis of porous copper samples.*

Recent Publications

1. Du H, Lu D, Qi J, Shen Y, Yin L, Wang Y, Zheng, Xiong T (2014) Heat dissipation performance of porous copper with elongated cylindrical pores, Journal of Materials Science and Technology, 30(9): 934-934.
2. Geoffroy P-M, Chartier T, Silvain J-F (2007) Preparation by tape casting and hot pressing of copper carbon composites films, Journal of the European Ceramic Society, 27:291-299.
3. Li H-Y, Chiang M-H, Lee C-I, Yang W-J (2010) Thermal performance of plate-fin vapor chamber heat sinks, International communication in heat and mass transfer, 37:731-738.
4. Liu Y, Chen H.F, Zhang H.W, Li Y.X (2013) Heat transfer performance of lotus-type porous copper heat sink with liquid GaInSn coolant, International Journal of Heat and Mass Transfer, 80: 605-613.
5. Mosalagae M, Goodall R, Elbadawi M (in press) Tape casting and lost carbonate sintering processes for production of heat sinks for portable electronics, Advanced Materials Letters, 8.
6. Thewsey D.J, Zhao Y. Y (2018) Thermal conductivity of porous copper manufactured by the lost carbonate sintering process, Physica Status Solidi a, 205(5): 1126-1131
7. Zhang L, Mullen D, Lynn K, Zhao Y (2009) Heat Transfer Performance of Porous Copper Fabricated by the Lost Carbonate Sintering Process, Materials Research Society Symposium Proceeding, 1188.
8. Zhao Y.Y, Fung T, Zhang L.P, Zhang F.L (2005) Lost carbonate sintering process for manufacturing metal foams, Scripta Materialia, 52: 295-298.



Biography

Mosalagae Mosalagae is a professional, highly motivated and dedicated materials science and engineering researcher. His main interest is on development of porous metals for heat transfer applications by powder metallurgical processes. He developed a process which combines lost carbonate sintering (Zhao et al, 2004) and tape casting to process copper powder into thin sheet of porous copper. And further developed a heat transfer rig to investigate the porous heat sinks produced by simple assessment of thermal properties. In this rig, porous metals are tested under a forced convection using air as a coolant.

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Notes/Comment