Engineers working to prevent heat buildup within 3D integrated circuits

December 19 2012

In the effort to pile more power atop silicon chips, engineers have developed the equivalent of mini-skyscrapers in three-dimensional integrated circuits and encountered a new challenge: how to manage the heat created within the tiny devices.

But a team of UT Arlington researchers funded by the National Science Foundation is working first to minimize the heat generated and then to developing nano-windows that will allow the heat to dissipate before it damages the chip.

Ankur Jain, assistant professor of mechanical and aerospace engineering, is working with colleague Dereje Agonafer, professor of mechanical and aerospace engineering, and Roger Schmidt, IBM fellow and chief engineer, on the project.

"There is only a very limited amount of space available on an integrated circuit so we've had to build vertically, placing wafers on top of wafers," Jain said. "These 3D integrated circuits have led to significant performance improvements. However, when we stack these circuits on top of each other, heat starts to become a problem."

He added: "All the heat being generated in this multi-layer stack needs to be removed, otherwise it causes deterioration in performance."

Agonafer said the team will investigate and measure fundamental thermal transport and thermomechanical properties of materials and

interfaces in 3D integrated circuit technology.

The team also will look at Through-Silicon Vias, or TSVs – high-performance wires that allow integrated circuits to talk to each other and pass instructions from one level to the next.

Jain and Agonafer believe the cooling effects will boost the efficiency and speed of the 3D integrated circuits as well.

Schmidt said UT Arlington is one of the many academic partners IBM works with to find solutions for tomorrow's computing needs.

"Cooling chips has come a long way in recent years, but the financial savings can be enormous," Schmidt said. "Reducing heat just a little can translate to millions of dollars in savings down the road. Plus, typically solving the heat problem also yields faster, more reliable and more powerful computing."

Jean-Pierre Bardet, dean of the UT Arlington College of Engineering, said the project demonstrates the important role that a research institution can play in partnering with industry leaders, such as IBM.

"Their work will help not only chip manufacturers but any business whose products depend on 3D, integrated circuit technology," Bardet said. "We are pleased to be partnering with a worldwide innovator in research that will improve technology we have all come to depend upon."

Provided by University of Texas at Arlington

Citation: Engineers working to prevent heat buildup within 3D integrated circuits (2012, December 19) retrieved 20 April 2024 from https://phys.org/news/2012-12-buildup-3d-

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