

Intel EMIB-T를 위한 1470 nm 선택 접합

조진현 쿨스 대표 jhcho@cools.co.kr

SUMMARY

EMIB-T에서는 TCB 가열 헤드의 열이 로직 다이를 지나 접합부에 닿아, 실리콘 브리지와 유기 기판의 열팽창 차이가 응력과 힘으로 남는다. 1470 nm 광은 실리콘을 투과해 패드 쪽 흡수층에서 열로 바뀐다. 투명 헤드로 가압한 채 로직 접합부를 한 번에 가열하는 공정과 공동 검증 프로그램을 제안한다.

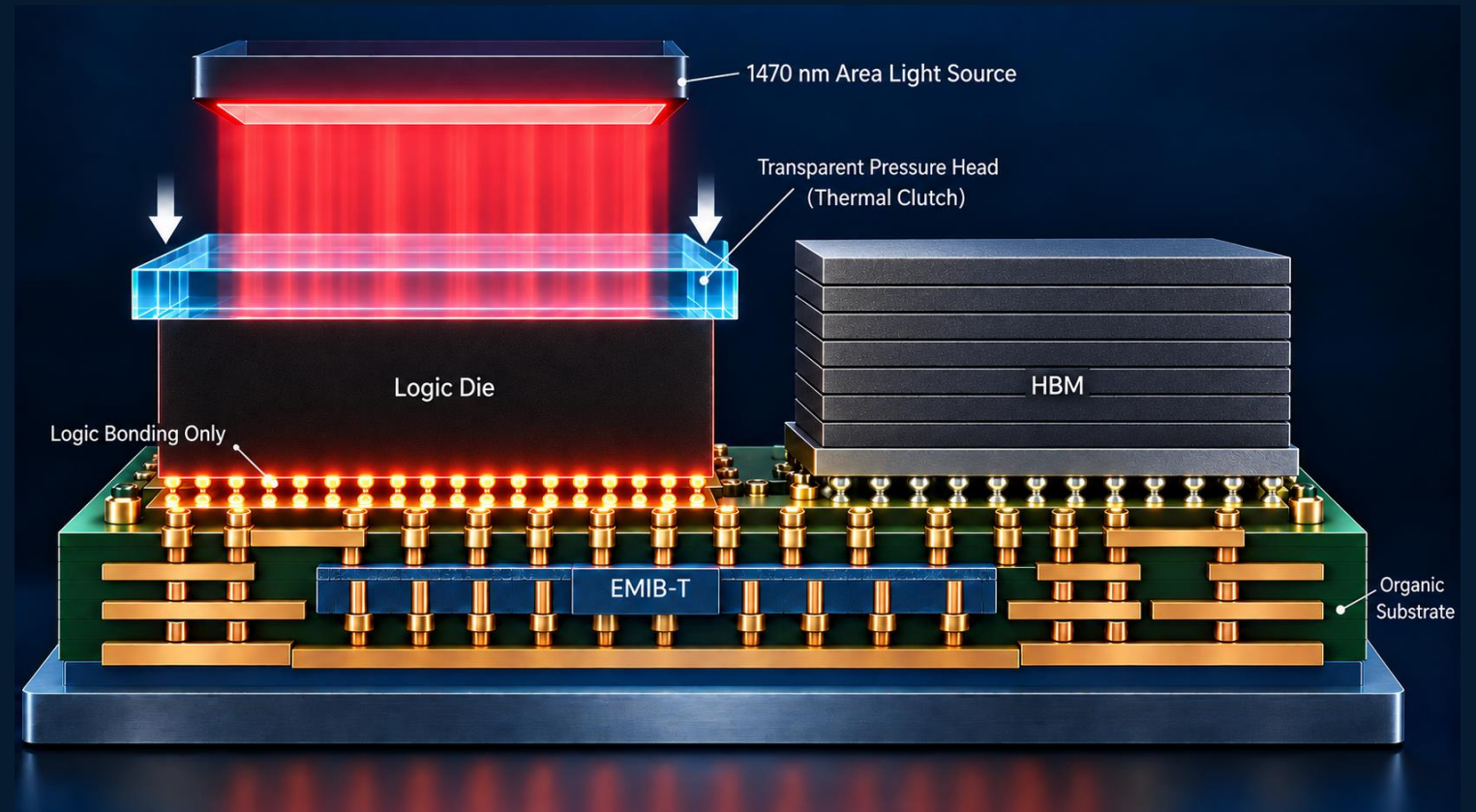
1470 nm Selective Bonding for Intel EMIB-T

Transparent Thermal Clutch for lower package thermal exposure

A Cools proposal

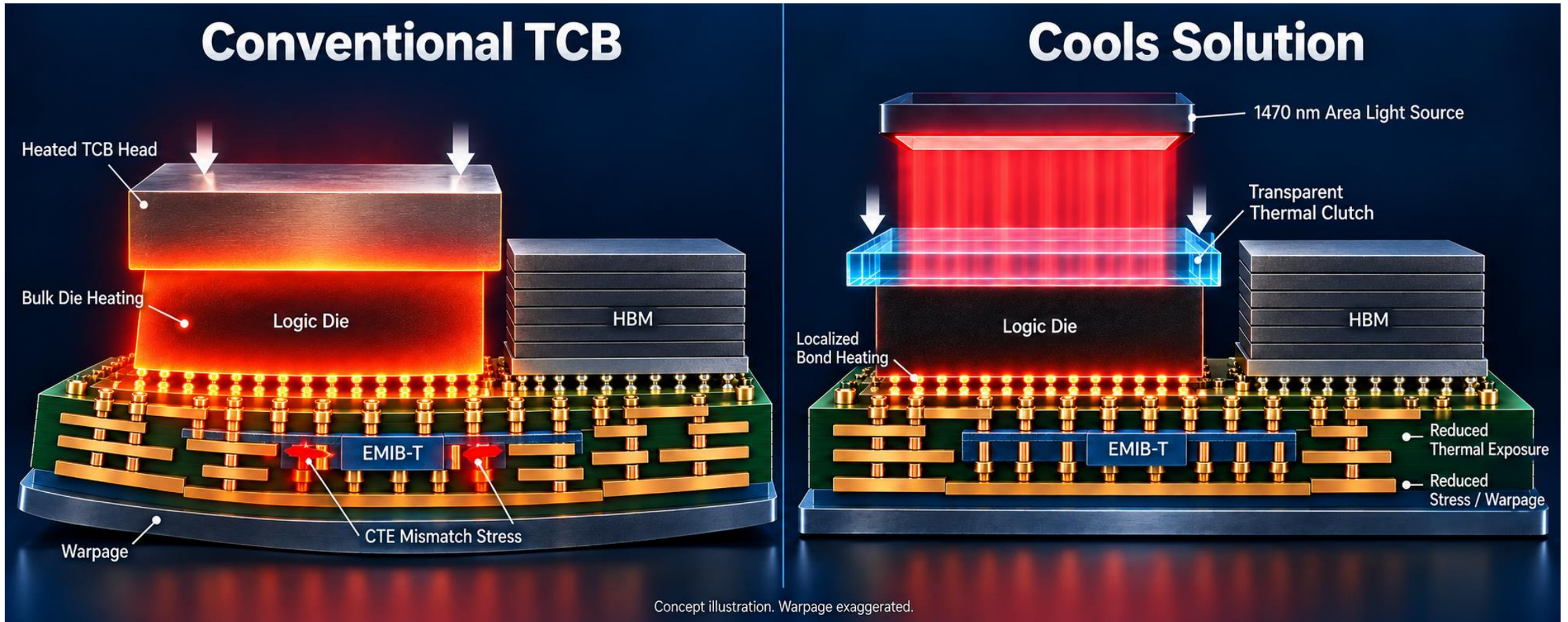
Full-area logic bonding
with pressure applied
through a transparent head

Jinhyun Cho, PhD
CEO, Cools Co., Ltd.
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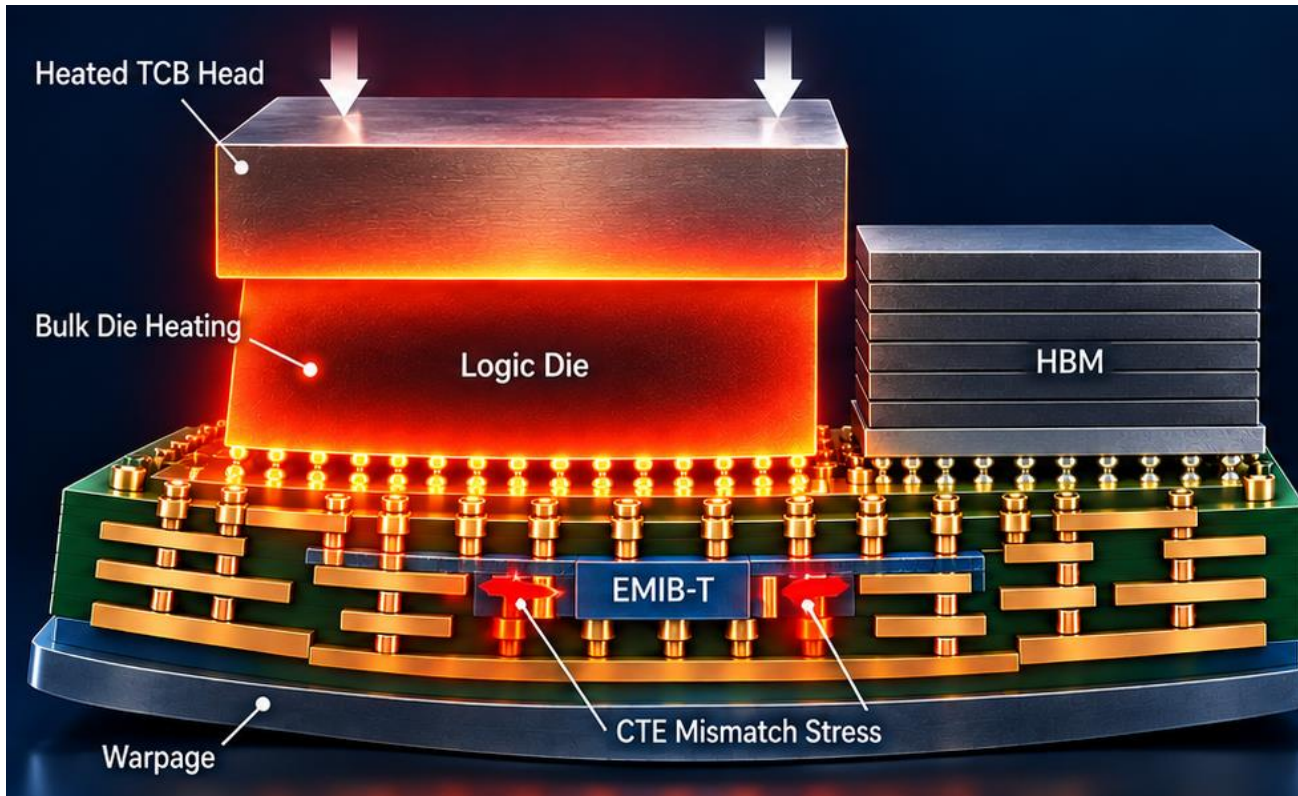
The problem and the Cools solution

Change where heat is generated while maintaining bonding pressure



TCB exposes the logic and substrate to heat

The embedded silicon bridge sits within a mechanically dissimilar organic structure



01 Heat passes through the die

A heated head raises the logic body temperature to deliver heat to the joints.

02 Expansion is nonuniform

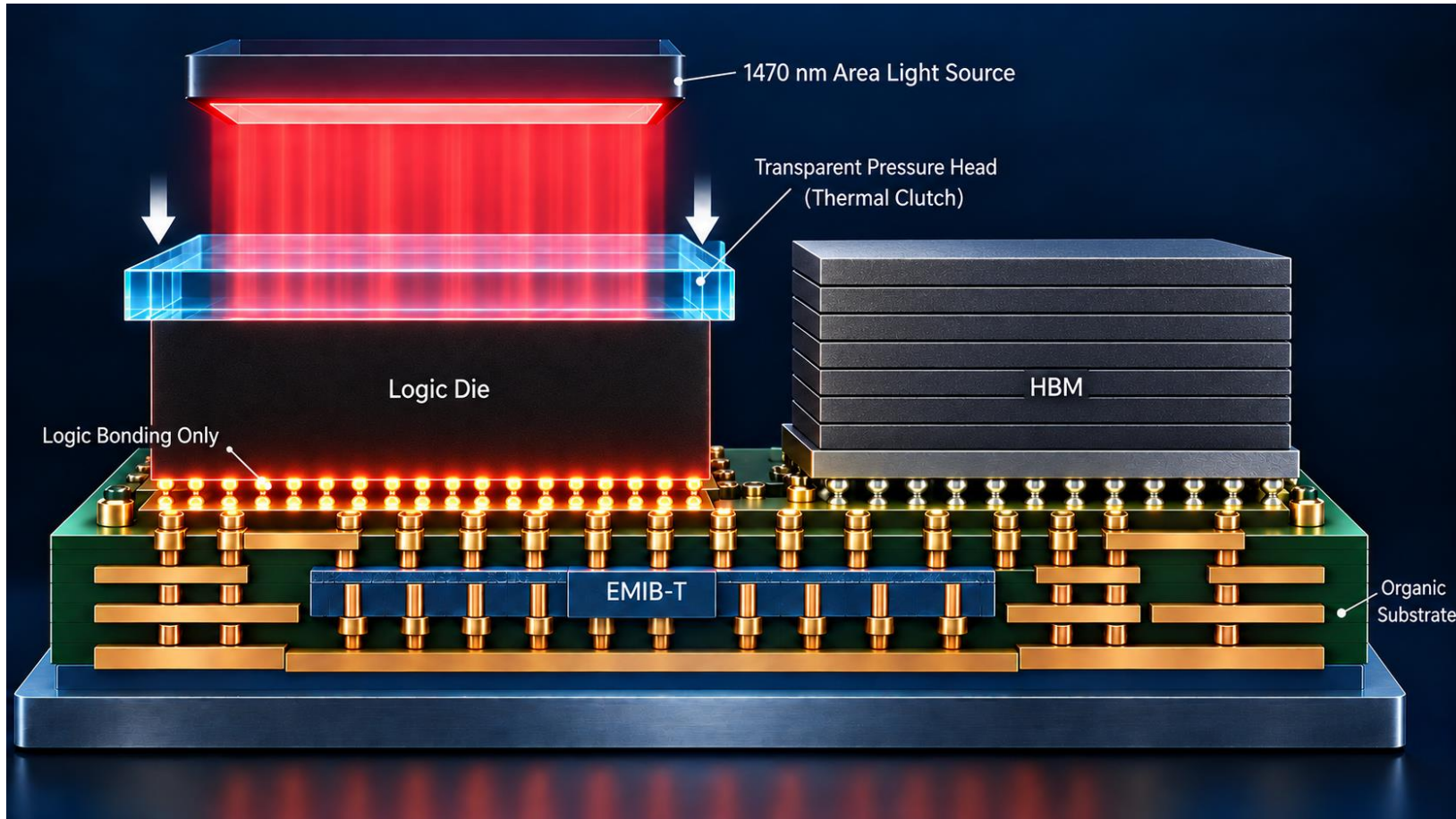
Silicon and organic materials expand differently. Constraint transfers that mismatch into stress.

Assembly consequence

Warpage and local displacement complicate fine-pitch contact and alignment

Cools heats the logic bond array in one exposure

1470 nm area illumination and a transparent Thermal Clutch share the logic footprint



Full-area illumination

Illuminate all logic joints in a single exposure field.

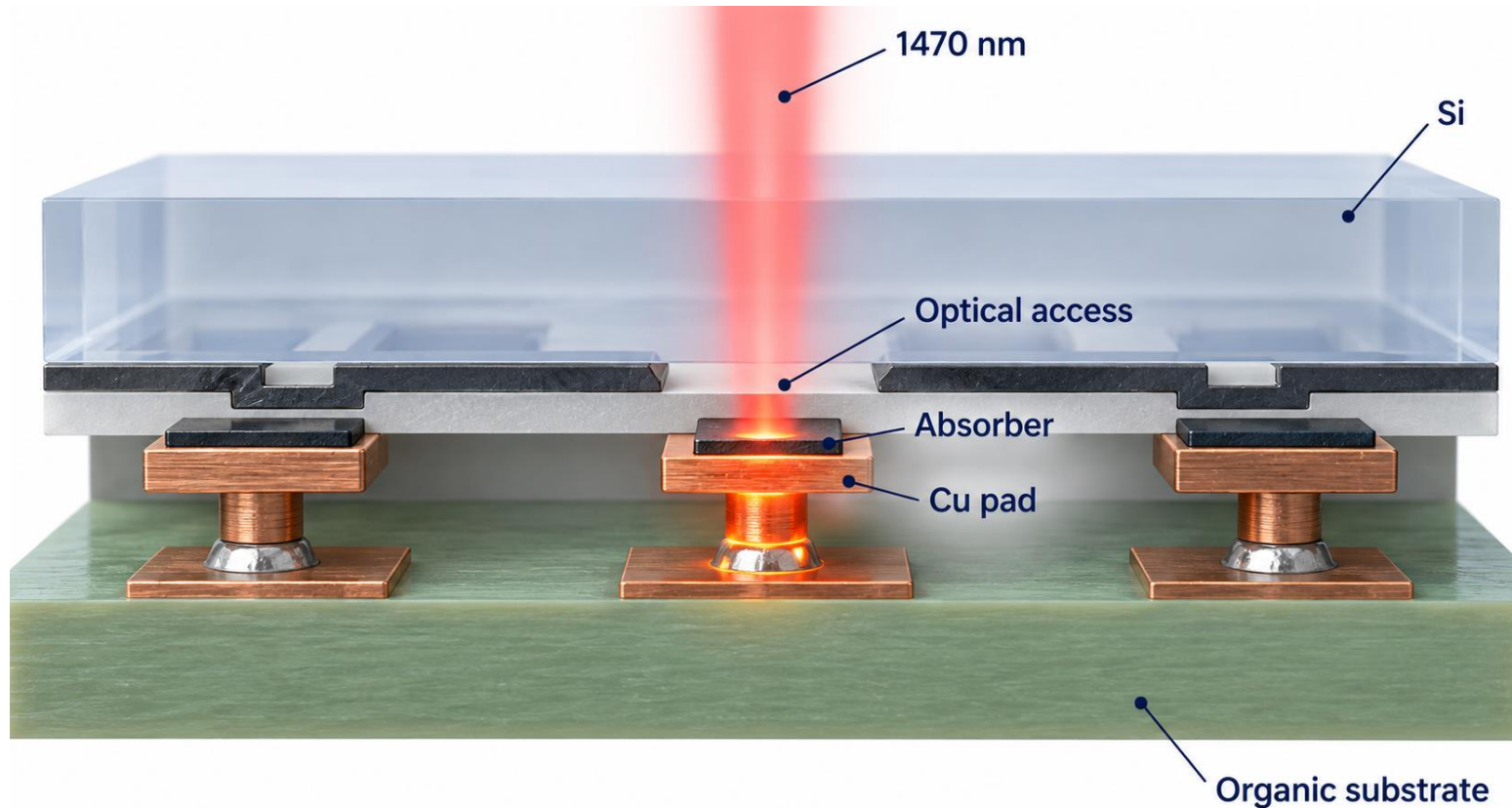
Pressure through the head

Keep the transparent head in direct contact with the logic backside.

Adjacent HBM remains outside the irradiation field.

1470 nm selective absorption

Sub-bandgap photons provide a route through silicon to a suitable bond-side absorber



0.843 eV

Photon energy at 1470 nm

**Below the ~ 1.12 eV
silicon bandgap**

Absorb near the pad.
Conduct heat over a short
path into the joint.

Design inputs: optical transmission,
metal shadowing and absorber distri
bution.

Transparent Thermal Clutch bonding head

Optical access, mechanical contact and thermal coupling meet at the logic backside

Function	Head requirement	Process purpose
Optical delivery	Transmit the 1470 nm field across the logic footprint	Deliver energy to the bond-side absorption region
Mechanical pressure	Flat contact surface and controlled load distribution	Maintain joint contact and die alignment
Thermal coupling	Controlled contact conductance and head thermal capacity	Provide a path for heat removal from the die

During irradiation

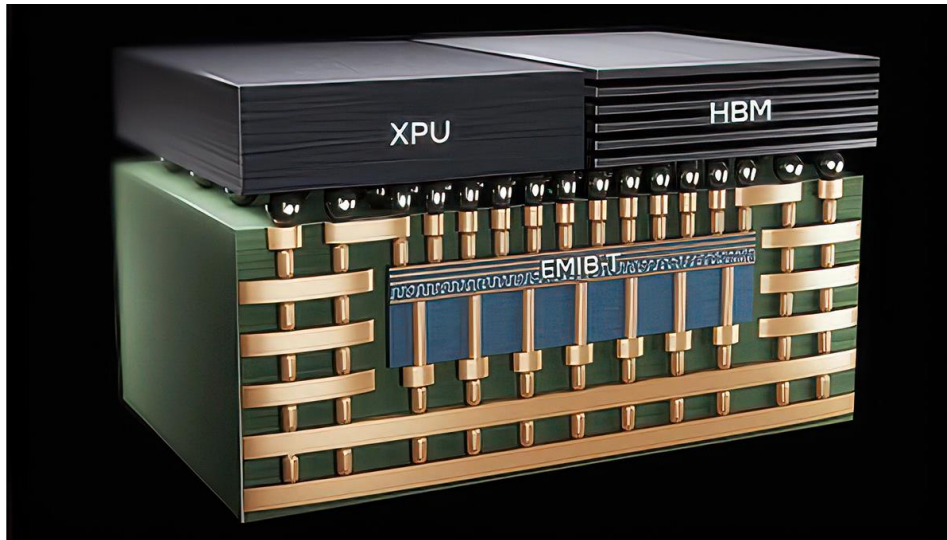
Preserve the bond thermal window.

After irradiation

Maintain pressure as the assembly cools.

Logic attachment is the first EMIB-T application

A die-specific optical field limits direct irradiation of the neighboring HBM



Initial process scope

Bond the logic die to the EMIB-T package substrate.

Match the source and head to the logic die footprint.

Monitor heat conducted toward the HBM and embedded bridge.

Public EMIB-T illustration, reproduced from the Synopsys / Intel collaboration article

HBM attachment is a separate optical-access design task.

Lower thermal exposure, wider assembly window

Targeted benefits at matched electrical and mechanical joint quality

Assembly concern	Cools mechanism	Targeted benefit
Bridge / organic stress	Reduce bulk temperature excursion and high-temperature dwell	Lower mismatch loading around the embedded bridge
Warpage and alignment	Limit differential expansion while maintaining pressure	More stable joint contact during bonding
Adjacent HBM exposure	Confine direct optical input to the logic footprint	Less thermal disturbance of previously assembled parts
Bonding cycle	Deliver energy to the joint region without heating the full die first	Shorter thermal portion of the assembly cycle

The gain is measured against the current TCB process on the same test vehicle.

A controlled comparison can isolate the benefit

Use the same EMIB-T representative coupon, joint metallurgy and acceptance criteria

Process arm	Purpose
A Baseline TCB	Establish reference joint quality, thermal history and warpage
B 1470 nm area bonding	Measure the effect of bond-side optical heating
C Area bonding + Thermal Clutch	Measure the added benefit of the transparent head and controlled thermal contact

Joint quality

Daisy-chain resistance
Cross-section and voiding
Mechanical strength

Thermal exposure

Logic and substrate T(t)
Time above material limits
Neighboring HBM temperature

Mechanical response

In-process warpage
Local joint displacement
Post-bond residual shape

Proposal: a joint EMIB-T feasibility program

Demonstrate bond quality with a smaller thermal burden on the package

Intel contribution

Representative stackup and bump map
Baseline TCB conditions
Joint-quality and warpage limits

Cools contribution

1470 nm area illumination concept
Transparent Thermal Clutch head
Integrated optical / pressure process

First deliverable

An instrumented logic-bonding coupon with matched joint quality, compared thermal histories and measured warpage.

Requested next step: technical discussion with Intel packaging and assembly engineers



주식회사 쿨스

대표이사 조진현

본사 | 경상남도 창원시 의창구 중동북로 23

지사 | 경기도 화성시 동탄구 삼성1로 160

M. 010-2280-9414

E. jhcho@cools.co.kr

H. www.cools.co.kr
