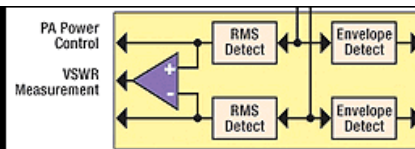


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Engineers develop cooling device for computer IC

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Engineers at Purdue University have developed a MEMS-based micro-pump cooling device small enough to fit on a computer chip that circulates coolant through channels etched into the chip.

The device has been integrated on to a silicon chip that is about 1cm². The prototype contains numerous water-filled micro-channels, grooves about 100µm wide. The channels are covered with a series of hundreds of electrodes, electronic devices that receive varying voltage pulses in such a way that a traveling electric

field is created in each channel.

The traveling field creates ions, or electrically charged atoms and molecules, which are dragged along by the moving field.

"Our goal is to develop advanced cooling systems that are self-contained on chips and are capable of handling the more extreme heating in future chips," said Suresh Garimella, director of Purdue's Cooling Technologies Research Center.

The center, supported by the National Science Foundation, industry and Purdue, was formed to help corporations develop miniature cooling technologies for a wide range of applications, from electronics and computers to telecommunications and advanced aircraft.

An article about the cooling device is scheduled to appear in the May issue of *Electronics Cooling* magazine. The article was written by doctoral student Brian Iverson, Garimella and former doctoral student Vishal Singhal, who recently graduated and co-founded Thorrn Micro Technologies Inc.

"Say every sixth electrode receives the same voltage, these varying voltages from one electrode to the next produce a traveling electrical field that pulls the ions forward, causing the water to flow and inducing a cooling action," Garimella said. "Essentially, you are pumping fluid forward."

The pumping action is created by electrohydrodynamics, which uses the interactions of ions and electric fields to cause fluid to flow. "Engineers have been using electrohydrodynamics to move fluids with electric fields for a long time, but it's unusual to be able to do this on the micro-scale as we have demonstrated," Garimella said.

The researchers have also added a feature to boost the force of the pumping action. A thin sheet of piezoelectric material, which expands and contracts in response to an electric current, was glued on top of

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the cover of the liquid-filled channels. "This material acts as a diaphragm that deforms up and down when you give it a voltage, causing it to push additional flow through the channels," Garimella said.

"We have developed mathematical models that show this piezo action enhances the electrohydrodynamic performance." The diaphragm has enhanced the pumping action by 13 percent in the current prototype, but the modeling indicates a possible enhancement of 100 percent or greater, he said.

However, the researchers concede several major challenges remain. "One big challenge is further developing mathematical models that are comprehensive and accurate because this is a very complicated, dynamic system," Garimella said.

Other challenges include sealing the tiny channels to prevent water leakage and designing the system so that it could be manufactured under the same conditions as semiconductor chips.

- [John Walko](#)
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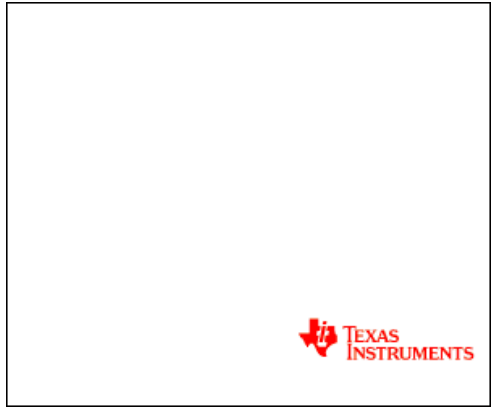
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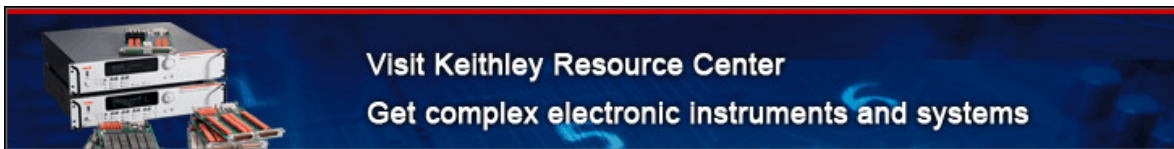
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