Eficient cost-effective cooling solution for high performance chips

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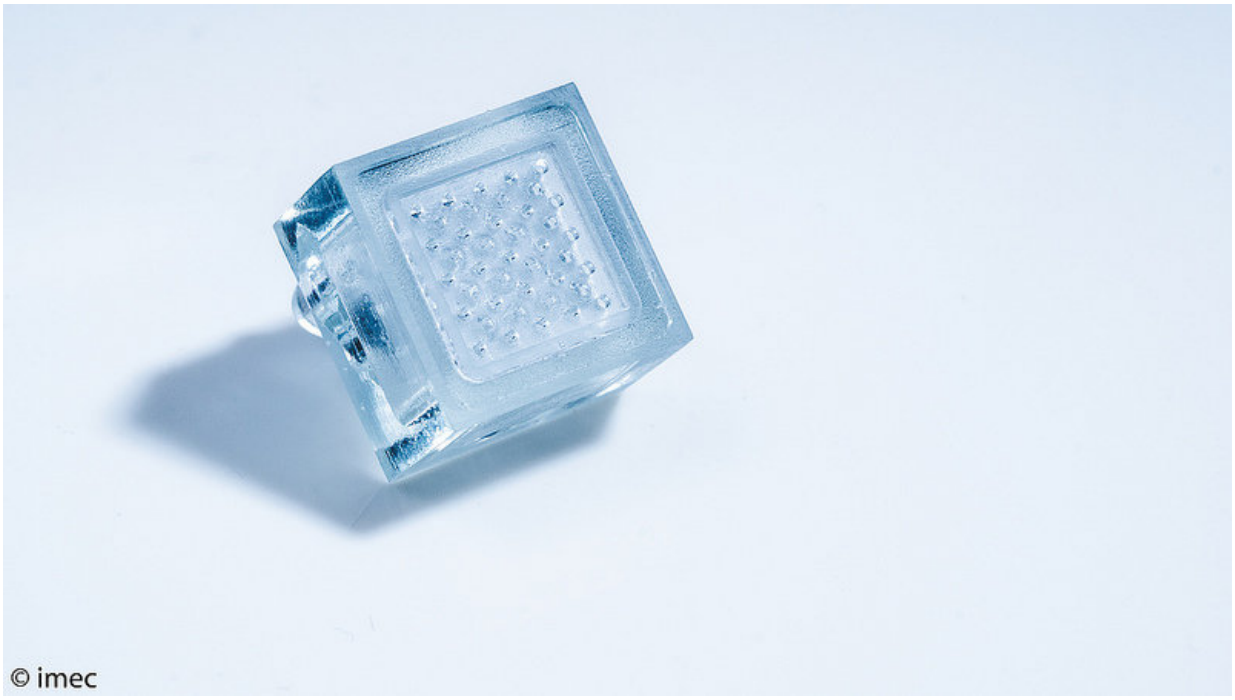
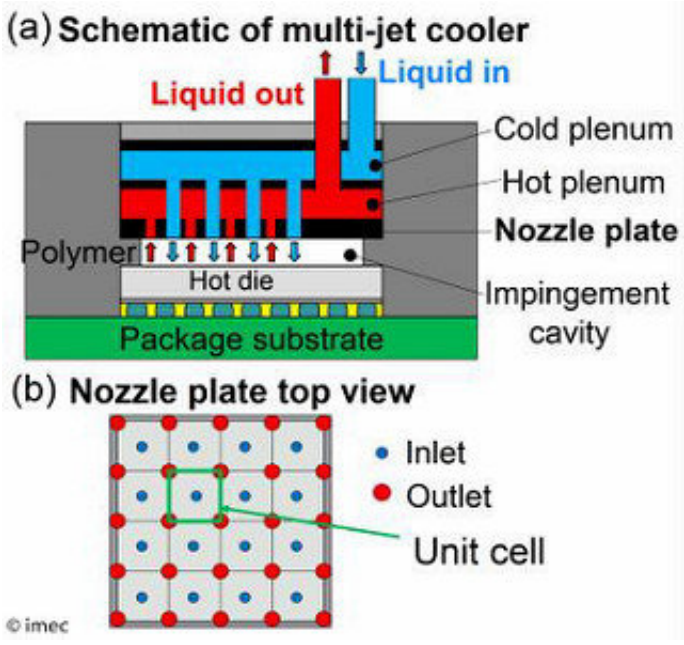


Multi-jet cooler. Credit: IMEC

Imec, the world-leading research and innovation hub in nano-electronics and digital technology, today announced that it has demonstrated for the first time a low-cost impingement-based solution for cooling chips at package level. This achievement is an important innovation to tackle the ever-increasing cooling demands of high-performance 3D chips and systems.

High performance electronic systems are coping with increasing cooling demands. Conventional solutions realize cooling through combining heat exchangers that are bonded to heat spreaders that are then attached to the chip backside. These are all interconnected with thermal interface materials (TIM) that create a fixed thermal resistance that can't be overcome by introducing more efficient cooling solutions. Direct cooling on the chip backside would be more efficient, but current direct cooling microchannel solutions create a temperature gradient across the chip surface.

The ideal chip cooler is an impingement-based cooler with distributed coolant outlets. It puts the cooling liquid in direct contact with the chip and sprays the liquid perpendicular to the chip surface. This ensures that all the liquid on the chip surface has the same temperature and reduces the contact time between coolant and chip. However, current impingement coolers have the drawback that they are silicon-based and thus expensive, or that their nozzle diameters and use processes are not compatible with the chip packaging process flow.



3D-shaped-polymer-cooler. Credit: IMEC

Imec has developed a new impingement chip cooler that uses polymers instead of silicon, to achieve a cost-effective fabrication. Moreover, imec's solution features nozzles of only 300µm, made by high-resolution stereolithography 3D printing. The use of 3D printing allows e customization of the nozzle pattern design to match the heat map and the fabrication of complex internal structures. Moreover, 3D printing allows to efficiently print the whole structure in one part, reducing production cost and time.

"Our new impingement chip cooler is actually a 3D printed 'showerhead' that sprays the cooling liquid directly onto the bare chip," clarifies Herman Oprins, senior engineer at imec. "3D prototyping has improved in resolution, making it available for realizing microfluidic systems such as our chip cooler. 3D printing enables an application-specific design, instead of using a standard design."

Imec's impingement cooler achieves a high cooling efficiency, with a chip temperature increase of less than 15°C per 100W/cm2 for a coolant flow rate of 1 l/min. Moreover, it features a pressure drop as low as 0.3 bar, thanks to the smart internal cooler design. It outperforms benchmark conventional cooling solutions in which the thermal interface materials alone already cause a 20-50°C temperature increase. Next to its high efficiency and its cost-effective fabrication, imec's cooling solution is much smaller compared to existing solutions, matching the footprint of the chip package enabling chip package reduction and more efficient cooling.

Provided by IMEC