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Enhanced Pool-Boiling Heat Transfer Using Nanostructured Surfaces

SUMMARY

Many devices, appliances, and systems -- such as advanced power electronics with high-power computer chips, high-power lasers and radars, and HVAC systems -- require cooling to keep them running for the long-haul and to reduce maintenance and system failures. Researchers at PNNL and Oregon State University (OSU) have developed a method using nanostructured surfaces to efficiently dissipate heat in such applications at the proper temperature.

Surfaces, such as copper and aluminum, are coated with zinc oxide, a compound that uniquely forms flower- or mesh-like surfaces when using micro-assisted nano-deposition techniques developed at the MicroProducts Breakthrough Institute, a collaboration between PNNL and OSU. These unique structures create porous surfaces with unique nano-scale cavities and surface features to efficiently dissipate excessive heat off liquid boiling surfaces in high-power electronics cooling applications. These coatings result in two significant improvements in the boiling heat transfer process:

* the coating method creates optimal surface wettability characteristics that allow better capillary flow of water on the liquid boiling surfaces often used to cool electronics.

* the dense pore-structures of the zinc oxide create nano-scale nucleation sites (holes) where the boiling occurs; allows the liquid to flow efficiently across the surface, thus keeping nucleation sites active; and creates vertical protrusions, which create more overall active boiling surface area for a given surface footprint.

Boiling heat transfer fluxes off nano-coated surfaces have been enhanced by up to 3.5 times compared to bare, uncoated surfaces in electronic cooling applications. In addition, boiling heat transfer coefficients have also been enhanced by almost an order of magnitude on the nano-coated surfaces.

ADVANTAGES

* more efficient heat transfer off surfaces using boiling heat transfer processes to cool electronics and other heat-generating devices

* control over hydrophilic and hydrophobic surface characteristics in water transfer and water management applications

U.S. DEPARTMENT OF ENERGY

RELATED LINKS

» **Microproducts Breakthrough Institute**

Collaboration with Oregon State University on technology development

http://mbi-online.org/

» **Publication: Enhancement of pool-boiling heat transfer using nanostructured surfaces on aluminum and copper**

Hendricks T. International Journal of Heat and Mass Transfer. Published by Elsevier. 2010.
http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6V3H-4YWY3XD-1-T&_cdi=5731&_user=2741876&_pii=S0017931010001006&_origin=search&_coverDate=07%2F31%2F2010&_sk=999469984&view=c&wchp=dGLbVlz-zSkzV&md5=e3c0964fa3fc92f2eda331859864a516&ie=/sdarticle.pdf

Technology Portfolio(s)

» Electronics

» Energy Efficiency

» Microtechnology

» Microsystems

Potential Industry Applications

» Aerospace & Defense

» Automotive & Transportation

» Computers & Electronics

» Energy & Utilities

» Manufacturing & Warehousing

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