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Nanoparticles for advanced two-phase heat transfer solutions

Innovative strategies for high heat flux dissipation are strongly needed to overcome the intrinsic limitations of the traditional cooling schemes. Passive cooling represents an interesting way to dissipate the heat rejected by electronic devices and when it is associated to a phase change, it can be very effective. The most common phase change process used in the electronics cooling is the liquid–vapor one (i.e. boiling), since it can be found in the heat pipes and vapor chambers largely used to cool electronics devices. On the other hand, the solid-liquid phase change process (as in the case of a phase change material, PCM) is another interesting possibility to reject even high heat loads, especially when they are intermittent as in the case of most electronics cooling. In the last decades, nanotechnologies have been demonstrated to open new interesting opportunities for the two-phase heat transfer enhancement on both liquid-vapor and solid-liquid processes. In particular, the use of nanoparticles to improve the heat transfer properties of fluids has been largely studied and implemented since the concept of nanofluid was firstly advanced by S Choi in 1995. Despite of the large research efforts on nanofluids, the results are still contradicting, especially in two-phase heat transfer, where the nanoparticles-fluid interaction is added to the already very complex phase change phenomenon. This lecture covers the most advanced research activities carried out the Nano Heat Transfer Lab (NHT-Lab) of the University of Padova; in particular, the results on surface functionalization via nanoparticles deposition during nanofluid boiling and the development of nano-PCM by seeding different carbon black and allumina nanoparticles in common paraffin waxes are presented and critically discussed to explore the possible use of these enabling technologies for the next generation of cooling strategies.

Speaker Biography

Simone Mancin is an Associate Professor at the Dept. of Management and Engineering of the University of Padova, where he teaches three courses: Applied Physics, Thermo-Fluid-dynamics, and Thermal Management of Electronics Devices. He set up an independent laboratory on Nano Heat Transfer (NHT-lab) where he has focused his research activities on Nanotechnologies applied to advanced single and two-phase heat transfer. In particular, his current research projects involve the use of nanoparticles to improve the heat transfer performance of phase change materials for enhanced thermal energy storage and to obtain specific surface functionalization via nanofluid pool boiling. Moreover, other research projects regard the experimental and numerical analyses of single and two-phase (both condensation and evaporation) heat transfer inside microgeometries and nanostructured materials aiming at developing innovative solutions for smart, efficient, and compact heat exchangers for refrigeration and air conditioning, and electronics cooling applications. He is author and co-author of more than 80 scientific papers published in several peer-review international journals and in proceeding of national and international congresses; he acts as reviewer of several scientific international journals. He is member of IIR B1 scientific commission and fellow of ASME.

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