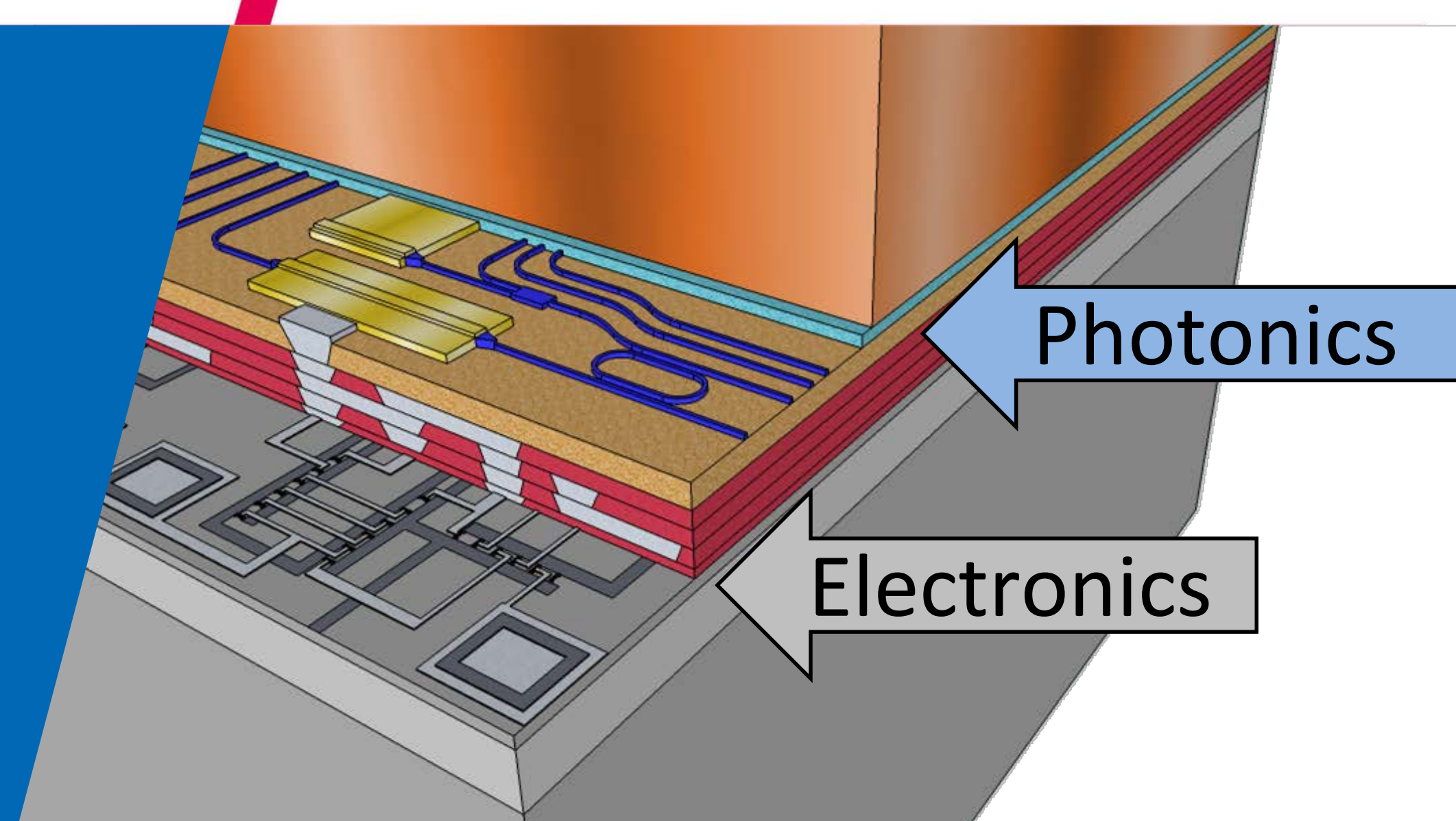


Heat sinking of highly integrated photonic and electronic circuits

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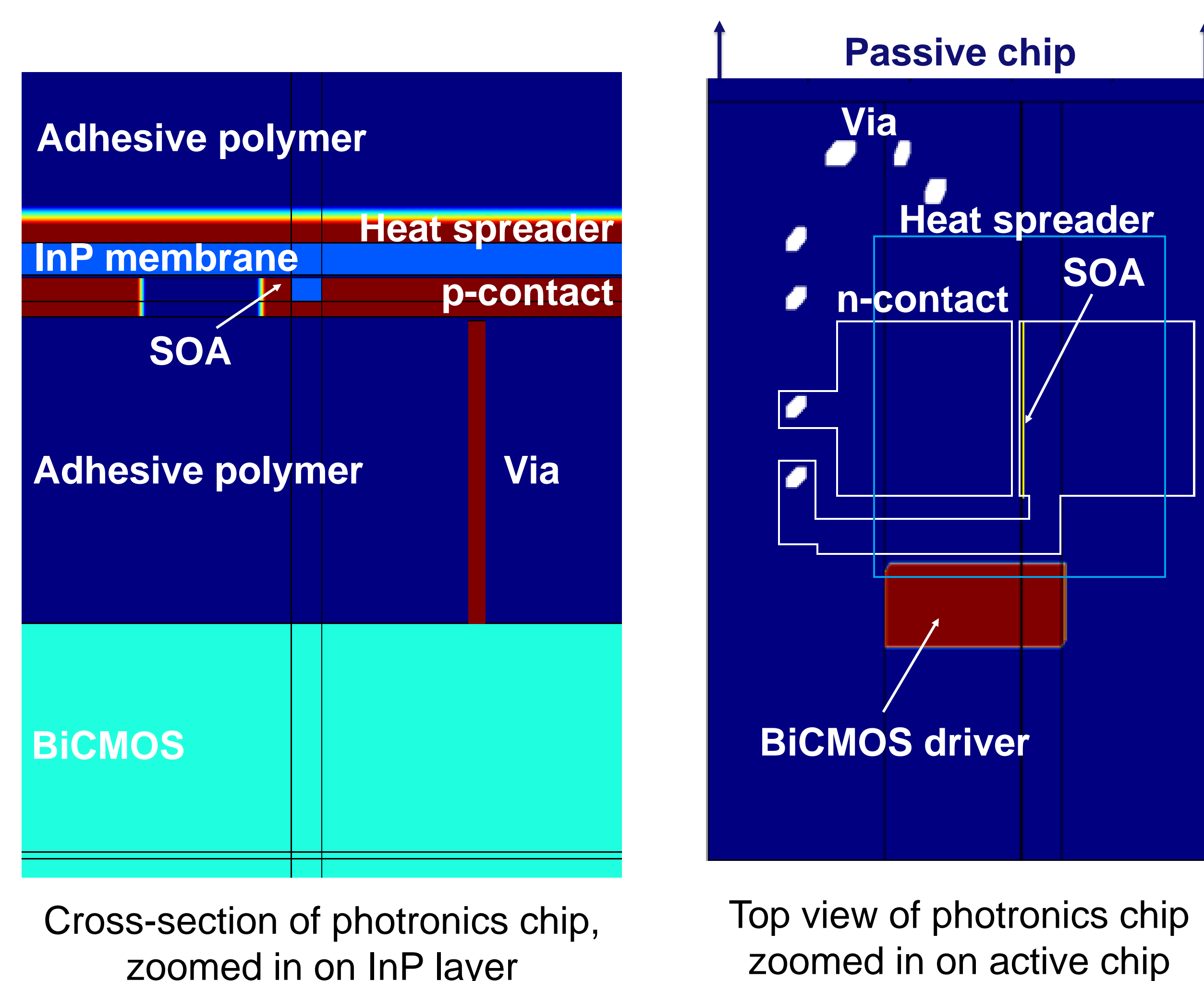
Introduction

Wafer scale integration of photonics and electronics is a cost effective solution to the increasing demand for high speed optical communication by enabling the creation of high-density, high performance electro-optical modules. This is achieved in a new concept, called photronics, where we bond a thin InP membrane containing a complete PIC on a BiCMOS chip using an adhesive polymer and electronically connect the two layers with wafer-scale processing.

On this poster we will investigate the thermal properties of an integrated optical transmitter and determine the necessary steps to keep the temperature of the BiCMOS chip and the InP chip below resp. 150 °C and 110 °C.

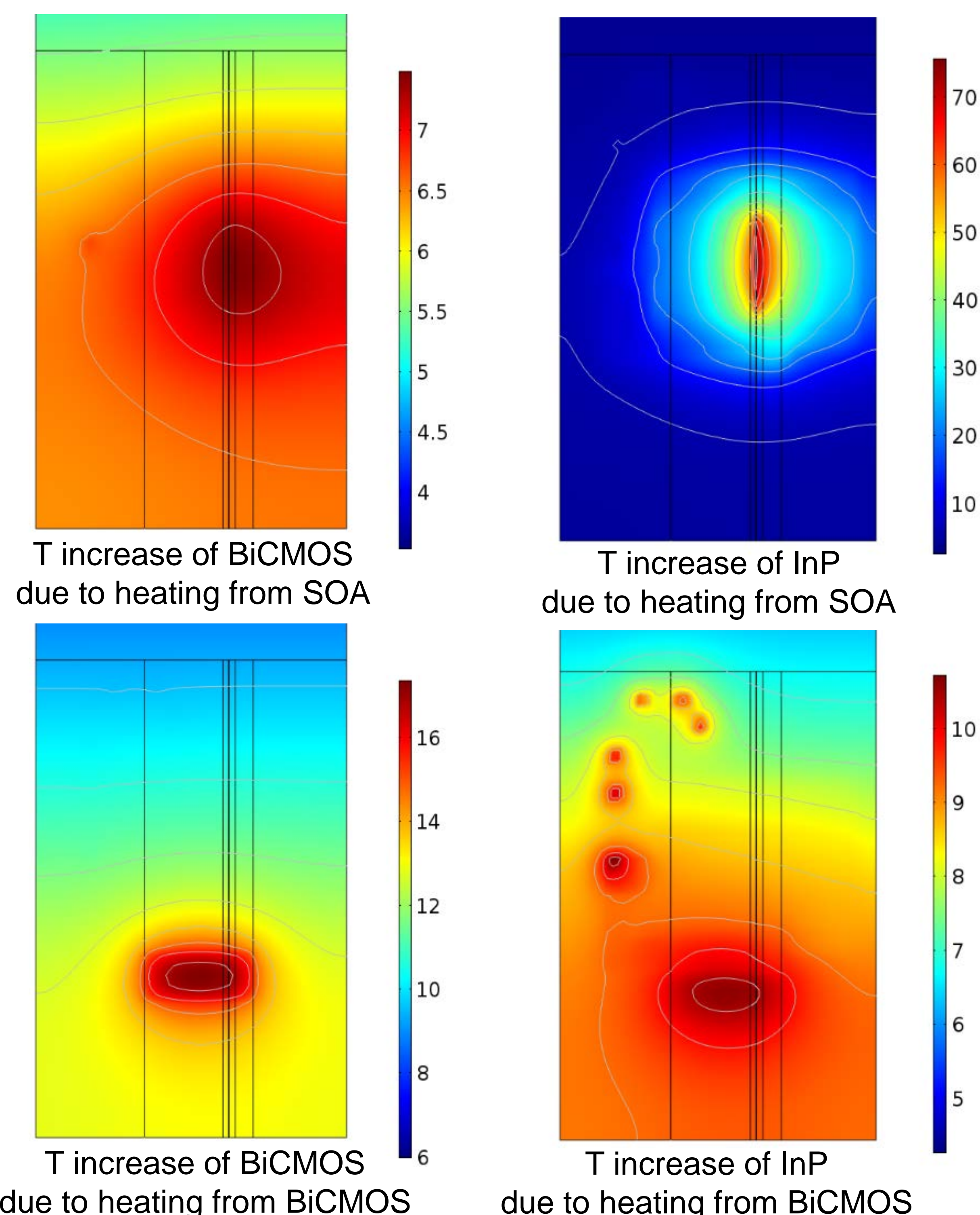
Simulation configuration

- Full 3D simulation of chip and surrounding material, including PCB carrier, thermal paste and epoxy.
- Heatsinks simulated as distributed thermal resistance.
- SOA and driver dissipate resp. 290 mW and 380 mW.
- Passive chip contains spot-size converter.
- Heat spreader is added to lower T_{max} of SOA.



Cross talk

Thermal cross talk between layers is important for this integration scheme. These images show the cross talk for chips with a 2 μm thick gold heat spreader.

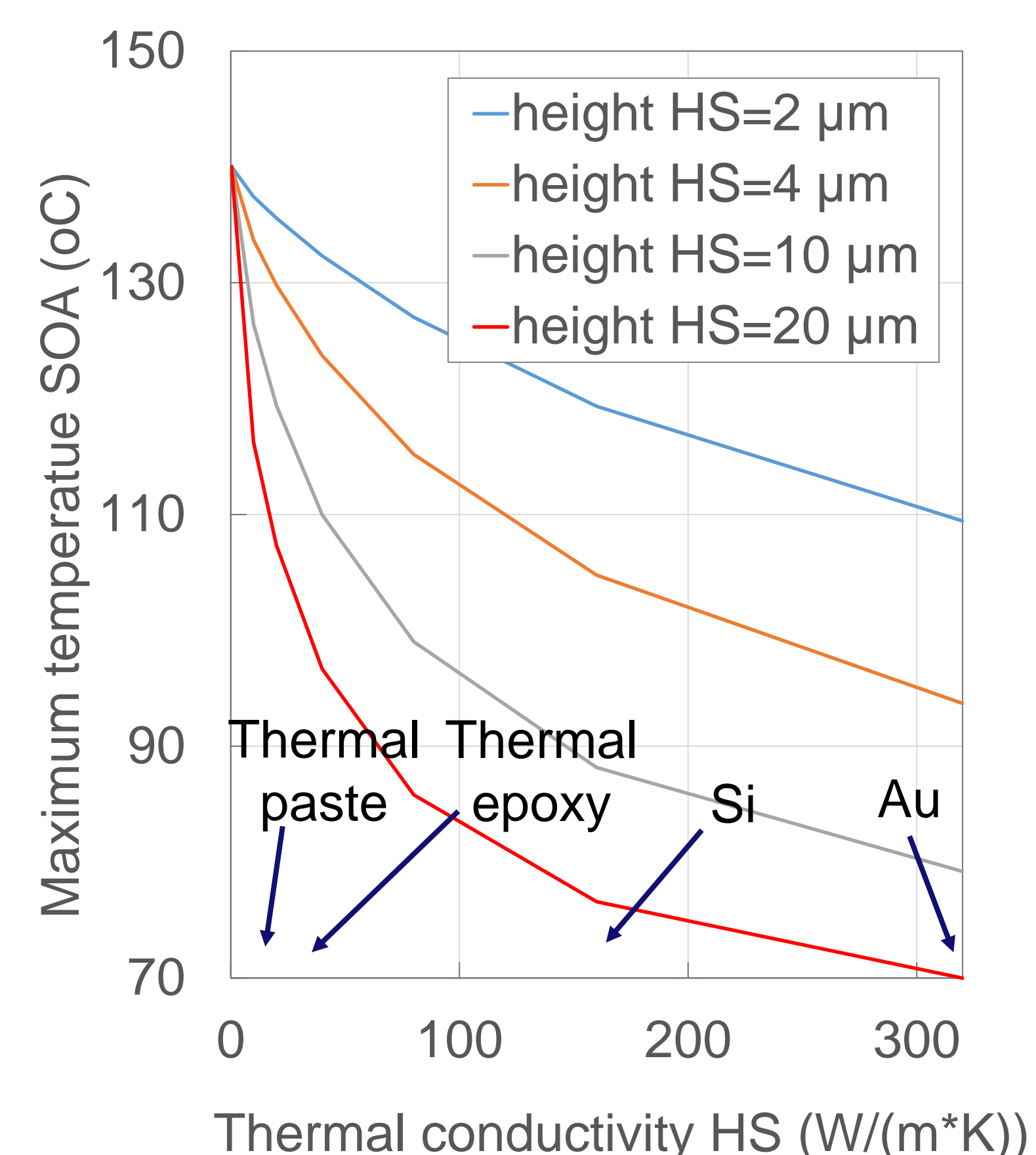


- Thermal cross talk remains below 10 °C.
- BiCMOS layer remains sufficiently cool.
- Heat conduction through vias does not influence the hotspots.
- Heat spreading around SOA still limited.

Heat spreader

T_{max} of the SOA can be reduced by increasing the thickness of the heat spreader or using material with a high thermal conductivity.

- A 2 μm thick gold heat spreader or 20 μm of thermal epoxy will keep T_{max} in the SOA below 110 °C.



Conclusions

We simulated the thermal behavior of a novel photonic-electronic integration scheme and found:

- Thermal cross talk remains below 10 °C.
- BiCMOS layer is cooled sufficiently.
- Heat spreader of at least 2 μm gold is needed to keep T_{max} of the SOA below 110 °C.