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CMOSAIC RTD 2009

FNSNF

EDA for CMOSAIC:

a new generation of CAD tools for liquid-cooled 2D/3D ICs

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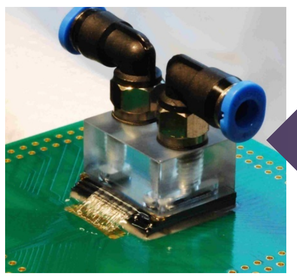
EPFL-Embedded Systems Laboratory

Partners: IBM Research
EPFL-LTCM



Our role in CMOSAIC:

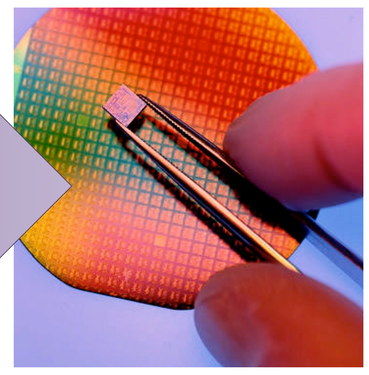
At the Embedded Systems Laboratory, we used our expertise in Electronic Design Automation to develop tools to aid the semiconductor industry in the adoption of liquid and two-phase cooled 2D/3D ICs of the future, and enable their commercially viable mass production.

•Simulation

We worked with our partners in IBM Research and LTCM to develop efficient thermal modeling and simulation tools to evaluate designs at early-stage.

•Optimization

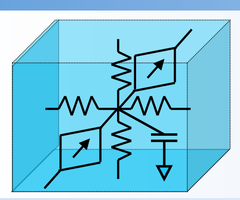
We also developed design-optimization and run-time thermal management schemes for multi-processor architectures to keep these designs operating in a reliable and energy efficient manner.



Simulation

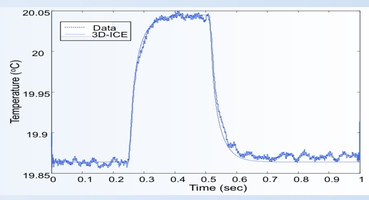
PhD Student: Arvind Sridhar

3D-ICE: "3D Interlayer Cooling Emulator"



The FIRST Compact Transient Thermal Model for liquid-cooled ICs

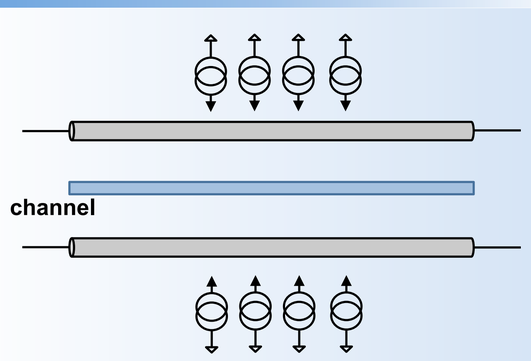
Validated against measurements from IBM



>180 Companies and Universities worldwide use 3D-ICE

3D-ICE cited in **>80** conferences and journals

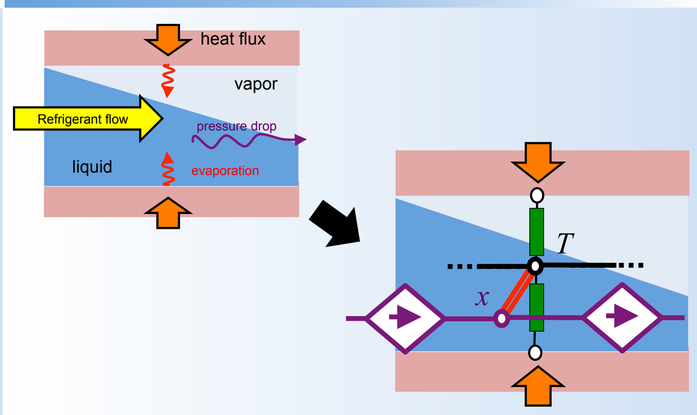
Semi-analytical model



A new semi-analytical model for liquid-cooled ICs based on transmission-line theory

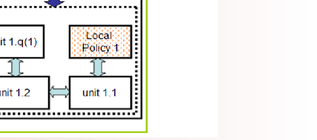
Successfully applied to design-time optimization ***GREENCOOL***

STEAM: Two-phase model



A new compact thermal model for two-phase cooling of ICs

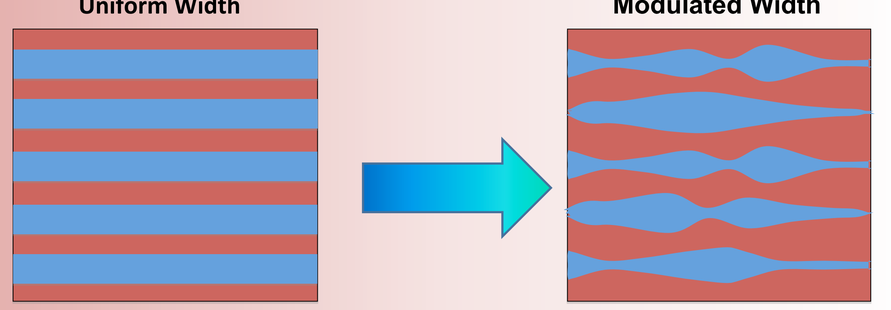
Validated against measurements from LTCM



PhD Student: Mohamed Sabry

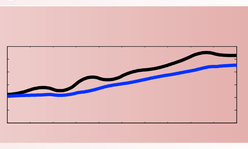
Optimization

Design-time optimization using channel modulation ***GREENCOOL***

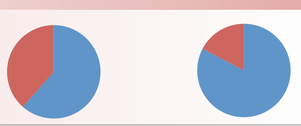


Customized channel width to meet thermal demands with low cooling power

31% thermal gradient reduction
(vs. straight channels)

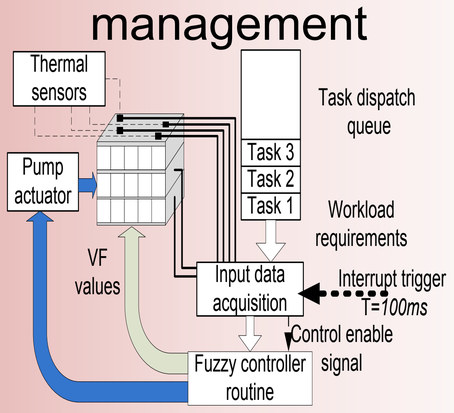


80% cooling power reduction
(vs. straight channels)



Run-time thermal management and optimization mechanisms

Centralized fuzzy Logic management



Rule-base decisions for flow rate and voltage/frequency tuning

Decentralized hierarchical management

Predictive control decisions for flow rate and voltage/frequency tuning

40% cooling and computation power reduction (vs. state of the art)
30% Peak temperature and thermal gradient reduction (vs. state of the art)