Beating the backup blues

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Thomas Brunschwiler, Urs Kloter, Ryan Linderman, Bruno Michel from the IBM's Zurich Research Lab in Switzerland and Hilton Toy from the IBM Server & Technology Group in Fishkill, New York, have been honored with the 2008 Harvey Rosten Award of Excellence for their work in overcoming a barrier in chip cooling by improving the application of a paste that binds chips to their cooling systems. The new technology will allow for faster computer chips to be cooled more efficiently. Mr. Michel represented the team and accepted the award at the IEEE SEMI-THERM 25 Symposium.

The Award commemorates achievements in the field of thermal analysis of electronics equipment, and the thermal modeling of electronics parts and packages. Its aims are to encourage innovation and excellence in these fields.

The findings were submitted in a paper titled “Hierarchal Nested Surface Channels for Reduced Particle Stacking and Low-Resistance Thermal Interfaces”. In today's computer chips, as the circuits on chips get smaller and smaller, the chip puts out more heat than ever before. To remove the heat from the chip, a cooling system is attached to the microprocessor using a special adhesive or paste. This paste is necessary to bind the two systems together, yet it poses a real barrier in heat transport.

To improve the glue's heat-conducting properties, it is enriched with micrometer-sized metal or ceramic particles. These particles form clusters and build “heat-evacuation bridges” from the chip to the cooler to make up for the glue's shortcomings. However, even highly particle-filled pastes are still inefficient, consuming up to 40 percent of the overall thermal budget, i.e. of the cooling capacity available to draw the heat away.

By observing how the paste spreads when attaching a chip with its cooling element, the IBM scientists noticed a cross forming in the paste, where large numbers of particles were pilling up, inhibiting the ability to thin out the layers of glue. The scientists were able to trace the cause of this back to the flow behavior of the paste, which simply follows the path of least resistance. Along the diagonals, the particles are pulled in opposite directions and as a result they do not move anywhere and pile up on each other as the squeezing process continues — forming the “magic cross”.

To overcome this problem, the team designed a special layout of micrometer-sized channels — or trenches — in a tree-like branched structure, consisting of larger and smaller channels, which functions like an drainage system for the paste at exactly those spots where the particles would pile up. This allows the particles to spread more homogeneously, and reduces the thickness of the resulting paste gap.

The results obtained are impressive: The paste thickness could be reduced by a factor of three, and the pressure needed to squeeze the paste to the same bondline thickness could be reduced by a similar factor. These lower assembly pressures ensure that the delicate components and interconnects below the chip are not damaged as the chip package is created. The channels also allow pastes with higher fill factor and higher bulk thermal conductivity to be squeezed to thinner gaps, thereby reducing the thermal resistance of the paste interface considerably by more than a factor of three. The new technology allows air-cooling systems to remove more heat and helps to improve the overall energy efficiency of computers.

Source: IBM

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