Journal of Heat Transfer

Guest Editorial

Recent Research in Molecular-to-Large-Scale Heat Transfer With Multiphase Interfaces and Their Applications

Heat and mass transfer across multiphase interfaces, or liquid-vapor/gas-solid phase boundaries, represent the most fundamental transport phenomena in diverse applications, which include boiling, two-phase flow, and spray and coating processes, to name a few. The collection of research papers in this special issue of the *Journal of Heat Transfer*, which is indeed topically timely in the current "energy crisis" debate, articulates the current efforts in characterizing the interfacial behavior and advancing the associated basic science as well as applied understanding. The reported work addresses long-standing unresolved issues in ebullient phase-change, capillary-forces driven convection, drop evaporation and/or thin-film cooling, and newer developments that are primarily driven by reductions of spatial scales.

Examining flow boiling in milli- to micro-scale channels in an effort to accommodate and sustain very high heat fluxes for a variety of industrial and electronic cooling applications continues to attract much attention. Four different studies in this issue have dealt with small-scale ducts and addressed questions relating to two-phase flow patterns and their maps, bubble-dynamics induced pressure instabilities and heat transfer, role of heated length on the critical heat flux (CHF), and the application of heat transfer enhancement strategies by producing structured reentrant cavities on the heated surface. Two other papers have explored the effects of altering unstructured surface roughness of a heater, and its wetting characteristics (modified by coatings) on nucleate pool boiling heat transfer. The influence of mesh structures of heat pipe wicks and metal-foam-filled flow ducts on evaporative heat transfer with net vapor generation are the platforms for investigating capillary action at liquid-solid interfaces in two different articles. A two-part publication reports an effort to develop a coupled statistical and mechanistic model for predicting wall heat flux and CHF in subcooled nucleate flow boiling. The enhancement of high heat fluxes for large-scale nuclear energy needs are also addressed in a study on boiling of liquid metals in the presence of magnetic fields, and modeling of liquid-metal thin-film evaporation is carried out in another effort. In three other papers, heat transport at the liquid-vapor-heated-wall interface in liquid mixtures is the subject of an experimental study, boiling of a liquid-mixture droplet in an immiscible liquid is similarly examined, and drop-impact thin-film cooling is numerically modeled. Furthermore, the role of bubble motion (or sliding) is studied experimentally to characterize spatial evolution of gas-liquid interfaces and the consequent heat transfer enhancement.

As is evident from the foregoing, and will be so from a more detailed reading of the collection of research articles in this issue, the study of multiphase interfaces (understanding the associated boundary transport as well as artificially modifying the boundaries) continues to be the fundamental basis for efforts to resolve many different issues in boiling, spray dynamics and coatings, and two-phase flow heat transfer. It is also clear that enhancement of heat transfer is and will be increasingly critical to both large and small (micro-scale and perhaps even smaller) heat exchange systems, and even more so in the emerging arena of the latter. Needless to add that the future bodes well for this field of study, which assumes even greater relevance in the current debate on finding alternative ways of meeting the world's energy needs, and it is hoped that synergistic work would help provide exciting directions and paths for new discoveries in times to come.

In closing, we are grateful for the invitation extended by Professor Yogesh Jaluria, Editor, *Journal of Heat Transfer*, for bringing out this special issue. The resourcefulness and help of Ms. Shefali Patel, assistant to the editor, Rutgers University, in keeping the paper reviews and production of this issue on track, as well as that of the ASME staff (associated with both the print production and the journal's web site) is thankfully acknowledged. And finally, we would like to thank all the authors for their submissions and the reviewers for their impartial and constructive reviews, which are essential to good scholarship.

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