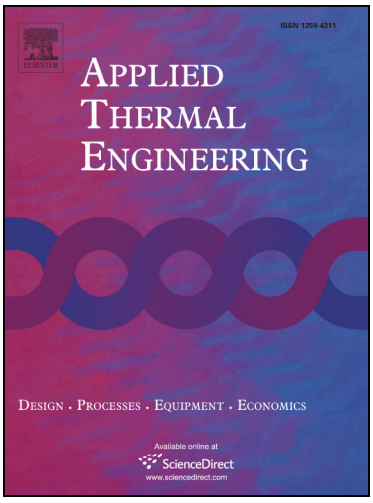

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Comparative Study of the Heating Surface Impact on Porous-material-involved Spray System for Electronic Cooling - an Experimental Approach

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Abstract

A spray cooling system integrated with porous material was previously studied with emphasis on the space-oriented application. As an extension, this paper presents a comparative study of cooling performances of three target surface processing methods (S1, S2 and S3). Among them S1 is a normal naked flat surface which functions as the reference. The latter two adopt phase-change microfluidic cooling tactics using porous foamed copper (PFC) which can realize liquid loop control and vapour-liquid separation in various gravitational field due to favourable characteristics possessed by porous material such as capillary forces and superhydrophilicity. Different from our previous study which centres on S3, the present one also includes thermal tests on S1 and S2. Results of the experiment and related comparative studies of the three surface processing methods are presented as well where effects of mass flow rate and spray distance upon heat transfer characteristics of the cooling performance are disclosed. Conclusions can be drawn that S2 has the best cooling performance since the maximum heat flux can reach 470.9 W/cm^2 under the given operation condition. An enhancement of 125.3% in terms of the maximum heat flux is attained compared with that for S3 and 24.58% for S1. The comparative study illustrates the S2 is a relatively efficient form of heating surface in cooling performance which retains properties that a space-oriented system should possess while eliminates the shortcomings such as reduced droplet impingement and huge thermal resistance when a layer of PFC is applied as well. In addition, empirical correlations based on the experimental results for S2 and S3 are developed under the dimensionless study for performance prediction with the relative errors of only ±1.84% and ±1.50%.

Keywords: spray cooling, space application, porous material, dimensionless study, electronic cooling.