Advanced Energy Conservation Technologies Utilizing Micro/NanoScale Phenomena

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1. Introduction

The necessity and trends of advanced energy conservation technologies utilizing waste heat from factories was investigated from micro/nanoscale viewpoints and systematic viewpoints. Some challenges of establishing broad area energy utilization network system were explained and consequently the necessity of establishing important technical seeds have been shown, which were seriously requested to realize the technical breakthrough for satisfying important technical needs.

2. Micro/Nanoscale Science and Engineering for Energy Conservation Technologies

The following five topics have been demonstrated as the typical advanced energy conservation technologies utilizing micro/nanoscale phenomena.

2-1. Ice Slurry

The ice slurry has been realized by use of AFP(Anti-freeze protein) contained in the blood of the flounder lived in the Arctic ocean. The mechanism of the adsorption of the hydrophilic side of AFP to the hydrogen bond on the determined ice crystal surface with the same hydrogen bond interval of 2nm has been cleared by the observation utilizing STM(scanning tunnel microscope). This mechanism was simulated by the similar structure of artificial organic compounds, such as silane coupling agents or poly-vinyl alcohol. This ice slurry would be useful for providing the cold energy for air-conditioning system in the building by the advantage of latent heat.

2-2. Drag Reduction by Microscale Concave-Convex Surfaces

The drag reduction of water laminar flow has been established by use of fabricated surfaces bu use of micro-machine techniques and MEMS, which have concave-convex structure of micrometer scale. The mechanism would be the equivalent boundary slip due to the interface between liquid and the gas absorbed on the concave structure of the fabricated surface. This would be useful for the drag reduction of pumps.

2-3. Boiling Heat Transfer Mechanism and Enhancement Techniques

The microscale pressure gauge has been realized by MEMS techniques to measure the pressure variation under the bubble. The boiling mechanism for the burnout heat flux has successfully cleared to create the pool boiling heat flux model.

2-4. Smart Control of Turbulent Heat Transfer

The addition of some kinds of surfactant has been useful for the drag reduction of water turbulent flow with about 80% by creating the rod-like micelles of nanometer size diameter. These rod-like micelles would behave like the rubber strings to maintain the large shear stress near the wall. These micelles would be recovered soon after the dissolution inside of the pump by the electrostatic recombination.

2-5. Nanoscale challenges for Energy Conservation Technologies

The nanoscale challenges of thin film thermo-electric cooling and nanoscale surface phenomena have been conducted for advance energy conservation technologies.