First simulations to study thermal conductivity of bonds

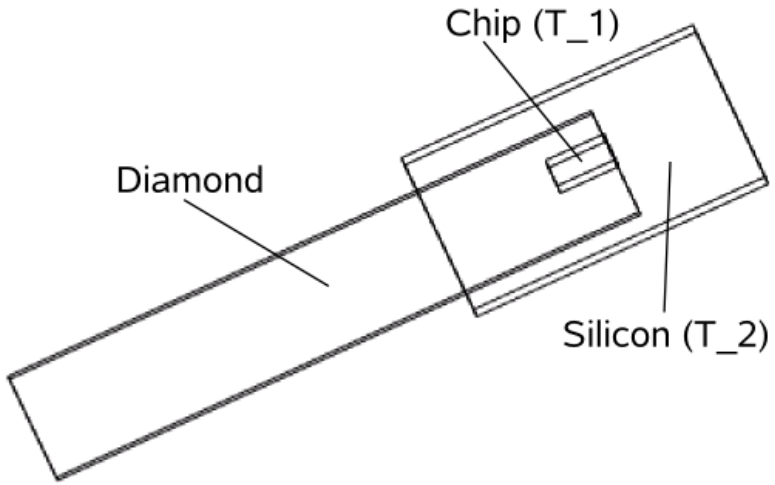
Oksana Brovchenko

Institut für Experimentelle Kernphysik, Universität Karlsruhe (TH)

DEPFET Evo-Meeting, 25.08.2009

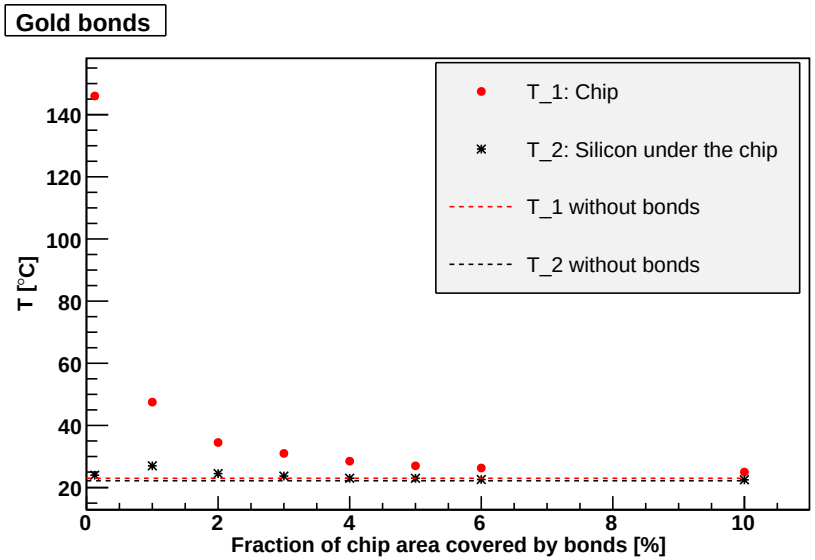
Model

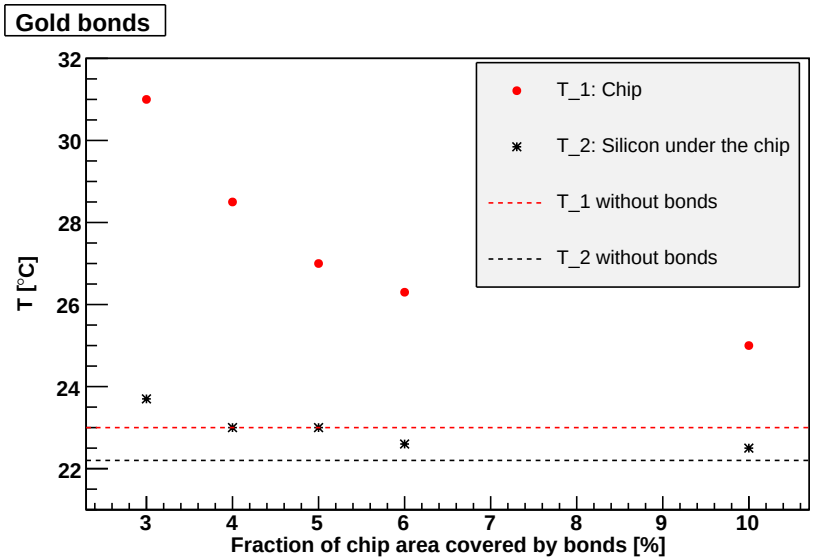
- Silicon chip with 1 W heating power placed on a silicon strip
- Piece of diamond placed below the silicon, the other end of diamond held on 10°C
- Consider the temperature of the chip (T_1) and the temperature of the silicon directly below the chip (T_2)



Gold bonds (k=317 W/mK)

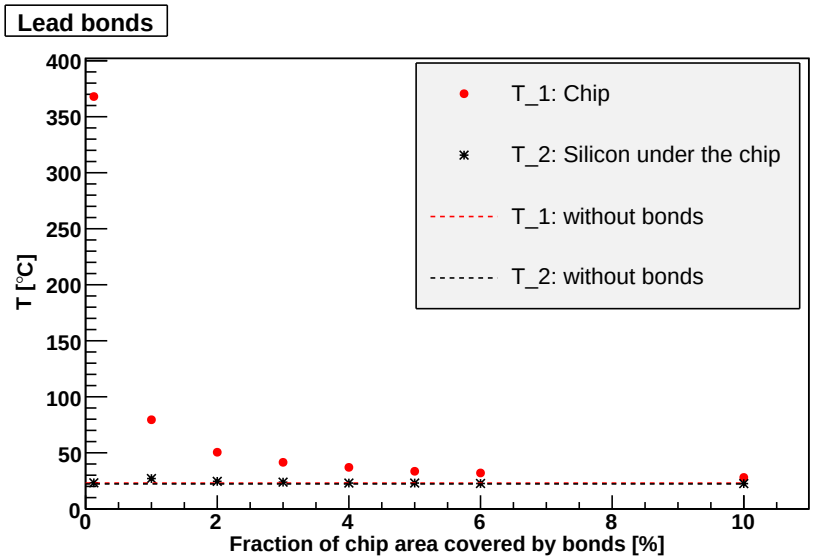
Compare the temperature obtained with ideal contact between chip and silicon (without bonds) to temperature obtained with different bonds (cuboid, 50x50x25μm^3)

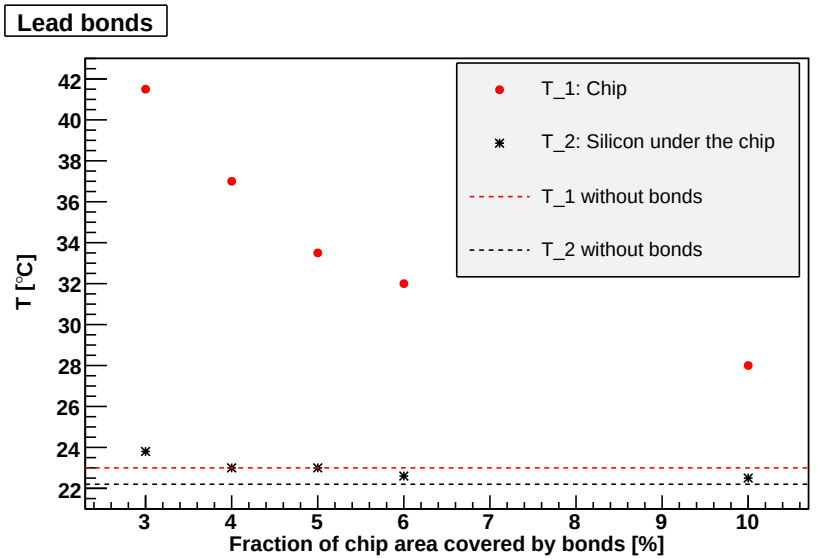




$\Rightarrow$ Silicon temperature nearly constant ($\pm 2°C$), ΔT for the chip $\approx 4°C$ for 5 % of chip area covered

Lead bonds (k=35 W/mK)





$\Rightarrow \Delta T$ for the chip $\approx 10^{\circ}C$ for 5 % of chip area covered

Conclusions

- by using bonds with good thermal conductivity and an area fraction of above 3% the chips get 'only' $\leq 10^{\circ}$C hotter $\rightarrow$ the heat transfer through bonds and silicon to the diamond may be good enough
- if the bonds will be of some lead compounds with bad thermal conductivity and cover below 3 % of the chip area, cooling only below the silicon won't be effective enough

$\Rightarrow$ the thermal conductivity of the bond layer depends *strongly* on the precise fraction of covered area and the thermal conductivity of material used

May it be possible to take it into account in the planning of the bonding process?