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Heat Transfer Enhancement – A Brief Review of 2018 Literature

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Abstract:

This article is a review of literature on heat transfer enhancement research published in 2018 in the English language. A topic search using “heat transfer” in the Web of Science resulted in about 17,000 articles published in 2018, of which nearly 4600 were relevant to heat transfer augmentation. Thus, some selection is inevitable. The included studies are grouped into the fields identified in the Aims and Scope of the *Journal of Enhanced Heat Transfer*, which considers a wide range of scholarly articles related to the subject of "enhanced heat and mass transfer" in natural and forced convection, phase-change heat transfer, conduction and radiative heat transfer, and the general topic of "high performance" heat transfer concepts, devices, or systems (e.g., heat exchangers and heat pipes).

Keywords: Enhancement, Conduction, Convection, Radiation, Phase-change, Thermal properties, Energy, Nanoscale, Nanofluid, Porous Media, Graphene, Diamond.

1. Introduction

Heat transfer enhancement or augmentation or intensification concerns the improvement of thermal performance of any heat transport process, heat exchanging medium, component, device, or equipment. In the early 1980s, Bergles et al. (1983) grouped the methodologies for augmenting convective heat transfer into three categories: passive techniques, active techniques, and compound techniques. Recent research has focused on thermal enhancement in conduction and radiative heat transfer, boiling and condensation, energy storage and phase-change materials (PCMs), micro/nanoscale structures and devices due to requirements of high heat-flux removal in modern technology.

On July 24, 2019, we conducted a topic search in the Web of Science with keywords "heat transfer" with a return of 17,010 articles published in 2018. A further topic search with keywords "heat transfer enhancement", or "heat transfer augmentation", or "heat transfer intensification", or "enhanced heat transfer", or "augmented heat transfer", or "intensified heat transfer" resulted in 4587 papers relevant to enhanced heat transfer published in 2018, representing a ratio of 27% heat transfer augmentation to general heat transfer. Table 1 presents the publication number data acquired from such topic searches for the period from 2009 to 2018. It also compares the yearly increase rates for articles published about general heat transfer or enhanced heat transfer, respectively, as well as the article ratio of enhanced heat transfer to heat transfer. The enhancement-related article ratio steadily increased from 16% in 2009 to 27% in 2018. This indicates that the research on enhanced heat transfer has become more and more important.

Table. 1 Number of papers indexed in the Web of Science in the past 10 years.

Year	Heat Transfer (HT)	Yearly increase rate in HT (%)	Enhanced HT (EHT)	Yearly increase rate in EHT (%)	EHT/HT (%)
2009	8723	-	1400	-	16.05
2010	9043	3.67	1521	8.64	16.82
2011	9556	5.67	1703	11.97	17.82
2012	11238	17.60	2198	29.07	19.56
2013	10855	-3.40	2190	-0.36	20.18
2014	12842	18.30	2677	22.23	20.85
2015	13503	5.15	2885	7.77	21.37
2016	15808	17.07	3683	27.66	23.30
2017	17641	11.60	4378	18.87	24.82
2018	17010	-3.58	4587	4.77	26.97

The present review is intended to circumscribe the heat transfer augmentation peer-reviewed literature published in 2018 in English language. Because the publication amount is huge and the volume of the *Journal of Enhanced Heat Transfer* is very limited, some selection is necessary. In many situations, dozens of publications involve in a narrow topic area; but only a few have been incorporated into this review. Nevertheless, a wide range of fields related to the subject of enhanced heat and mass transfer involved passive, active, and compound techniques in convective heat transfer, phase-change heat transfer and PCMs for energy storage, micro/nanoscale heat conduction, radiation and solar energy, and high-performance heat transfer devices.

2. Passive Techniques in Convection

2.1 Extended Surfaces

Use of extended surfaces or fins is very effective in enhancing heat transfer as heat transfer rate is linearly proportional to surface area through which heat is transported. Conjugate heat transfer in a finned channel with equally spaced fins placed transversely to the flow direction following in-line and staggered arrangements was evaluated (Perao et al., 2018). Geometric and design parameters of embedded fins in phase-change materials (PCMs) were reviewed for enhancing thermal energy storage systems (Abdulateef et al., 2018a). Angled fins were considered to enhance PCM melting (Ji et al., 2018). Based on a numerical simulation using the enthalpy-porosity model, PCM melt with different numbers of installed fins at different constant wall temperatures was examined (Cao et al., 2018). Experimental investigation for optimization of heat transfer in electronic integrated circuits using close packed PCMs filled pin-fin heat sinks was carried out (Ali et al., 2018). The effect of attack angle of triangular ribs has been numerically studied in a 2-D microchannel using Ag/water nanofluid as cooling fluid (Heydari et al., 2018). The flow and heat transfer characteristics have been studied numerically in a wavy channel (Krishna et al., 2018), or for flow over three rows of circular cylinders mounted on a flat plate (Naik and Tiwari, 2018) or past two elliptic cylinders arranged in a tandem manner (Sunakraneni et al., 2018). Novel airfoil fins for printed circuit heat exchanger (PCHE) using supercritical CO_2 were compared with the zigzag channel in PCHE (Cui et al., 2018). Enhancement in the melting rate of PCM by addition of fins in rectangular enclosures was experimentally explored under different inclination angles (Kamkari and Groulx, 2018).

2.2 Treated Surfaces

This technique involves fine-scale alteration of surface finish or application of a coating (Bergles and Manglik, 2013). The role of passive techniques such as porous coating, reentrant cavities, microchannels, grooved surfaces, and integral fins on heat transfer enhancement of horizontal tube falling film and flooded evaporators was reviewed (Balaji et al., 2018). Pool boiling heat transfer in capillary-porous coatings was experimentally studied and results showed that the use of capillary-porous coatings leads to significant enhancement of heat transfer up to 4 times at boiling of liquid nitrogen and up to 3.5 times at boiling of water in the region of low heat fluxes (Surtaev et al., 2018). Dropwise condensation experiments on the outer surface of a cold tube with oil infused nanograss thin hydrophobic film coating showed that heat transfer can be enhanced up to approximately 50% compared to raw copper surface (Quan et al., 2018). Sharma et al. (2018) presented a rationally driven, hierarchical texturing process of copper surfaces, guided by fundamental principles of wettability and coalescence, which achieves controlled droplet departure under vapor flow conditions and thus significantly enhances phase-change heat transfer. The evaporation behavior of water through the capillary channel of a vertically aligned graphene bilayer was examined using molecular dynamics (MD) simulations, with tunable surface wettability by changing the surface charge states (Kieu et al., 2018). The effect of nanoparticle coating was experimentally probed on the performance of a miniature loop heat pipe (Tharayil et al., 2018) or on boiling heat transfer (Gupta and Misra, 2018). A plasma-enhanced chemical vapor deposition (PECVD) technique was used to grow both few layer graphene and carbon nanotubes (CNTs) over the copper substrate for enhancing pool boiling heat transfer (Ganesan et al., 2018). Research on boiling and condensation with modified surfaces has increased substantially in recent years.

2.3 Rough Surfaces

Ribs are often employed in internal cooling passages of turbine blades to augment heat transfer with cooling air flowing through the internal ribbed passages. With various truncation types and arrangements of truncated ribs, the optimized thermal performance of ribbed channels has been attempted for by taking both heat transfer and pressure drop into consideration (Liu et al., 2018b). The thermo-hydraulic characteristics of the novel longitudinal wavy ribs along a wavy two-pass square channel was experimentally studied (Chang et al., 2018). The thermo-hydraulic performance of solar air heater duct roughened with non-uniform cross-sectioned square wave profiled transverse ribs was numerically simulated (Singh and Singh, 2018). The interrupted microchannel heat sinks with ribs in the transverse microchambers showed a 4%-31% decrease in the total thermal resistance, a 4%-26% decrease in the total entropy generation rates, the maximum value 1.39 in performance evaluation criteria, compared with the straight microchannel heat sink (Chai and Wang, 2018).

The orientation of oval-French dimples on the heated surface in a dimpled narrow channel was evaluated numerically to establish the superior thermo-hydraulic performance over spherical dimples (Isaev et al., 2018). Convergence angle and dimple shape effects on the heat transfer characteristics in a rotating dimple-pin fin wedge duct were numerically investigated (Luo et al., 2018). The fin and tube heat exchanger with a semi-dimple pair was numerically studied in terms of the air side's thermal performance (Chimres et al., 2018). The effects of different dimples-protrusions arrangements on the improving the thermal performance of a rough tube were inspected at various Richardson numbers (Sobhani and Behzadmehr, 2018). Computational fluid dynamics (CFD) modeling showed that multiple and single texturing on the leading and the trailing faces of the vortex generator, respectively, can intensify the primary vortex downstream of the vortex generator (Kashyap et al., 2018). The use of twisted tape inserts, perforated plate inserts, and internally finned absorbers were compared with the reference case of the smooth absorber to evaluate the performance of evacuated and non-evacuated parabolic trough collectors (Bellos and Tzivanidis, 2018). A review on the recent investigations on the potential applications of different inserts including baffles, wire coils, vortex generators, and twisted tapes, in different solar thermal energy processes was carried out (Rashidi et al., 2018c). In a numerical study, Zhang et al. (2018c) showed that roughness does not always mean a heat-transfer enhancement; it can also reduce the overall heat transport in turbulent Rayleigh-Benard convection in some situations.

2.4 Displaced Enhancement Devices

Vortex generators are inserted into the flow channel to augment thermal transport. Al-Asad et al. (2018) evaluated the benefits of introducing various gaps along the length of the vortex generators, both for reducing pressure drop and improving the thermal conductance of the system. The effect of different vortex generators on fin-plate heat exchanger performance with a triangular channel cross-section was numerically scrutinized (Samadifar and Toghraie, 2018). A numerical study demonstrated that a novel anchor-shaped vortex generator insert is a promising device for turbulent convection heat transfer enhancement in a heat exchanger tube (Chamoli et al., 2018). Mixed convection and surface radiation heat transfer characteristics were investigated using five protruding discrete heat sources of different sizes arranged at various positions on a Bakelite board mounted on a vertical channel (Hotta et al., 2018). Turbulent convective heat transfer in a solar air heater duct with winglet-type vortex generators placed on the absorber plate was studied (Skullong et al., 2018). Heat transfer intensification in parallel plate-fin heat exchanger was examined by performing 3-D numerical simulations of longitudinal vortex generators with protrusions (Oneissi et al., 2018).

2.5 Swirl-Flow Devices

These devices include many geometric duct arrangements or tube inserts for forced flow that create rotating and/or secondary flow; some examples include twisted-tapes, inlet helical vanes or stationary propellers, axial-core inserts with a screw-type winding, and axially twisted noncircular tubes (Bergles and Manglik, 2013). A new design of curved ducts, namely spirally-coiled twisted-duct, was introduced and analyzed both experimentally and numerically (Khoshvaght-Aliabadi et al., 2018). The thermo-hydraulic performance of equilateral triangle cross sectioned coiled-wire inserted in a tube was experimentally investigated (Keklikcioglu and Ozceyhan, 2018). Three wire-coils and three twisted-tapes were compared in an experimental study of heat transfer augmentation in a flat-plate solar water collector (Garcia et al., 2018). A solution was applied to assess the heat transfer characteristics in a pipe with turbulent decaying swirling flow by using the boundary layer integral scheme (Aghakashi and Saidi, 2018). A numerical study on flow and heat transfer in an outwardly convex corrugated tube with various structural twisted tape inserts was conducted (Han et al., 2018). The heat transfer characteristics of a horizontal circular tube in the transition regime with conical strip inserts were probed experimentally (Arulprakasajothi et al., 2018). Meyer and Abolarin (2018) experimentally investigated the heat transfer and pressure drop characteristics in the transitional flow regime of twisted tape inserts in a circular tube. A variety of tube inserts such as twisted tape, wire coil, swirl flow generator on heat transfer rates and fluid flow friction have been reviewed (Kumar et al., 2018c). Experiments to determine the Nusselt number and friction factor of heat exchanger tube with multiple square perforated twisted tape inserts were carried out (Suri et al., 2018).

2.6 Coiled Tubes

The heat and mass transfer performances of falling liquid films subjected to evaporative heating and sensible heating inside two converging-diverging tubes were studied and compared to a built-in spring coil tube and a smooth tube (Huang and Deng, 2018). An analytical model for predicting the onset of dry-out quality in annular flow regime in helically coiled tubes was presented (Niu et al., 2018). Experimental investigation of the cooling heat transfer of supercritical CO_2 in helically coiled tubes with constant wall heat flux was analyzed based on exergy analysis (Xu et al., 2018b). Condensation heat transfer of hydrocarbon mixture refrigerant in a helical tube was characterized numerically (Yu et al., 2018).

2.7 Additives and Nanofluids

Additives for liquids or gases include solid particles, liquid droplets, soluble substances, and gas bubbles, among others. Early bubble departure at smaller sizes is known to improve boiling heat transfer, especially with addition of small amounts of surfactant additives in water. Kumar et al. (2018b) elucidated the role of a lesser-known force of repulsion on surfactant aided bubble departure. An air bubble injection system was integrated into an energy storage tank and the impact of bubble formation on heat transfer was experimentally examined (Oktent and Biyikoglu, 2018). Burkov et al. (2018) simulated robot-assisted prostatectomy to acquire preliminary cooling parameters for hypothermia before the operation by using pneumoperitoneum gas with additional liquid local intensification (e.g., water and ice slurry). Humidity of air at the inlet and the values of a thermal flux on the wall on the rate of evaporation on a wet wall were studied for buildings (Terekhov et al., 2018).

Viscosity, density and thermal conductivity of Diamond-COOH and multiwall carbon nanotube (MWCNT)-COOH nanoparticles dispersed in water were studied without adding any surfactants or additives and an adaptive neuro-fuzzy inference system (ANFIS) and optimal artificial neural network (ANN) were developed (Alrashed et al., 2018). Various artificial intelligence (AI) approaches were used to estimate pool boiling heat transfer coefficient of alumina water-based nanofluids (Hassanpour et al., 2018). Steady-state laminar natural convection of Cu and TiO_2 nanofluids inside different enclosures was numerically investigated and a new curved enclosure was suggested to augment heat transfer (Abbood et al., 2018). Developing forced laminar convection flow of Al_2O_3-water nanofluid in a 2-D rectangular section channel was modelled (Bianco et al., 2018). The cooling performance of a microchannel heat sink was experimentally examined with alumina nanofluids of various base fluids as coolants (Sandhu et al, 2018). Thermal performance of the diatomite-deionized water nanofluid usage as the working fluid in a wickless loop heat pipe at varying operating conditions was experimentally and numerically investigated (Sozen et al., 2018).

A comprehensive literature review on CO_2 absorption enhancement by nanofluids was compiled by Zhang et al. (2018b). Rashidi et al. (2018a) showed that the nanoparticle deposition and nanoparticle suspension are two important factors affecting the thermal system's efficiency. These factors should be considered when using different nanofluids in condensing and evaporating systems. Thermal performance of a copper-made heat sink with rectangular microchannel was assessed using Ag nanoparticles suspension in water as a potential coolant. Pressure drop, friction factor, heat transfer coefficient (HTC), and fouling thermal resistance parameter in a heat sink microchannel were experimentally investigated (Sarafraz et al., 2018). The heat transfer capability of $Mg(OH)_2$/MWCNT- engine oil hybrid nano-lubricant was theoretically investigated in both the internal laminar and turbulent flow regimes (Asadi et al., 2018). Nanofluids are promising to enhance the efficiencies of solar collectors (Mahbubul et al., 2018). A comprehensive outlook about the role of nanofluids in many fields especially in solar energy desalination technologies was reviewed (Bait and Si-Ameur, 2018). The turbulent flow of nanofluid in a tubular heat exchanger with two twisted-tape inserts was numerically investigated (Hosseinnezhad et al., 2018).

2.8 Surface Tension Devices:

The surface tension technique consists of wicking or grooved surfaces to direct the flow of liquid in boiling or condensing. Capillary evaporation on wicking structures has received increased interest owing to its capability dissipating high heat flux by increasing the effective evaporation area and sustaining the liquid supply. Wen et al. (2018) proposed a cost-effective hybrid wicking structure, that can be scalably manufactured using commercial copper micromeshes along with simple etching processes, to enable a novel capillary-driven liquid film boiling heat transfer by simultaneously improving liquid supply and increasing nucleation sites. Nasersharifi et al. (2018) found that the monolayer wicks without or with the mushroom post structure provided 20% or 87% critical heat flux (CHF) enhancements, respectively, compared to the plain surface, and the multilevel wick design provided fundamental insights into simultaneous CHF and HTC augmentations.

2.9 Porous Media

The dependence of velocity on foam porosity and the effect of porosity on flow separation in open-cell foams was studied (Iasiello et al., 2018). An enthalpy-porosity-based fixed grid scheme was used to solve the convection-diffusion mushy region phase-change problem for energy storage (Tabassum et al., 2018). Gradient and multi-layered porous media with optimized properties and arrangement were considered to maximize the heat transfer and minimize the pressure drop (Siavashi et al., 2018). A general topology model was proposed for maximum heat and mass transfer efficiency in structured packing (Arkharov et al., 2018a) and applied to the modeling of hydrodynamics in a porous structure of low-temperature regenerator (Arkharov et al., 2018b). An exergy analysis was performed to investigate the application of a reticular porous insert in a single slope solar still for improving performance (Rashidi et al., 2018b). The effects of porosity and mass-to-thermal drive ratio on aiding and opposing convection in porous enclosures were examined (de Lemos and Carvalho, 2018). The effect of inert metal foam matrices on hydrogen production intensification was investigated (Settar et al., 2018). The stratum porosity was found to significantly affect the fire propagation in spontaneous combustion of coal (Wang et al., 2018c).

3. Active Techniques in Convection

3.1 Mechanical Aids

With mechanical aids, the fluid may be stirred by mechanical means or the surface may be rotated (Bergles and Manglik, 2013). The dissolution dynamics of salt particles in water were investigated in two baffled tanks stirred by Rushton turbines, pitched blade turbines and Lightnin A310 impellers (Carletti, 2018). Ethanol-water solutions were freeze-concentrated by the progressive stirred technique and solute recovery by the fractionated thawing of ice was studied (Osorio et al., 2018).

3.2 Surface Vibration

Experimental investigation of surface vibration effects on increasing the stability and HTC of MWCNTs-water nanofluid in a flexible double pipe heat exchanger was conducted (Hosseinian et al., 2018). The forced vibration on the outer surface of a heat exchanger was imposed by electro-dynamic vibrators. Inspired by blades of grass vibrating in the wind, Li et al. (2018c) developed a self-agitator for convective heat transfer enhancement.

3.3 Fluid Vibration

A novel process on simultaneous absorption of SO_2 and NO from flue gas using ultrasound /Fe(2+)/heat coactivated persulfate system was proposed (Liu et al, 2018a). Cryoprobe and urethral warming system heat transfer were tested in an ultrasound gel phantom study (Zherdev et al., 2018). An approximate method was presented to calculate enhanced heat and mass transfer on the surface of a hypersonic aircraft of a complex geometric shape, including at low temperatures (Kuzenov and Ryzhkov, 2018).

3.4 Electro-Magnetic Fields

Electrostatic field or magnetic field or both can be directed to cause greater mixing or disruption of flow, which intensifies heat transfer. Heat transfer enhancement using corona wind generators in a square channel was numerically examined (Zhang and Lai, 2018), in which the emitting electrodes of the corona wind generator were flush mounted on the channel walls so that the corona wind produced directly perturbed the momentum and thermal boundary layers. The counter flow of corona wind was analyzed (Shin et al., 2018). The generalized integral transform solution procedure to the unsteady magneto-convection problem of an electrically conducting Newtonian fluid with hall and ion-slip effects within a parallel-plate channel was proposed (da Silva et al., 2018). The effects of alternating current electrowetting on the heat transfer characteristics of various boiling regimes, including the onset of nucleate boiling, fully developed nucleate boiling, and film boiling at CHF conditions, were investigated (Sur et al., 2018). The ballistic ejection of liquid drops from a superhydrophobic surface was investigated (Li et al., 2018b). The wettability of super-aligned CNT films could be simply, effectively and *in situ* controlled by the electrowetting method (Zhang et al., 2018d).

3.5 Injection or Suction

The impingement jet issuing from the lobed nozzles constructed using three small circular orifices was investigated and the heat transfer characteristics and flow fields were respectively determined using temperature-sensitive paint and particle image velocimetry (He and Liu, 2018). The effect of obstacle parameters on thermal and hydrodynamic performance of impingement jets solar air passage having protrusion with combined arc obstacles on the heated surface was experimentally inspected (Nadda et al., 2018). The heat transfer characteristics of a vertical stainless steel foil by circular impinging jets of various fluids were studied using an infrared thermal imaging camera (Modak et al., 2018b). A maximal 65.6% enhancement in heat flux was found in immersed spray cooling integrated with an ejector designed based on the theory of suction (Wang et al., 2018b). Chen et al. (2018a) showed how the nanostructures enhance the spray cooling by improving the surface wettability and the liquid transport to quickly rewet the surface and avoid dry-out. An experimental investigation analyzed the heat transfer of CuO-water nanofluids jet on a hot surface (Modak et al., 2018a). An experimental study using the liquid crystal thermography technique was conducted to investigate the convective heat transfer performance in jet impingement cooling using various porous media configurations (Kumar and Pattamatta, 2018). A comparative experimental and numerical study has been done on multiple-jet impingement heat transfer in narrow channels with different pin fin configurations on the target surfaces (Rao, 2018).

4. Compound Techniques in Convection

Compound methods are based on the use of at least two means for intensifying heat transfer (e.g., use of rough surface and a twisted tape, use of helical pipe and of porous coating, and use of circular knurling and flow twisting in helical pipes) (Kuzenov and Ryzhkov, 2018). The incorporation of multiple enhancement methods in microchannel heat sinks is advantageous in high heat-flux removal systems. A numerical study of pulsating rectangular double slot jets with Al_2O_3-Cu-water hybrid nanofluid was conducted (Selimefendigil, 2018). Solar collectors having absorber plate attached with fins and twisted tapes are more efficient than conventional and finned absorber solar air collector (Kumar and Chand, 2018). Combination of dimples, impinging jets and microchannel heat sink was adopted to enhanced heat transfer (Ming et al., 2018). The effects of a combination of pulsating flow, nanofluids, micro-fins tube, and magnetic field in the micro-fins tube were investigated (Naphon and Wiriyasart, 2018). Li et al. (2018d) numerically optimized the corrugation height of fin and angle of attack of delta winglet type vortex generators in a wavy fin-and-tube heat exchanger.

The most popular compound technique nowadays is probably the use of nanofluid with any other enhancement methods. Nanofluids were employed in conjunction with a diverging microchannel with a staggered dimpled surface to improve overall heat-transfer characteristics (Nandakrishnan et al., 2018). Using Cu-water nanofluid as a cooling fluid in a thin channel with wall mounted blunt ribs was considered (Pal and Bhattacharyya, 2018). Sheikholeslami et al. (2018a, b, c) numerically modeled alumina nanofluid magnetohydrodynamic convective heat transfer in a permeable medium, Lorentz forces effect on nano-enhanced PCM heat transfer during solidification in a porous energy storage system, and nanofluid heat transfer augmentation and exergy loss inside a pipe equipped with innovative turbulators, respectively. Lattice Boltzmann method (LBM) was applied for numerical simulation of forced convection in a channel with extended surface using three different nanofluids (Mohebbi et al., 2018). LBM was also applied to investigate the effects of uniform vertical magnetic field on thermo-hydrodynamics of nanofluid in a partially porous channel (Ashorynejad and Zarghami, 2018). The convective heat transfer, friction factor, effectiveness and number of transfer units of Fe_3O_4/water nanofluids flow in a double pipe U-bend heat exchanger and with twisted tape inserts were estimated experimentally (Kumar et al., 2018a). Heat transfer enhancement using non-Newtonian nanofluids in a shell and helical coil heat exchanger was analyzed (Naik and Vinod, 2018).

Kim et al. (2018) constructed composites featuring micropillar arrays and a porous graphene networks to enhance nucleate boiling performance; but found that as graphene coating proceeded, the enhancement ratios of the CHF and the boiling HTC of the composite decreased, probably because the porous graphene network occupied the vacant space between the pillars. It is not necessarily true that any combination will produce accumulative positive results.

5. Conduction

In the category of heat conduction, we restrict the literature on micro/nanoscale heat conduction and thermal conductivity in PCMs for energy storage. In this context, the articles are categorized into nanofilms, interfaces, high-conductivity carbon materials in various forms (carbon nanotubes, graphene, and diamond), and PCMs.

5.1 Nanofilm

Metallic or semiconductor nanofilms exist in many micro/nano devices or systems. To overcome the mechanical brittleness in expanded graphite (EG) films, which exhibit excellent thermal, electric properties and electromagnetic interference (EMI) shielding for application to flexible electronics, flexible graphene (GE) was introduced to endow EG films with good flexibility and mechanical properties (Liu et al., 2018c). Qiu et al. (2018) provided a review on advances in thermal transport properties research at nanoscale in China. The effects of electrical contact resistance on the measurement of thermal conductivity and Wiedemann-Franz law for different metallic nanostructures were discussed (Wang et al., 2018d).

Recent studies confirmed a dramatic decrease in the electrical and thermal conductivities when the dimension is comparable or even smaller than the electron mean free path (Wang et al., 2018d). The thermoelectric performance of few-quintuple Sb_2Te_3 nanofilms was much larger than that of bulk (Li et al., 2018e). Gao et al. (2018) reported phononic thermal transport properties of monolayer C_3N and compared with graphene by using first-principles calculations combined with phonon Boltzmann transport equation.

5.2 Interfaces

Thermal interface exists between two components. Using MD simulations, Ma et al. (2018b) investigated the impact of interfacial charge decoration on the Kapitza resistance between graphene and water and found that the Kapitza resistance could be substantially reduced by up to 97% compared to the case without charge decoration. Xu et al (2018a) studied the mechanism of thermal transport, the enhancement of thermal conductivity in polymer nanocomposites/fibers, and their potential application as thermal interface materials. Interfacial thermal conductance and effective thermal conductivity of both freestanding and silica supported in-plane graphene/hexagonal boron nitride heterostructures were investigated via MD simulations (Li et al., 2018a). Yao et al. (2018) reported vertically aligned and interconnected SiC nanowire networks as efficient fillers for polymer composites, achieving significantly enhanced thermal conductivity. The effect of the localized strain field on the interfacial thermal resistance of graphene nanoribbons was exploited using nonequilibrium MD simulations (Xue et al., 2018a). To improve the inter-layer heat transfer of graphite films, a simple interfacial modification with a short duration mixed-acid treatment was proposed (Wang et al., 2018a). A critical particle size has been identified above which thermal conductivity enhancement in metal nanoparticle-polymer composites can be achieved, caused by the interplay between high particle thermal conductivity and the added electron-phonon and phonon-phonon thermal boundary resistance brought by the particle fillers (Lu et al., 2018).

Graphene-metal nanocomposites are promising materials to address the heat dissipation problems in nanoscale electronic and computing devices. A low resistance interface between metal and graphene contact is crucial for the development of highly efficient nanodevices. using MD simulations, Namsani and Singh (2018) investigated the thermal conductance across the gold-graphene interface for various thicknesses of the graphene layer and temperatures.

5.3 CNT, Graphene, and Diamond

1-D structures such as CNT, 2-D structures (graphene), and diamond have recently received increasing attention of research because of their high heat transfer ability. The sequential process of current-induced thermal annealing on improving the structure, electrical and thermal conductivities of chemical vapor deposition grown CNT bundles was studied and a 19-fold thermal conductivity increase was found (Xie et al., 2018). Graphene has an ultra-high thermal conductivity along its basin plane. However, the thermal conductivity of graphene/metal composites is still far below the expectation, due primarily to the lack of sufficient graphene alignment in the metal matrix. Chu et al. (2018) reported an efficient route to prepare the graphene nanoplatelet (GNP)/Cu composites with highly aligned GNPs by a vacuum filtration method followed by spark plasma sintering, leading to a surprisingly high in-plane thermal conductivity of 525 W/mK. Thermal rectification in defect-engineered graphene with asymmetric hole arrangements was assessed via MD simulations; results showed that increase in porosity produced more significant thermal rectification (Nobakht et al., 2018). Unexpected thermal conductivity enhancement in pillared graphene nanoribbon with isotopic resonance was found (Ma et al., 2018a). Diamond and graphene heat spreaders were placed onto GaN high-electron-mobility transistor (HEMT) devices for ultra-high heat-flux thermal management using serpentine minichannel heat sinks (Al-Neama et al., 2018). An innovative solution to chemically bond Cu to diamond via coating diamond reinforcements with Cu particles through a gas–solid nucleation and growth process has been investigated and formation of Cu nanodots on diamond surface can improve heat transfer in Cu/diamond composites (Guillemet et al., 2018).

5.4 Phase-Change Materials (PCMs)

Use of PCMs for thermal energy storage and management in building technology and energy industry plays a major role in the transition towards a low-carbon economy. A major drawback that seriously limits the application of PCMs in a latent heat thermal energy storage (LHTES) system is the low thermal conductivity. Various methods for enhancing the thermal conductivity and heat transfer of PCMs were reviewed (Zhang et al., 2018a; Qureshi et al., 2018). To improve the performance of lithium-ion power battery thermal management system, MWCNT-based, graphene-based and MWCNT/graphene-based composite PCMs were prepared and experimentally studied (Zou et al., 2018). The heat transfer enhancement using fins and nanoparticles for PCMs in a triplex-tube heat exchanger was numerically investigated (Abdulateef et al., 2018b; Mahdi and Nsofor, 2018).

6. Radiation and Solar Energy

6.1 Radiation

Agrawal et al. (2018) provided a comprehensive review on the fundamental electromagnetic dynamics governing light matter interaction in plasmonic semiconductor nanocrystals (NCs). Localized surface plasmon resonance in semiconductor NCs that results in resonant absorption, scattering, and near-field enhancement around the NC can be tuned across a wide optical spectral range from visible to far-infrared by synthetically varying doping level, and post synthetically via chemical oxidation and reduction, photochemical control, and electrochemical control. Emerging graphene quantum dots (GQDs) have received much attention for use as next-generation light-emitting diodes. High quantum yields in GQDs incorporated with boron oxynitride demonstrated promise for the use of GQDs in the field of low-cost, ecofriendly electroluminescent devices (Park et al., 2018). Thermal quenching, in which light emission experiences a loss with increasing temperature, broadly limits luminescent efficiency at higher temperature in optical materials. It is commonly caused by the increased activity of phonons that leverages the nonradiative relaxation pathways. Zhou et al. (2018) reported a kind of heat-favorable phonons existing at the surface of lanthanide-doped upconversion nanomaterials to combat thermal quenching. An approximately 2,000-fold enhancement in blue emission for 9.7 nm Yb3+-Tm3+ co-doped nanoparticles at 453 K was demonstrated. Nano titanium dioxide with excellent capabilities of refraction and absorption has been acknowledged as an efficient enhancer of radiative thermal insulation performance of fibrous materials. The methods of loading nano TiO_2 and optimizing the diameter of fibrous insulations were demonstrated (Yang et al., 2018).

A significant enhancement of the near-field radiative heat transfer through meshed photonic crystals was numerically demonstrated (Elzouka and Ndao, 2018). Near-field radiative transfer in spectrally tunable double-layer phonon-polaritonic metamaterials was numerically studied (Didari et al., 2018). Near-field thermal radiative transfer in many body systems composed of core-shell nanoparticles was investigated (Chen et al., 2018b). Realizing accurate nanometric gaps, necessary for near-field, has been and remains a formidable challenge. The fluctuations of nonequilibrium radiative heat transfer between two bodies both in the far-and near-field regimes were described, and in the near-field regime, the presence of surface polaritons makes this variance more than one order of magnitude larger than the mean flux (Biehs and Ben-Abdallah, 2018). An ~40-fold enhancement in the power output at nominally 60 nm gaps relative to the far field was demonstrated in a microfabricated thermophotovoltaic system (Fiorino et al., 2018) as the near-field may be leveraged to enhance photon flux to the photovoltaic cell.

6.2 Solar Energy

Solar energy is considered to be one of the most important alternatives to conventional fossil fuels, due to its ability to convert solar energy directly into heat or electricity without negative environmental impact. The addition of nanoparticles in a base fluid can augment solar radiation absorption, and thus, nanofluids can be used in solar collectors to replace absorber plates. Dugaria et al. (2018) modeled the performance of a direct absorption solar receiver using carbon based nanofluids under concentrated solar radiation. Recent advances in the applications of nanofluids in solar energy were reviewed (Elsheikh et al., 2018). Spectral investigation on solar energy absorption and visible light transmission through a glass-water louver was conducted (Cai and Guo, 2018). This innovative louver installed in buildings serves dual-purpose: harvesting solar energy and improving natural illumination.

7. High-Performance Heat-Exchange Devices

Samokhvalov et al. (2018) reviewed existing numerical models for predicting the HTC for hydrocarbon mixture condensation in a horizontal, slightly inclined, smooth tube in the structure of a spiral-wound heat exchanger. For optimizing the helically baffled shell-and-tube heat exchanger (HBHX) used in the liquefied natural gas process, the condensation heat transfer mechanism of the mixed hydrocarbon refrigerant flow condensation in shell side of HBHX was examined (Hu et al., 2018). The classical work of Webb (2018) on compact heat exchangers was republished. Recent investigations on use of nanofluids in heat exchangers including those carried out on plate heat exchangers, double-pipe heat exchangers, shell and tube heat exchangers, and compact heat exchangers were reviewed (Bahiraei et al., 2018). Heat transfer enhancement with the use of water-based polyaniline nanofluid was experimentally tested in vertical helically coiled tube heat exchanger (Bhanvase et al., 2018). The plate fin heat exchanger is a compact heat exchanger applied in many industries because of its high thermal performance. To enhance the heat transfer of plate fin heat exchanger further, three new kinds of wavy plate fins, namely perforated wavy fin, staggered wavy fin and discontinuous wavy fin, were proposed and investigated by simulations (Xue et al., 2018b).

Pulsating heat pipes (PHPs) are heat transfer devices that are widely utilized in electronic devices and energy systems. An experimental investigation was performed on the thermal performance of a PHP by applying graphene oxide nanofluid as working fluid (Nazari et al., 2018b). Sharif et al. (2018) provided a review on mechanism for improving vapor compression refrigeration system performance by using nanorefrigerants and nanolubricants. PHP applications in renewable energy systems, cooling electronic devices, heat recovery systems, among others, were reviewed (Nazari et al., 2018a).

References

Abbood, S.A., Wang, J., Wu, Z. and Sunden, B., Analysis of natural convection of Cu and TiO2 nanofluids inside nonconventional enclosures, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 315-332, 2018.

Abdulateef, A.M., Mat, S., Abdulateef, J., Sopian, K. and Al-Abidi, A.A., Geometric and design parameters of fins employed for enhancing thermal energy storage systems: a review, *Renew. Sustain. Energy Rev.*, vol. **82**, pp. 1620-1635, 2018a.

Abdulateef, A.M., Mat, S., Abdulateef, J., Sopian, K. and Al-Abidi, A.A., Thermal performance enhancement of triplex tube latent thermal storage using fins-nano-phase change material technique, *Heat Transf. Eng.*, vol. **39**, pp. 1067-1080, 2018b.

Aghakashi, V. and Saidi, M.H., Turbulent decaying swirling flow in a pipe, *Heat Transf. Res.*, vol. **49**, pp. 1559-1585, 2018.

Agrawal, A., Cho, S.H., Zandi, O., Ghosh, S., Johns, R.W. and Milliron, D.J., Localized surface plasmon resonance in semiconductor nanocrystals, *Chem. Rev.*, vol. **118**, pp. 3121-3207, 2018.

Al-Asad, M.T., Alkasmoul, F.S. and Wilson, M.C.T., Benefits of spanwise gaps in cylindrical vortex generators for conjugate heat transfer enhancement in micro-channels, *Appl. Therm. Eng.*, vol. **130**, pp. 571-586, 2018.

Ali, H.M., Ashraf, M.J., Giovannelli, A., Irfan, M., Bin Irshad, T., Hamid, H.M., Hassan, F. and Arshad, A., Thermal management of electronics: An experimental analysis of triangular, rectangular and circular pin-fin heat sinks for various PCMs, *Int. J. Heat Mass Transf.*, vol. **123**, pp. 272-284, 2018.

Al-Neama, A.F., Kapur, N., Summers, J. and Thompson, H.M., Thermal management of GaN HEMT devices using serpentine minichannel heat sinks, Appl. Therm. Eng., vol. 140, pp. 622-636, 2018.

Alrashed, A.A.A.A., Gharibdousti, M.S., Goodarzi, M., de Oliveira, L.R., Safaei, M.R. and Bandarra, E.P., Effects on thermophysical properties of carbon based nanofluids: Experimental data, modelling using regression, ANFIS and ANN, *Int. J. Heat Mass Transf.*, vol. **125**, pp. 920-932, 2018.

Arkharov, I.A., Arkharov, A.M., Navasardyan, E.S. and Dontzov, AV., Minimal surfaces as constant-energy surfaces for maximum heat and mass transfer efficiency in structured packing of the distillation column, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 143-159, 2018a.

Arkharov, I.A., Arkharov, AM., Navasardyan, E.S. and Chekhovich, V.A., Modeling of hydrodynamics in a porous structure of low temperature regenerator friction factor at low Reynolds' numbers, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 169-180, 2018b.

Arulprakasajothi, M., Elangovan, K., Chandrasekhar, U. and Suresh, S., Experimental study of a water-based titanium oxide nanofluid in a circular pipe with transition flow and conical strip inserts, *Heat Transf. Res.*, vol. **49**, pp. 439-456, 2018.

Asadi, A., Asadi, M., Rezaniakolaei, A., Rosendahl, L.A. and Wongwises, S., An experimental and theoretical investigation on heat transfer capability of $Mg(OH)_2$/MWCNT-engine oil hybrid nano-lubricant adopted as a coolant and lubricant fluid, *Appl. Therm. Eng.*, vol. **129**, pp. 577-586, 2018.

Ashorynejad, H.R. and Zarghami, A., Magnetohydrodynamics flow and heat transfer of Cu-water nanofluid through a partially porous wavy channel, *Int. J. Heat Mass Transf.*, vol. **119**, pp. 247-258, 2018.

Bahiraei, M., Rahmani, R., Yaghoobi, A., Khodabandeh, E., Mashayekhi, R. and Amani, M., Recent research contributions concerning use of nanofluids in heat exchangers: A critical review, *Appl. Therm. Eng.*, vol. **133**, pp. 137-159, 2018.

Bait, O. and Si-Ameur, M., Enhanced heat and mass transfer in solar stills using nanofluids: A review, *Sol. Energy*, vol. **170**, pp. 694-722, 2018.

Balaji, D., Velraj, R. and Murthy, M.V.R., A review of the role of passive techniques on heat transfer enhancement of horizontal tube falling film and flooded evaporators, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 239-282, 2018.

Bellos, E. and Tzivanidis, C., Enhancing the Performance of Evacuated and Non-Evacuated Parabolic Trough Collectors Using Twisted Tape Inserts, Perforated Plate Inserts and Internally Finned Absorber, *Energies*, vol. **11**, 1129, 2018.

Bergles, A.E., Nirmalan, V., Junkhan, G.H. and Webb, R.L., Bibliography on Augmentation of Convective Heat and Mass Transfer–II, Iowa State University, Ames, IA, 1983.

Bergles, A.E. and Manglik, R.M., Current progress and new development in enhanced heat and mass transfer, *J. Enhanc. Heat Transf.*, vol. **20**, pp. 1-15, 2013.

Bhanvase, B.A., Sayankar, S.D., Kapre, A., Fule, P.J. and Sonawane, S.H., Experimental investigation on intensified convective heat transfer coefficient of water based PANI nanofluid in vertical helical coiled heat exchanger, *Appl. Therm. Eng.*, vol. **128**, pp. 134-140, 2018.

Bianco, V., Marchitto, A., Scarpa, F. and Tagliafico, L.A., Computational fluid dynamics modeling of developing forced laminar convection flow of Al(2)O(3)-water nanofluid in a two-dimensional rectangular section channel, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 387-398, 2018.

Biehs, S.A. and Ben-Abdallah, P., Fluctuations of radiative heat exchange between two bodies, *Phys. Rev. B*, vol. **97**, 201406, 2018.

Burkov, I.A., Zherdev, A.A., Pushkarev, A.V., Tsiganov, D.I. and Shakurov, A.V., Simulation of fluid hypothermia for robot-assisted prostatectomy, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 121-136, 2018.

Cai, Y.M. and Guo, Z., Spectral Monte Carlo simulation of collimated solar irradiation transfer in a water-filled prismatic louver, *Appl. Opt.*, vol. **57**, pp. 3021-3030, 2018.

Cao, X.L., Yuan, Y.P., Xiang, B., Sun, L.L. and Zhang, X.X., Numerical investigation on optimal number of longitudinal fins in horizontal annular phase change unit at different wall temperatures, *Energy Build.*, vol. **158**, pp. 384-392, 2018.

Carletti, C., Bikic, S., Montante, G. and Paglianti, A., Mass transfer in dilute solid-liquid stirred tanks, *Ind. Eng. Chem. Res.*, vol. **57**, pp. 6505-6515, 2018.

Chai, L. and Wang, L., Thermal-hydraulic performance of interrupted microchannel heat sinks with different rib geometries in transverse microchambers, *Int. J. Therm. Sci.*, vol. **127**, pp. 201-212, 2018.

Chamoli, S., Lu, R.X., Xie, J. and Yu, P., Numerical study on flow structure and heat transfer in a circular tube integrated with novel anchor shaped inserts, *Appl. Therm. Eng.*, vol. **135**, pp. 304-324, 2018.

Chang, S.W., Liou, T.M., Yu, K.C. and Huang, S.S., Thermal-hydraulic performance of longitudinal wavy rib along wavy two-pass channel, *Appl. Therm. Eng.*, vol. **133**, pp. 224-236, 2018.

Chen, J.N., Xu, R.N., Zhang, Z., Chen, X., Ouyang, X.L., Wang, G.Y. and Jiang, P.X., Phenomenon and mechanism of spray cooling on nanowire arrayed and hybrid micro/nanostructured surfaces, *J. Heat Transf.*, vol. **140**, 112401, 2018a.

Chen, J., Zhao, C.Y. and Wang, B.X., Near-field thermal radiative transfer in assembled spherical systems composed of core-shell nanoparticles, *J. Quant. Spectro. Rad. Transf.*, vol. **219**, pp. 304-312, 2018b.

Chimres, N., Wang, C.C. and Wongwises, S., Optimal design of the semi-dimple vortex generator in the fin and tube heat exchanger, *Int. J. Heat Mass Transf.*, vol. **120**, pp. 1173-1186, 2018.

Chu, K., Wang, X.H., Wang, F., Li, Y.B., Huang, D.J., Liu, H., Ma, W.L., Liu, F.X. and Zhang, H., Largely enhanced thermal conductivity of graphene/copper composites with highly aligned graphene network, *Carbon*, vol. **127**, pp. 102-112, 2018.

Cui, X.Y., Guo, J.F., Huai, X.L., Cheng, K.Y., Zhang, H.Y. and Xiang, M.R., Numerical study on novel airfoil fins for printed circuit heat exchanger using supercritical CO2, *Int. J. Heat Mass Transf.*, vol. **121**, pp. 354-366, 2018.

da Silva, B.N.M., Assad, G.E. and de Lima, J.A., Unsteady magnetohydrodynamic channel flow with hall and ion-slip effects: the integral transform solution procedure, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 367-386, 2018.

de Lemos, M.J.S. and Carvalho, P.H.S., The effects of porosity and mass-to-thermal drive ratio on aiding and opposing convection in porous enclosures, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 399-419, 2018.

Didari, A., Elcioglu, E.B., Okutucu-Ozyurt, T. and Menguc, M.P., Near-field radiative transfer in spectrally tunable double-layer phonon-polaritonic metamaterials, *J. Quant. Spectro. Rad. Transf.*, vol. **212**, pp. 120-127, 2018.

Dugaria, S., Bortolato, M. and Col, D.D., Modelling of a direct absorption solar receiver using carbon based nanofluids under concentrated solar radiation, *Renew. Energy*, vol. **128**, pp. 495-508, 2018,

Elsheikh, A.H., Sharshir, S.W., Mostafa, M.E., Essa, F.A. and Ali, M.K.A., Applications of nanofluids in solar energy: A review of recent advances, *Renew. Sustain. Energy Rev*., vol. **82**, pp. 3483-3502, 2018.

Elzouka, M. and Ndao, S., Meshed doped silicon photonic crystals for manipulating near-field thermal radiation, *J. Quant. Spectro. Rad. Transf.*, vol. **204**, pp. 56-62, 2018.

Fiorino, A., Zhu, L.X., Thompson, D., Mittapally, R., Reddy, P. and Meyhofer, E., Nanogap near-field thermophovoltaics, *Nature Nanotech*., vol. **13**, pp. 806-811, 2018.

Ganesan, U.K., Soni, K., Sivan, S., Ghosh, K., Thansekhar, M.R. and Babu, P.D., Modified surfaces using seamless graphene/carbon nanotubes based nanostructures for enhancing pool boiling heat transfer, *Exp. Therm. Fluid Sci.*, vol. **96**, pp. 493-506, 2018.

Yan Gao, Haifeng Wang, Maozhu Sun, Yingchun Ding, Lichun Zhang, Li, Q.F., First-principles study of intrinsic phononic thermal transport in monolayer C_3N, *Physica E*, vol. 99, pp. 194-201, 2018.

Garcia, A., Herrero-Martin, R., Solano, J.P. and Perez-Garcia, J., The role of insert devices on enhancing heat transfer in a flat-plate solar water collector, *Appl. Therm. Eng*., vol. **132**, pp. 479-489, 2018.

Guillemet, T., Heintz, H.M., Mortaigne, B., Lu, Y.F., and Silvain, J.F., Formation of Cu nanodots on diamond surface to improve heat transfer in Cu/D composites, *Adv. Eng. Mater*., vol. **20**, 1700894, 2018.

Gupta, S.K. and Misra, R.D., An experimental investigation on flow boiling heat transfer enhancement using Cu-TiO2 nanocomposite coating on copper substrate, *Exp. Therm. Fluid Sci.*, vol. **98**, pp. 406-419, 2018.

Han, H.Z., Yang, L.B., Chen, X. and Li, B.X., Numerical and experimental study of flow and heat transfer in outwardly convex corrugated tubes with a twisted tape insert, *Heat Transf. Res*., vol. **49**, pp. 1605-1628, 2018.

Hassanpour, M., Vaferi, B. and Masoumi, M.E., Estimation of pool boiling heat transfer coefficient of alumina water-based nanofluids by various artificial intelligence (AI) approaches, *Appl. Therm. Eng*., vol. **128**, pp. 1208-1222, 2018.

He, C.X. and Liu, Y.Z., Jet impingement heat transfer of a lobed nozzle: Measurements using temperature-sensitive paint and particle image velocimetry, *Int. J. Heat Fluid Flow*, vol. **71**, pp. 111-126, 2018.

Heydari, A., Akbari, O.A., Safaei, M.R., Derakhshani, M., Alrashed, A., Mashayekhi, R., Shabani, G., Zarringhalam, M. and Nguyen, T.K., The effect of attack angle of triangular ribs on heat transfer of nanofluids in a microchannel, *J. Therm. Anal. Calorim.,* vol. **131**, pp. 2893-2912, 2018.

Hosseinian, A., Isfahani, A.H.M. and Shirani, E., Experimental investigation of surface vibration effects on increasing the stability and heat transfer coefficient of MWCNTs-water nanofluid in a flexible double pipe heat exchanger, *Exp. Therm. Fluid Sci.*, vol. **90**, pp. 275-285, 2018.

Hosseinnezhad, R., Akbari, O.A., Afrouzi, H.H., Biglarian, M., Koveiti, A. and Toghraie, D., Numerical study of turbulent nanofluid heat transfer in a tubular heat exchanger with twin twisted-tape inserts, *J. Therm. Anal. Calorim.,* vol. **132**, pp. 741-759, 2018.

Hotta, T.K., Harsha, P.S. and Venkateshan, S.P., Experimental investigation of mixed convection and surface radiation heat transfer from protruding discrete heat sources mounted on a vertical channel, *Heat Transf. Res*., vol. **49**, pp. 965-977, 2018.

Hu, H.T., Yang, G.C., Ding, G.L., Chen, J., Yang, W.G. and Hu, S.Y., Heat transfer characteristics of mixed hydrocarbon refrigerant flow condensation in shell side of helically baffled shell-and-tube heat exchanger, *Appl. Therm. Eng*., vol. **133**, pp. 785-796, 2018.

Huang, K. and Deng, X.H., Enhanced heat and mass transfer of falling liquid films in vertical tubes, *J. Enhanc. Heat Transf*., vol. **25**, pp. 79-96, 2018.

Iasiello, M., Cunsolo, S., Bianco, N., Chiu, W.K.S. and Naso, V., Fully developed convection heat transfer in open-cell foams, *J. Enhanc. Heat Transf*., vol. **25**, pp. 333-346, 2018.

Isaev, S., Leontiev, A., Chudnovsky, Y. and Popov, I., Vortex heat transfer enhancement in narrow channels with a single oval-trench dimple oriented at different angles to the flow, *J. Enhanc. Heat Transf*., vol. **25**, pp. 579-604, 2018.

Ji, C.Z., Qin, Z.H., Low, Z., Dubey, S., Choo, F.H. and Duan, F., Non-uniform heat transfer suppression to enhance PCM melting by angled fins, *Appl. Therm. Eng*., vol. **129**, pp. 269-279, 2018.

Kamkari, B. and Groulx, D., Experimental investigation of melting behaviour of phase change material in finned rectangular enclosures under different inclination angles, *Exp. Therm. Fluid Sci.*, vol. **97**, pp. 94-108, 2018.

Kashyap, U., Das, K. and Debnath, B.K., Effect of surface modification of a rectangular vortex generator on heat transfer rate from a surface to fluid, *Int. J. Therm. Sci*., vol. **127**, pp. 61-78, 2018.

Keklikcioglu, O. and Ozceyhan, V., Experimental investigation on heat transfer enhancement in a circular tube with equilateral triangle cross sectioned coiled-wire inserts, *Appl. Therm. Eng*., vol. **131**, pp. 686-695, 2018.

Khoshvaght-Aliabadi, M., Khaligh, S.F. and Tavassoli, Z., An investigation of heat transfer in heat exchange devices with spirally-coiled twisted-ducts using nanofluid, *Appl. Therm. Eng*., vol. **143**, pp. 358-375, 2018.

Kieu, H.T., Liu, B., Zhang, H., Zhou, K. and Law, W.K., Molecular dynamics study of water evaporation enhancement through a capillary graphene bilayer with tunable hydrophilicity, *Appl. Surf. Sci*., vol. **452**, pp. 372-380, 2018.

Kim, J.M., Park, S.C., Kong, B., Lee, H.B.R. and Ahn, H.S., Effect of porous graphene networks and micropillar arrays on boiling heat transfer performance, *Exp. Therm. Fluid Sci.*, vol. **93**, pp. 153-164, 2018.

Krishna, P.M.M., Deepu, M. and Shine, S.R., Numerical investigation of wavy microchannels with rectangular cross section, *J. Enhanc. Heat Transf*., vol. **25**, pp. 293-313, 2018.

Kumar, R. and Chand, P., Performance prediction of extended surface absorber solar air collector with twisted tape inserts, *Sol. Energy*, vol. **169**, pp. 40-48, 2018.

Kumar, C.S. and Pattamatta, A., Assessment of heat transfer enhancement using metallic porous foam configurations in laminar slot jet impingement: an experimental study, *J. Heat Transf*., vol. **140**, 022202, 2018.

Kumar, N., Bhramara, P., Kirubeil, A., Sundar, L.S., Singh, M.K. and Sousa, A., Effect of twisted tape inserts on heat transfer, friction factor of Fe3O4 nanofluids flow in a double pipe U-bend heat exchanger, *Int. Commun. Heat Mass Transf.*, vol. **95**, pp. 55-62, 2018a.

Kumar, N., Raza, Q. and Raj, R., Surfactant aided bubble departure during pool boiling, *Int. J. Therm. Sci*., vol. **131**, pp. 105-113, 2018b.

Kumar, B., Srivastava, G.P., Kumar, M. and Patil, A.K., A review of heat transfer and fluid flow mechanism in heat exchanger tube with inserts, *Chem. Eng. Process*, vol. 123, pp. 126-137, 2018c.

Kuzenov, V.V. and Ryzhkov, S.V., Approximate calculation of convective heat transfer near hypersonic aircraft surface, *J. Enhanc. Heat Transf*., vol. **25**, pp. 181-193, 2018.

Kuzma-Kichta, Y. and Leontiev, A., Choice and justification of the heat transfer intensification methods, *J. Enhanc. Heat Transf*., vol. **25**, pp. 465-564, 2018.

Li, T., Tang, Z.N., Huang, Z.X. and Yu, J., Substrate effects on the thermal performance of in-plane graphene/hexagonal boron nitride heterostructures, *Carbon*, vol. **130**, pp. 396-400, 2018a.

Li, N., Wu, L., Yu, C.L., Dai, H.Y., Wang, T., Dong, Z.C. and Jiang, L., Ballistic jumping drops on superhydrophobic surfaces via electrostatic manipulation, *Adv. Mater*., vol. **30,** 1703838, 2018b.

Li, Z., Xu, X.C., Li, K.J., Chen, Y.Y., Ke, Z.Q., Wang, S., Chen, H.H., Huang, G.L., Chen, C.L. and Chen, C.H., Bio-inspired self-agitator for convective heat transfer enhancement, *Appl. Phys. Lett*., vol. **113**, 113703, 2018c.

Li, W., Khan, T.A., Tang, W.Y. and Minkowycz, W.J., Numerical study and optimization of corrugation height and angle of attack of vortex generator in the wavy fin-and-tube heat exchanger, *J. Heat Transf*., vol. **140**, 111801, 2018d.

Li, Z., Miao, N.H., Zhou, J., Sun, Z.M., Liu, Z.K. and Xu, H.B., High thermoelectric performance of few-quintuple Sb_2Te_3 nanofilms, *Nano Energy*, vol. **43**, pp. 285-290, 2018e.

Liu, Y.X., Liu, Z.Y., Wang, Y., Yin, Y.S., Pan, J., Zhang, J. and Wang, Q., Simultaneous absorption of SO2 and NO from flue gas using ultrasound/Fe2+/heat coactivated persulfate system, *J. Hazardous Mater*., vol. **342**, pp. 326-334, 2018a.

Liu, J., Hussain, S., Wang, J.S., Wang, L., Xie, G.N. and Sunden, B., Heat transfer enhancement and turbulent flow in a high aspect ratio channel (4:1) with ribs of various truncation types and arrangements, *Int. J. Therm. Sci*., vol. **123**, pp. 99-116, 2018b.

Liu, Y.H., Zeng, J., Han, D., Wu, K., Yu, B.W., Chai, S.G., Chen, F. and Fu, Q., Graphene enhanced flexible expanded graphite film with high electric, thermal conductivities and EMI shielding at low content, *Carbon*, vol. **133**, pp. 435-445, 2018c.

Lu, Z.X., Wang, Y. and Ruan, X.L., The critical particle size for enhancing thermal conductivity in metal nanoparticle-polymer composites, *J. Appl. Phys*., vol. **123**, 074302, 2018.

Luo, L., Yan, H., Yang, S.Y., Du, W., Wang, S.T., Sunden, B. and Zhang, X.H., Convergence angle and dimple shape effects on the heat transfer characteristics in a rotating dimple-pin fin wedge duct, *Numer. Heat Transf. A*, vol. **74**, pp. 1611-1635, 2018.

Ma, D.K., Wan, X. and Yang, N., Unexpected thermal conductivity enhancement in pillared graphene nanoribbon with isotopic resonance, *Phys. Rev. B*, vol. **98**, 245420, 2018a.

Ma, Y.L., Zhang, Z.W., Chen, J.G., Saaskilahti, K., Volz, S. and Chen, J., Ordered water layers by interfacial charge decoration leading to an ultra-low Kapitza resistance between graphene and water, *Carbon*, vol. **135**, pp. 263-269, 2018b.

Mahbubul, I.M., Khan, M.M.A., Ibrahim, N.I., Ali, H.M., Al-Sulaiman, F.A. and Saidur, R., Carbon nanotube nanofluid in enhancing the efficiency of evacuated tube solar collector, *Renew. Energy*, vol. **121**, pp. 36-44, 2018.

Mahdi, J.M. and Nsofor, E.C., Solidification enhancement of PCM in a triplex-tube thermal energy storage system with nanoparticles and fins, *Appl. Energy*, vol. **211**, pp. 975-986, 2018.

Meyer, J.P. and Abolarin, S.M., Heat transfer and pressure drop in the transitional flow regime for a smooth circular tube with twisted tape inserts and a square-edged inlet, *Int. J. Heat Mass Transf.*, vol. **117**, pp. 11-29, 2018.

Ming, T.Z., Cai, C.J., Yang, W., Shen, W.Q. and Gan, T., Optimization of dimples in microchannel heat sink with impinging jets - Part A: mathematical model and the influence of dimple radius, *J. Therm. Sci.*, vol. **27**, pp. 195-202, 2018.

Modak, M., Chougule, S.S. and Sahu, S.K., An experimental investigation on heat transfer characteristics of hot surface by using CuO-water nanofluids in circular jet impingement cooling, *J. Heat Transf.*, vol. **140**, 012401, 2018a.

Modak, M., Sharma, A.K. and Sahu, S.K., An experimental investigation on heat transfer enhancement in circular jet impingement on hot surfaces by using Al2O3/water nano-fluids and aqueous high-alcohol surfactant solution, *Exp. Heat Transf.*, vol. **31**, pp. 275-296, 2018b.

Mohebbi, R., Rashidi, M.M., Izadi, M., Sidik, N.A.C. and Xian, H.W., Forced convection of nanofluids in an extended surfaces channel using lattice Boltzmann method, *Int. J. Heat Mass Transf.*, vol. **117**, pp. 1291-1303, 2018.

Nadda, R., Kumar, A., Maithani, R. and Kumar, R., Investigation of thermal and hydrodynamic performance of impingement jets solar air passage with protrusion with combination arc obstacle on the heated plate, *Exp. Heat Transf.*, vol. **31**, pp. 232-250, 2018.

Naik, H. and Tiwari, S., Effect of aspect ratio and arrangement of surface-mounted circular cylinders on heat transfer characteristics, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 443-463, 2018.

Naik, B.A.K. and Vinod, A.V., Heat transfer enhancement using non-Newtonian nanofluids in a shell and helical coil heat exchanger, *Exp. Therm. Fluid Sci.*, vol. **90**, pp. 132-142, 2018.

Namsani, S. and Singh, J.K., Enhancement of Thermal Energy Transport across the Gold-Graphene Interface Using Nanoscale Defects: A Molecular Dynamics Study, *J. Phys. Chem. C*, vol. **122**, pp. 2113-2121, 2018.

Nandakrishnan, S.L., Deepu, M. and Shine, S.R., Numerical investigation of heat-transfer enhancement in a dimpled diverging microchannel with Al2O3-water nanofluid, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 347-365, 2018.

Naphon, P. and Wiriyasart, S., Experimental study on laminar pulsating flow and heat transfer of nanofluids in micro-fins tube with magnetic fields, *Int. J. Heat Mass Transf.*, vol. **118**, pp. 297-303, 2018.

Nasersharifi, Y., Kaviany, M. and Hwang, G., Pool-boiling enhancement using multilevel modulated wick, *Appl. Therm. Eng.*, vol. **137**, pp. 268-276, 2018.

Nazari, M.A., Ahmadi, M.H., Ghasempour, R., Shafii, M.B., Mahian, O., Kalogirou, S. and Wongwises, S., A review on pulsating heat pipes: From solar to cryogenic applications, *Appl. Energy*, vol. **222**, pp. 475-484, 2018a.

Nazari, M.A., Ghasempour, R., Ahmadi, M.H., Heydarian, G. and Shafii, M.B., Experimental investigation of graphene oxide nanofluid on heat transfer enhancement of pulsating heat pipe, *Int. Commun. Heat Mass Transf.*, vol. **91**, pp. 90-94, 2018b.

Niu, X.J., Yuan, H.J., Quan, C. and Zhao, L., Dryout quality prediction for boiling two-phase flow in vertical helically coiled tubes, *Appl. Therm. Eng.*, vol. **128**, pp. 982-992, 2018.

Nobakht, A.Y., Gandomi, Y.A., Wang, J.Q., Bowman, M.H., Marable, D.C., Garrison, B.E, Kim, D. and Shin, S., Thermal rectification via asymmetric structural defects in graphene, *Carbon*, vol. **132**, pp. 565-572, 2018.

Oktent, K. and Biyikoglu, A., Effect of air bubble injection on the overall heat transfer coefficient, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 195-210, 2018.

Oneissi, M., Habchi, C., Russeil, S., Lemenand, T. and Bougeard, D., Heat transfer enhancement of inclined projected winglet pair vortex generators with protrusions, *Int. J. Therm. Sci.*, vol. **134**, pp. 541-551, 2018.

Osorio, M., Moreno, F.L., Raventós, M., Hernández, E. and Ruiz, Y., Progressive stirred freeze-concentration of ethanol-water solutions, *J. Food Eng.*, vol. **224**, pp. 71-79, 2018.

Pal, S.K. and Bhattacharyya, S., Enhanced heat transfer of Cu-water nanofluid in a channel with wall mounted blunt ribs, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 61-78, 2018.

Park, M., Yoon, H., Lee, J., Kim, J., Lee, J., Lee, S.E., Yoo, S. and Jeon, S., Efficient Solid-State Photoluminescence of Graphene Quantum Dots Embedded in Boron Oxynitride for AC-Electroluminescent Device, *Adv. Mater.*, vol. **30,** 18029951, 2018.

Perao, L.H., Zdanski, P.S.B. and Vaz, M., Conjugate heat transfer in channels with heat-conducting inclined fins, *Numer. Heat Transf. A*, vol. **73**, pp. 75-93, 2018.

Qiu, L., Zhu, N., Zou, H.Y., Feng, Y.H., Zhang, X.X. and Tang, D.W., Advances in thermal transport properties at nanoscale in China, *Int. J. Heat Mass Transf.*, vol. **125**, pp. 413-433, 2018.

Quan, X.J., Chen, S., Li, J.J. and Cheng, P., Enhanced dropwise condensation by oil infused nano-grass coatings on outer surface of a horizontal copper tube, *Int. Commun. Heat Mass Transf.*, vol. **91**, pp. 11-16, 2018.

Qureshi, Z.A., Ali, H.M. and Khushnood, S., Recent advances on thermal conductivity enhancement of phase change materials for energy storage system: A review, *Int. J. Heat Mass Transf.*, vol. **127**, pp. 838-856, 2018.

Rao, Y., Jet impingement heat transfer in narrow channels with different pin fin configurations on target surfaces, *J. Heat Transf.*, vol. **140**, 072201, 2018.

Rashidi, S., Mahian, O. and Languri, E.M., Applications of nanofluids in condensing and evaporating systems: A review, *J. Therm. Anal. Calorim.,* vol. **131**, pp. 2027-2039, 2018a.

Rashidi, S., Rahbar, N., Valipour, M.S. and Esfahani, J.A., Enhancement of solar still by reticular porous media: Experimental investigation with exergy and economic analysis, *Appl. Therm. Eng.*, vol. **130**, pp. 1341-1348, 2018b.

Rashidi, S., Kashefi, M.H. and Hormozi, F., Potential applications of inserts in solar thermal energy systems – A review to identify the gaps and frontier challenges, *Sol. Energy*, vol. **171**, pp. 929-952, 2018c.

Samadifar, M. and Toghraie, D., Numerical simulation of heat transfer enhancement in a plate-fin heat exchanger using a new type of vortex generators, *Appl. Therm. Eng*., vol. **133**, pp. 671-681, 2018.

Samokhvalov, Y., Kolesnikov, A., Krotov, A., Parkin, A., Navasardyan, E. and Arkharov, I., Heat transfer in the structure of a spiral-wound heat exchanger for liquefied natural gas production: review of numerical models for the heat-transfer coefficient of condensation for a hydrocarbon mixture in a horizontal tube, *J. Enhanc. Heat Transf*., vol. **25**, pp. 109-120, 2018.

Sandhu, H., Gangacharyulu, D. and Singh, M.K., Experimental investigations on the cooling performance of microchannels using alumina nanofluids with different base fluids, *J. Enhanc. Heat Transf*., vol. **25**, pp. 283-291, 2018.

Sarafraz, M.M., Nikkhah, V., Nakhjavani, M. and Arya, A., Thermal performance of a heat sink microchannel working with biologically produced silver-water nanofluid: Experimental assessment, *Exp. Therm. Fluid Sci*., vol. **91**, pp. 509-519, 2018.

Selimefendigil, F., Pulsating hybrid nanofluids double slot jets impingement onto an isothermal wall, *Heat Transf. Res*., vol. **49**, pp. 173-188, 2018.

Settar, A., Abboudi, S. and Lebaal, N., Effect of inert metal foam matrices on hydrogen production intensification of methane steam reforming process in wall-coated reformer, *Int. J. Hydrogen Energy*, vol. **43**, pp. 12386-12397, 2018.

Sharif, M.Z., Azmi, W.H., Mamat, R. and Shaiful, A., Mechanism for improvement in refrigeration system performance by using nanorefrigerants and nanolubricants - A review, *Int. Commun. Heat Mass Transf.*, vol. **92**, pp. 56-63, 2018.

Sharma, C.S., Stamatopoulos, C., Suter, R., von Rohr, P.R. and Poulikakos, D., Rationally 3D-Textured Copper Surfaces for Laplace Pressure, Imbalance-Induced Enhancement in Dropwise Condensation, *ACS Appl. Mater. Inter*., vol. **10**, pp. 29127-29135, 2018.

Sheikholeslami, M., Shehzad, S.A., Li, Z.X. and Shafee, A., Numerical modeling for alumina nanofluid magnetohydrodynamic convective heat transfer in a permeable medium using Darcy law, *Int. J. Heat Mass Transf*., vol. **127**, pp. 614-622, 2018a.

Sheikholeslami, M., Li, Z.X. and Shafee, A., Lorentz forces effect on NEPCM heat transfer during solidification in a porous energy storage system, *Int. J. Heat Mass Transf*., vol. **127**, pp. 665-674, 2018b.

Sheikholeslami, M., Jafaryar, M., Saleem, S., Li, Z.X., Shafee, A. and Jiang, Y., Nanofluid heat transfer augmentation and exergy loss inside a pipe equipped with innovative turbulators, *Int. J. Heat Mass Transf*., vol. **126**, pp. 156-163, 2018c.

Shin, D.H., Baek, S.H. and Ko, H.S., Analysis of counter flow of corona wind for heat transfer enhancement, *Heat Mass Transf*., vol. **54**, pp. 841-854, 2018.

Siavashi, M., Bahrami, H. and Aminian, E., Optimization of heat transfer enhancement and pumping power of a heat exchanger tube using nanofluid with gradient and multi-layered porous foams, *Appl. Therm. Eng*., vol. **138**, pp. 465-474, 2018.

Singh, I. and Singh, S., CFD analysis of solar air heater duct having square wave profiled transverse ribs as roughness elements, *Sol. Energy*, vol. **162**, pp. 442-453, 2018.

Skullong, S., Promthaisong, P., Promvonge, P., Thianpong, C. and Pimsarn, M., Thermal performance in solar air heater with perforated-winglet-type vortex generator, *Sol. Energy*, vol. **170**, pp. 1101-1117, 2018.

Sobhani, M. and Behzadmehr, A., Investigation of thermo-fluid behavior of mixed convection heat transfer of different dimples-protrusions wall patterns to heat transfer enhancement, *Heat Mass Transf.*, vol. **54**, pp. 3219-3229, 2018.

Sozen, A., Ciftci, E., Kecel, S., Guru, M., Variyenli, H.I. and Karakaya, U., Usage of a diatomite-containing nanofluid as the working fluid in a wickless loop heat pipe: experimental and numerical study, *Heat Transf. Res.*, vol. **49**, pp. 1721-1744, 2018.

Sunakraneni, S., Puliyeri, V. and Prakash, K.A., Fluid flow and heat transfer characteristics past two tandem elliptic cylinders: a numerical study, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 421-441, 2018.

Sur, A., Lu, Y., Pascente, C., Ruchhoeft, P. and Liu, D., Pool boiling heat transfer enhancement with electrowetting, *Int. J. Heat Mass Transf.*, vol. **120**, pp. 202-217, 2018.

Suri, A.R.S., Kumar, A. and Maithani, R., Experimental determination of enhancement of heat transfer in a multiple square perforated twisted tape inserts heat exchanger tube, *Exp. Heat Transf.*, vol. **31**, pp. 85-105, 2018.

Surtaev, A., Kuznetsov, D., Serdyukov, V., Pavlenko, A., Kalita, V., Komlev, D., Ivannikov, A. and Radyuk, A., Structured capillary-porous coatings for enhancement of heat transfer at pool boiling, *Appl. Therm. Eng.*, vol. **133**, pp. 532-542, 2018.

Tabassum, T., Hasan, M. and Begum, L., Thermal energy storage through melting of a commercial phase-change material in a horizontal cylindrical annulus, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 211-237, 2018.

Terekhov, V.I., Khafaji, H.Q. and Gorbachev, M.V., Heat and mass transfer enhancement in laminar forced convection wet channel flows with uniform wall heat flux, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 565-577, 2018.

Tharayil, T., Asirvatham, L.G., Rajesh, S. and Wongwises, S., Effect of nanoparticle coating on the performance of a miniature loop heat pipe for electronics cooling applications, *J. Heat Transf.*, vol. **140**, 022401, 2018.

Wang, H., Wang, S.K., Lu, W.B., Li, M., Gu, Y.Z., Zhang, Y.Y. and Zhang, Z.G., Through-thickness thermal conductivity enhancement of graphite film/epoxy composite via short duration acidizing modification, *Appl. Surf. Sci.*, vol. **442**, pp. 170-177, 2018a.

Wang, J.X., Li, Y.Z., Li, J.X., Li, C., Xiong, K. and Ning, X.W., Enhanced heat transfer by an original immersed spray cooling system integrated with an ejector, *Energy*, vol. **158**, pp. 512-523, 2018b.

Wang, Y.M., Li, X.Q. and Guo, Z., Prediction of self-ignition fire propagation and coal loss in an inclined seam, *Heat Transf. Res.*, vol. **49**, pp. 827-845, 2018c.

Wang, J.L., Wu, Z.Z., Mao, C.K., Zhao, Y.F., Yang, J.K. and Chen, Y.F., Effect of electrical contact resistance on measurement of thermal conductivity and Wiedemann-Franz law for individual metallic nanowires, *Sci. Reports*, vol. **8**, 4862, 2018d.

Webb, R.L., Compact heat exchangers, *J. Enhanc. Heat Transf.*, vol. **25**, pp. 1-59, 2018.

Wen, R.F., Xu, S.S., Lee, Y.C. and Yang, R.G., Capillary-driven liquid film boiling heat transfer on hybrid mesh wicking structures, *Nano Energy*, vol. **51**, pp. 373-382, 2018.

Xie, Y.S., Wang, T.Y., Zhu, B.W., Yan, C.Y., Zhang, P.X., Wang, X.W. and Eres, G., 19-Fold thermal conductivity increase of carbon nanotube bundles toward high-end thermal design applications, *Carbon*, vol. **139**, pp. 445-458, 2018.

Xu, X.F., Chen, J., Zhou, J. and Li, B.W., Thermal Conductivity of Polymers and Their Nanocomposites, *Adv. Mater*., vol. **30**, 1705544, 2018a.

Xu, X.X., Zhang, Y.D., Liu, C., Zhang, S.J. and Dang, C.B., Experimental investigation of heat transfer of supercritical CO2 cooled in helically coiled tubes based on exergy analysis, *Int. J. Refrigeration*, vol. **89**, pp. 177-185, 2018b.

Xue, Y.X., Chen, Y., Cai, K., Liu, Z.Y., Zhang, Y.Y. and Wei, N., Local strain field engineering on interfacial thermal resistance of graphene nanoribbon, *Appl. Phys. Lett*., vol. **112**, 021604, 2018a.

Xue, Y., Ge, Z.H., Du, X.Z. and Yang, L.J., On the Heat Transfer Enhancement of Plate Fin Heat Exchanger, *Energies*, vol. **11**, 1398, 2018b.

Yang, J.M., Wu, H., Wang, M.R. and Liang, Y.Y., Prediction and optimization of radiative thermal properties of nano TiO2 assembled fibrous insulations, *Int. J. Heat Mass Transf*., vol. **117**, pp. 729-739, 2018.

Yao, Y.M., Zhu, X.D., Zeng, X.L., Sun, R., Xu, J.B. and Wong, C.P., Vertically aligned and interconnected sic nanowire networks leading to significantly enhanced thermal conductivity of polymer composites, *ACS Appl. Mater. Inter*., vol. **10**, pp. 9669-9678, 2018.

Yu, J.W., Jiang, Y.Q., Cai, W.H. and Li, F.Z., Forced convective condensation flow and heat transfer characteristics of hydrocarbon mixtures refrigerant in helically coiled tubes, *Int. J. Heat Mass Transf*., vol. **124**, pp. 646-654, 2018,

Zhang, N., Yuan, Y.P., Cao, X.L., Du, Y.X., Zhang, Z.L. and Gui, Y.W., Latent heat thermal energy storage systems with solid-liquid phase change materials: a review, *Adv. Eng. Mater*., vol. **20**, 1700753, 2018a.

Zhang, Z., Cai, J.C., Chen, F., Li, H., Zhang, W.X. and Qi, W.J., Progress in enhancement of CO2 absorption by nanofluids: A mini review of mechanisms and current status, *Renew. Energy*, vol. **118**, pp. 527-535, 2018b.

Zhang, Y.Z., Sun, C., Bao, Y. and Zhou, Q., How surface roughness reduces heat transport for small roughness heights in turbulent Rayleigh-Benard convection, *J. Fluid Mech*., vol. **836**, article R2, 2018c.

Zhang, G., Duan, Z., Wang, Q.G., Li, L., Yao, W. and Liu, C.H., Electrical potential induced switchable wettability of super-aligned carbon nanotube films, *Appl. Surf. Sci*., vol. **427**, pp. 628-635, 2018d.

Zhang, J. and Lai, F.C., Heat transfer enhancement using corona wind generator, *J. Electrostatics*, vol. **92**, pp. 6-13, 2018.

Zherdev, A.A., Tsiganov, D.I., Pushkarev, A.V., Shakurov, A.V., Burkov, I.A. And Vasilyev, A.O., Cryoprobe and urethral warming system heat transfer: ultrasound gel phantom study, *J. Enhanc. Heat Transf*., vol. **25**, pp. 97-108, 2018.

Zhou, J.J., Wen, S., Liao, J.Y., Clarke, C., Tawfik, S.A., Ren, W., Mi, C., Wang, F. and Jin, D.Y., Activation of the surface dark-layer to enhance upconversion in a thermal field, *Nature Photonics*, vol. **12**, pp. 154-158, 2018.

Zou, D.Q., Ma, X.F., Liu, X.S., Zheng, P.J. and Hu, Y.P., Thermal performance enhancement of composite phase change materials (PCM) using graphene and carbon nanotubes as additives for the potential application in lithium-ion power battery, *Int. J. Heat Mass Transf*., vol. **120**, pp. 33-41, 2018.