Boiling breakthrough: Nano-coating doubles rate of heat transfer

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By adding an incredibly thin coating of alumina to a metal surface, researchers at the Georgia Institute of Technology have doubled the rate that heat travels from a solid surface - such as a pot on a stove - into the liquid in the pot. The results are published in the American Institute of Physics' journal *Applied Physics Letters*.

Pool boiling is the most common and familiar method of heating a container's contents, and is a remarkably efficient heat transfer method. The transfer of heat in this case is referred to as the "heat flux." There exists, however, a critical point at which a solid surface gets too hot and pool-boiling efficiency is lost.

"Delaying the critical flux could play an important role in advancing thermal management of electronics as well as improving the efficiency of a number of energy systems," says Bo Feng, Ph.D., the Georgia Tech researcher leading this project.

In boiling, bubbles carry away large amounts of heat from solid surfaces, but the bubbles also act as an insulator, preventing the liquid from rewetting the surface and thereby interrupting heat transfer. The alumina coating - only a few hundreds of atoms thick (1/1,000 the thickness of a human hair) - has a high affinity to water and, as a result, facilitates the rapid rewetting of the solid surface.

"This is the primary reason for the enhancement of heat transfer," says Feng. An atomic layer deposition technique was used to control the thickness. By achieving such a thin coating, the additional layer of alumina did not appreciably increase thermal resistance, but it did increase the overall heat transfer.

"The potential contribution of this investigation lies in tailoring the wettability of surfaces at the nanometer scale, thereby greatly increasing the heat transfer during pool boiling," adds G.P. "Bud" Peterson, Ph.D., director of Georgia Tech's Two-Phase Heat Transfer Lab. "This is especially promising for applications where the implementation of nanotube or nanowire arrays are possible."

Nanotube and nanowire arrays are another effective way to enhance pool boiling heat transfer. Combining these two techniques - nanotube and/or nanowire arrays and nano-coating by atomic layer deposition - may increase pool-boiling efficiency even further.

More information: "Enhancement of Critical Heat Flux in Pool Boiling Using Atomic Layer Deposition of Alumina" is published in *Applied Physics Letters*.

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