Nano work chases self-cooled chips

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PORTLAND, Ore. — Future chips may be self-ventilating, thanks to added microfluidic-like layers that pump heat-laden air off-chip using a classic "corona wind" effect. Purdue University has patented the technique at the nanoscale, and two team members have co-founded a company to commercialize aspects of the cooling system.

The Purdue team recently demonstrated a chip that created ions between closely spaced carbon-nanotube electrodes and funneled the resulting air currents down microfluidic channels, allowing the resultant heat to squirt out the sides of the chip.

"We believe this to be breakthrough technology for the chip industry, though they may not yet realize it. We have created a 'bucket brigade,' charge-coupled-like device that pumps heat out of chips with electrical signals," said recent doctoral grad Daniel J. Schlitz.

Schlitz co-founded Thorrn Micro Technologies Inc. with Purdue doctoral candidate Vishal Singhal to pursue commercial applications for the technique, developed under a project led by mechanical-engineering professor Suresh Garimella at Purdue (West Lafayette, Ind.). Associate professor Timothy Fisher also worked on the device's development.

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A corona wind is created by the ions that follow an electrical field set up by opposite charges. It is a well-documented phenomenon, represented by an electrohydrodynamic model based on Maxwell's seminal equations.

In man-made devices, generated ions are passed from electrode to electrode, in the mode of a charge-coupled device, with collisions between ions and neutral air atoms propelling the air forward in what is called the corona wind effect (recently trademarked by The Sharper Image as the Ionic

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Breeze).

The Purdue researchers nanosized the effect and combined it with microfluidic channels with embedded, megahertz-sequenced electrodes suitable for pumping heat-laden air molecules literally through the core of a chip and out the other side.

"What we have now is a laboratory demonstration that we can switch at the right frequency so that the ion cloud is constantly moving forward," Schlitz said. "As the ions move forward, they make repeated collisions with neutral molecules, producing the breeze."

The Purdue researchers used traditional photolithographic fabrication for the sequenced electrodes that propel the breeze along, but they created the ions by depositing closely spaced carbon nanotubes on a quartz substrate. In future devices the team plans to use a thin diamond film in place of the nanotubes.

"The grain boundaries in the diamond film provide the same kind of opportunity for electron emission and ion generation as carbon nanotubes," Garimella said. "The entire thing could sit on, and be integrated into, a chip that is 10 x 10 millimeters."

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