
„FAST/SPS and Hot Pressing of hBN/TiB₂ Composites“

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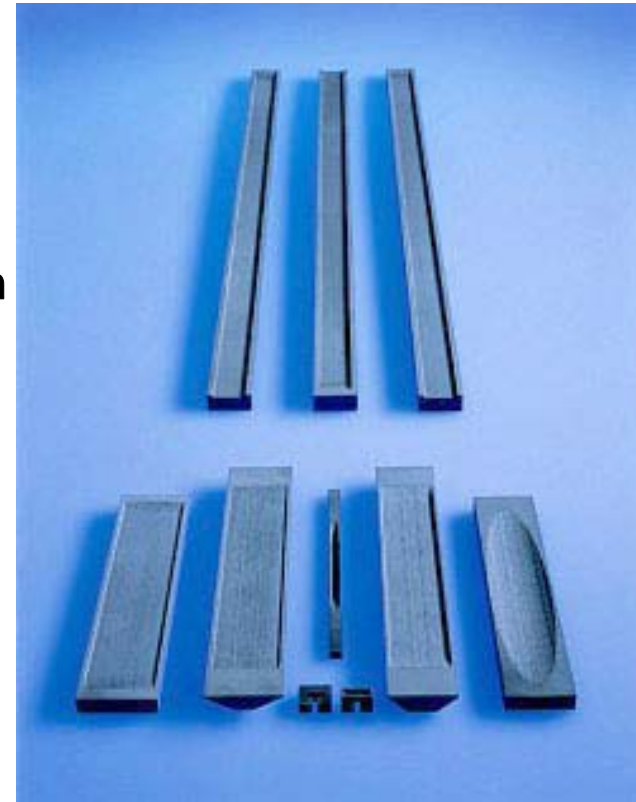
Outline

- **Motivation**
- FAST/SPS of hBN/TiB₂ composite material
- Conclusion – general applicability

Motivation

Electrically conductive composites based on hBN/TiB₂

- Production
 - ball milled (homogeneity)
 - Hot pressed (1,800 – 2,000°C), up to 5h dwell time, overall cycle time 24h
 - cut in shape
- Application
 - Aluminum (Ag, Sn) evaporation boat material
 - Used at continuously and discontinuously working evaporation devices



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Motivation

- Production of functional and decorative layers on different materials (plastics, metals, ceramics)
- Market volume
 - 2004: \$40 Mio. (evaporation boats)
- Challenges to solve during FAST/SPS!
 - overall hot pressing cycle time
 - cutting of boats expensive (diamond wire)
 - spreading of evaporation boats resistivity



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Motivation

Electrically Conductive composites based on hBN/TiB₂

- Approach to solution
 - FAST/SPS of hBN/TiB₂ composite material in near net-shape tool
- Advantages
 - shorten overall cycle time
 - decreasing cutting costs
 - production of small batches

→ Challenges to solve by FAST/SPS!

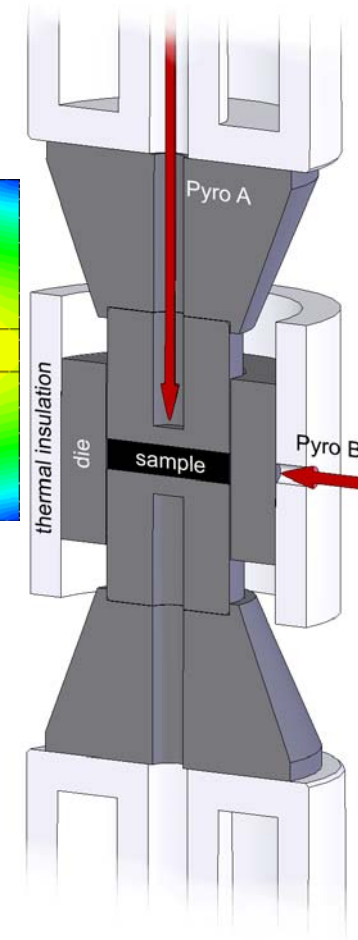
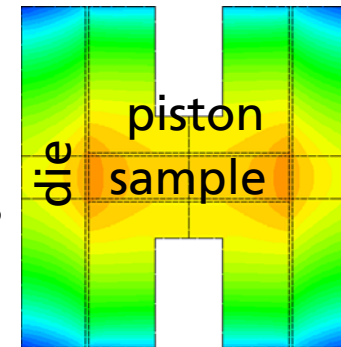
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- Motivation
- FAST/SPS of hBN/TiB₂ composite material
 - FEM Simulation
 - Temperature measurements
 - Multiple pressing tool
- Conclusion – general applicability

FAST/SPS of hBN/TiB₂ composite material

Investigation on two different FAST/SPS devices

- FCT HPD 25/1
 - Sample diameter 40mm
 - 1900°C, 50MPa, various dwell times
 - Temperature, resistivity measurements
- FCT HPD 250
 - Sample size 110x110 (rectangular), quasi near net-shape samples
 - 1900°C, 35MPa, 20min dwell time
 - Tool design
 - General applicability of samples for evaporation

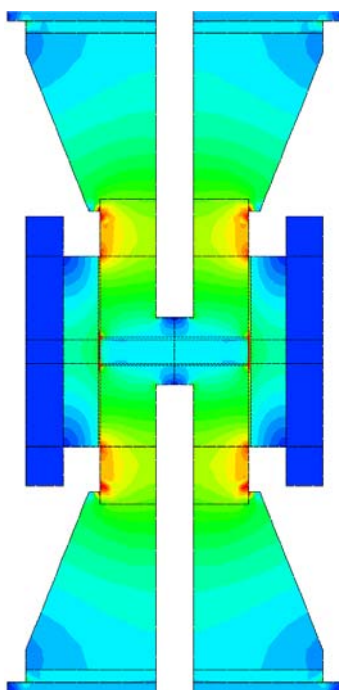


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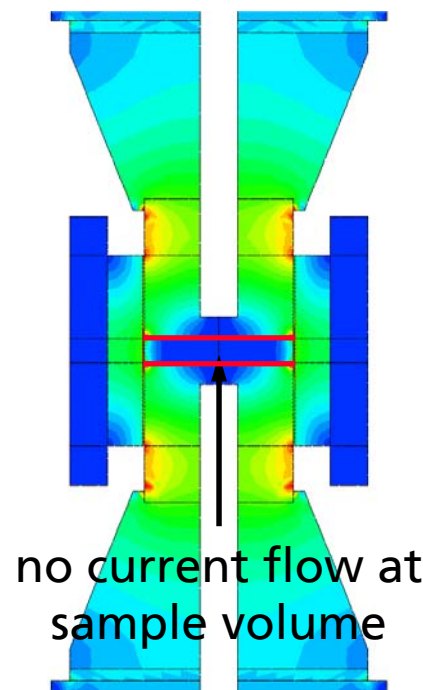
FEM simulation – FCT HPD 25/1

Current density distribution during dwell time for different tool setups

Standard setup
(conductive)

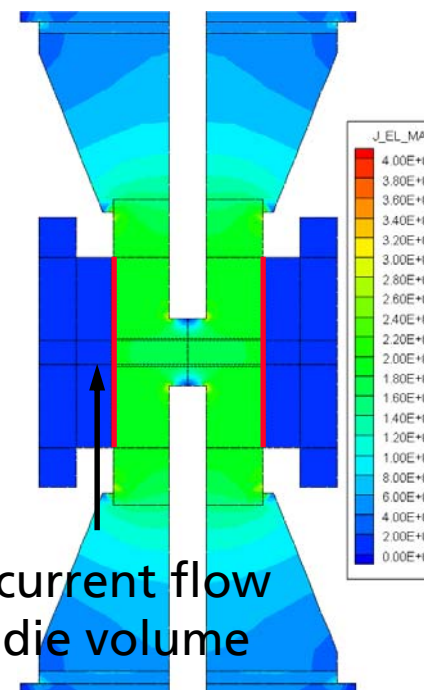


horizontal hBN foil
(electr. isolated sample)

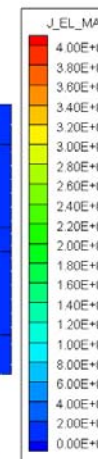


no current flow at
sample volume

vertical hBN foil
(electr. isolated die)

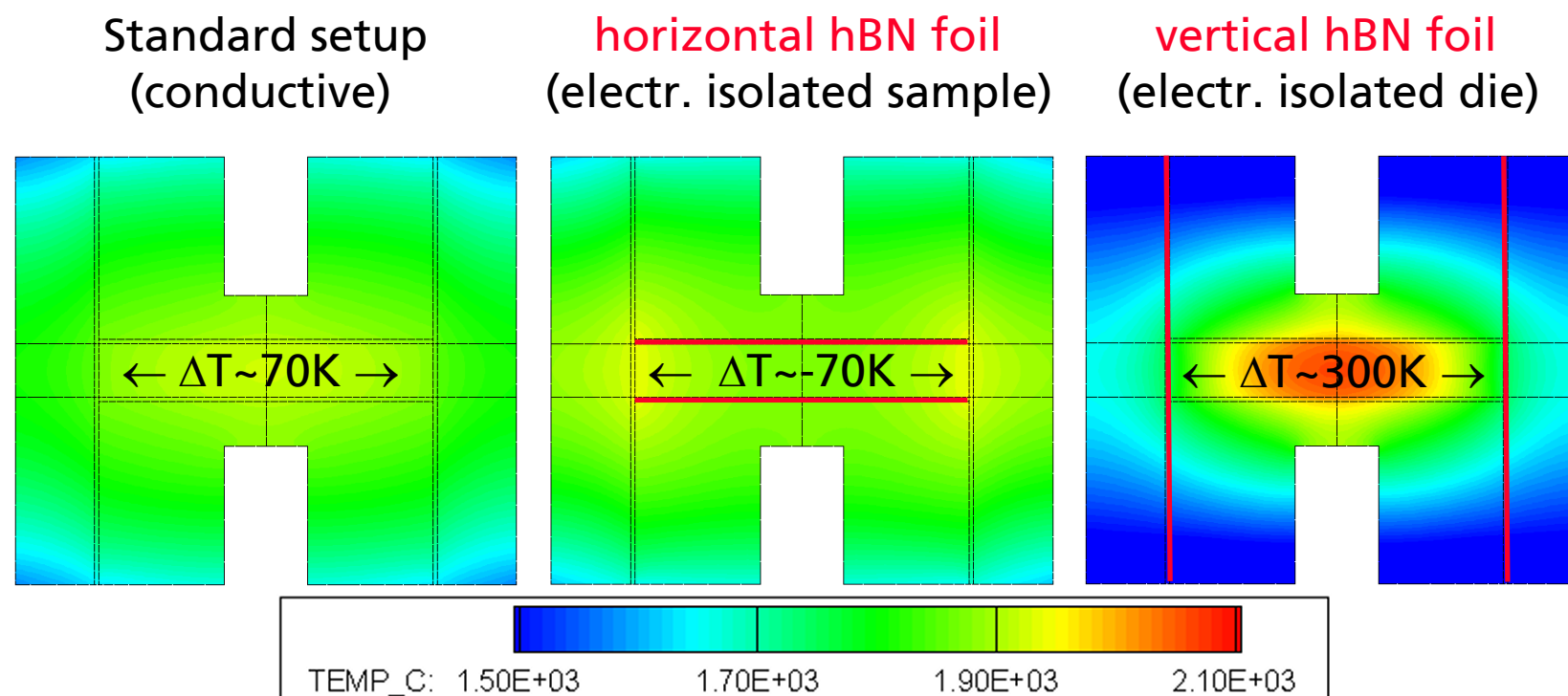


no current flow at
die volume



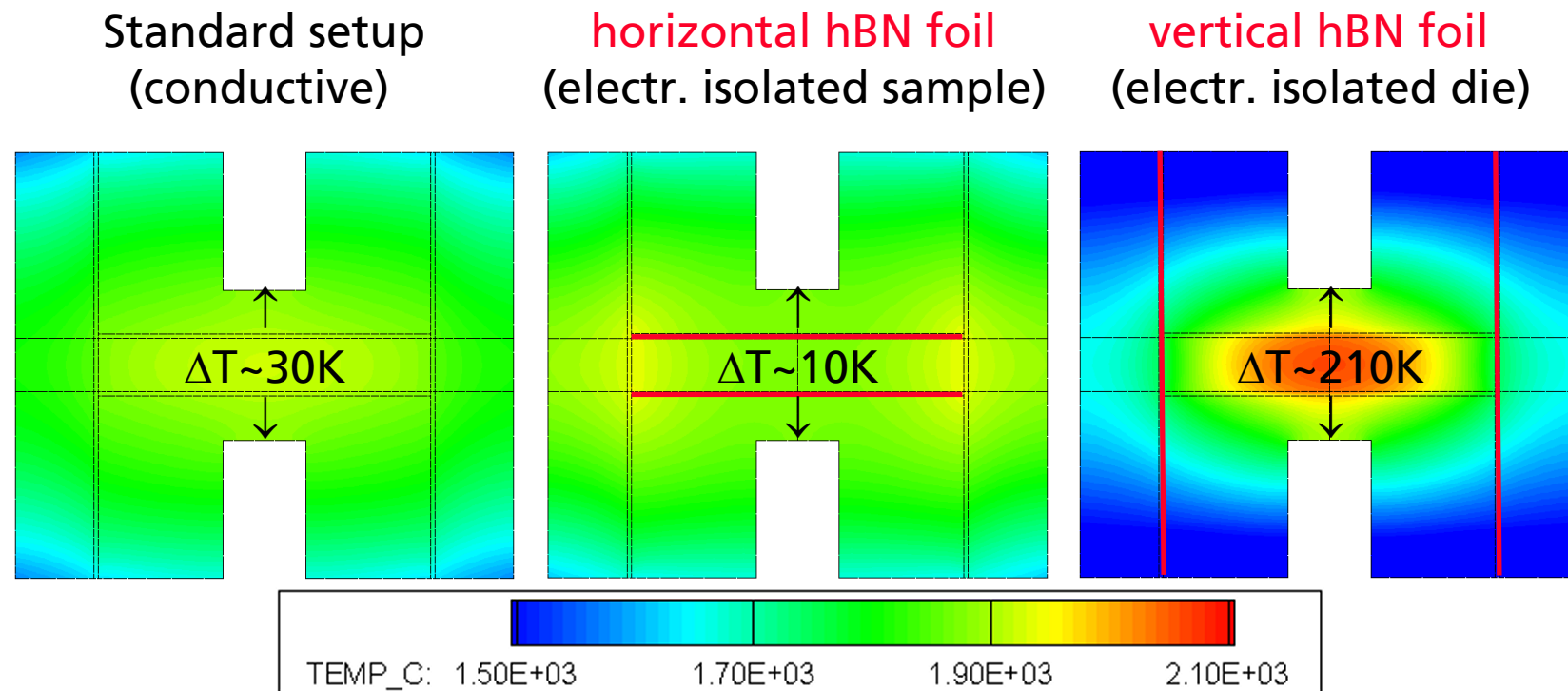
FEM simulation – FCT HPD 25/1

Temperature distribution during dwell time for different tool setups



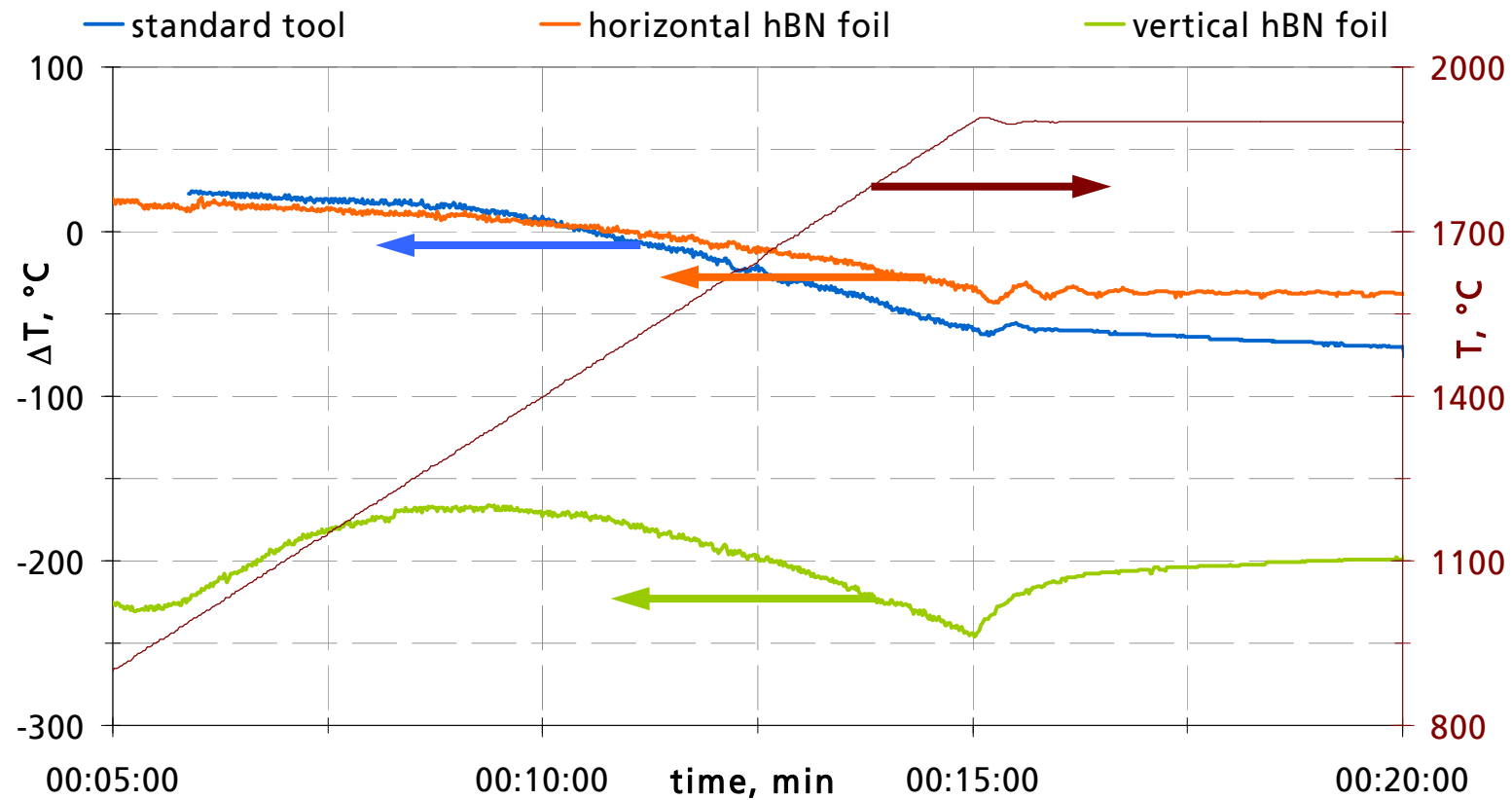
FEM simulation – FCT HPD 25/1

Temperature distribution during dwell time for different tool setups



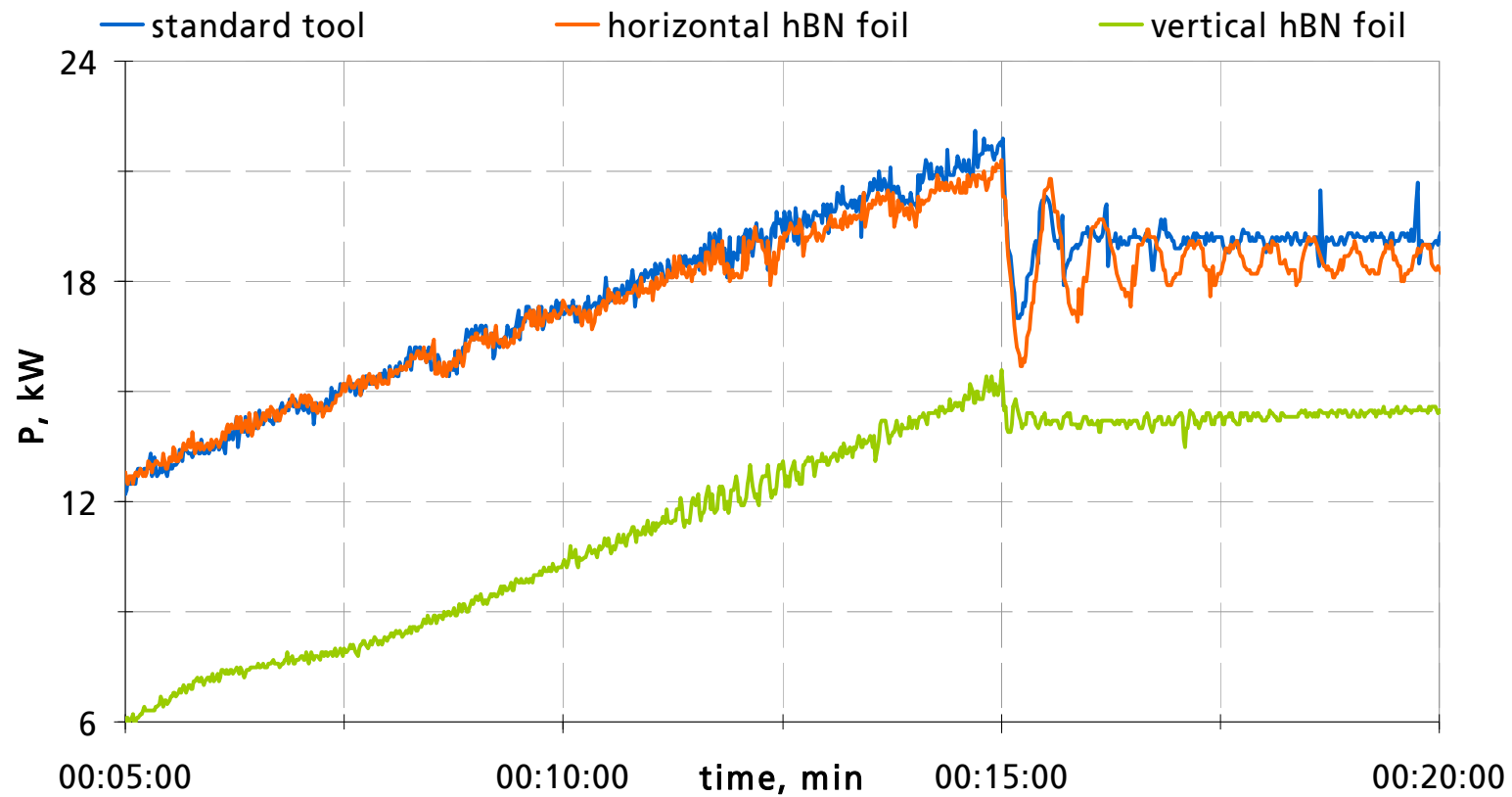
Temperature measurements – FCT HPD 25/1

Temperature difference of pyro B and A as a function of time



Temperature measurements – FCT HPD 25/1

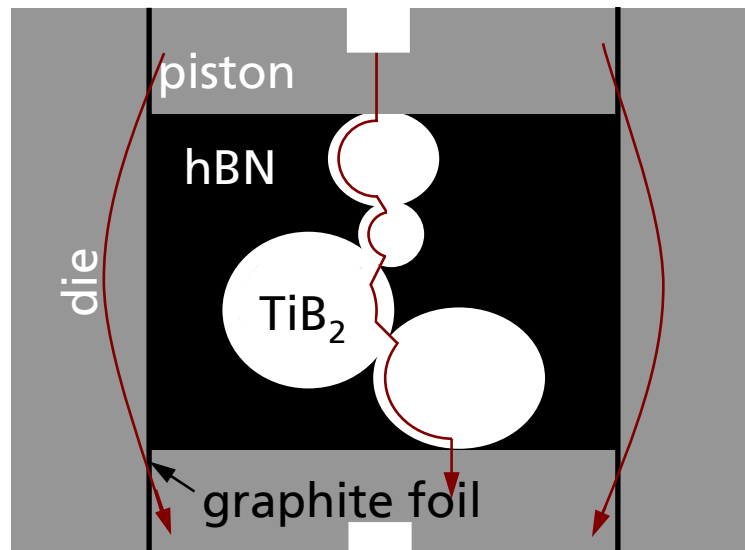
Electrical power output as a function of time



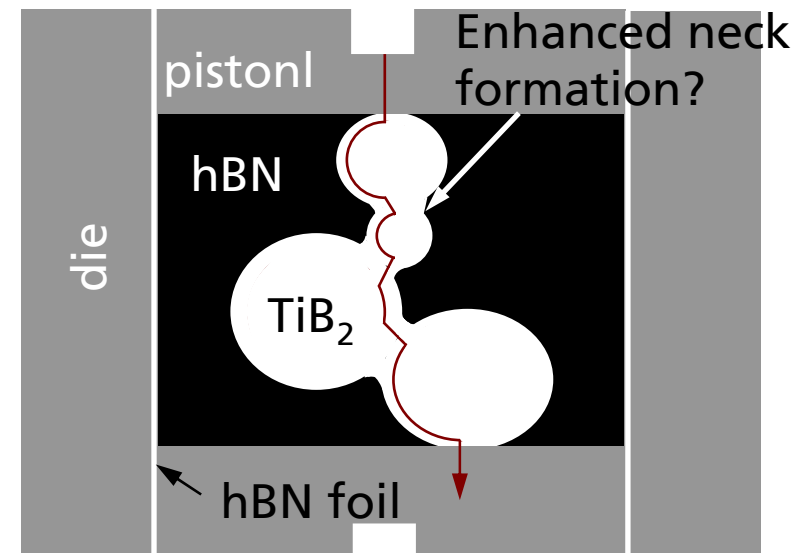
Temperature measurements – FCT HPD 25/1

Enhanced neck formation induced by tool design?

standard tool setup

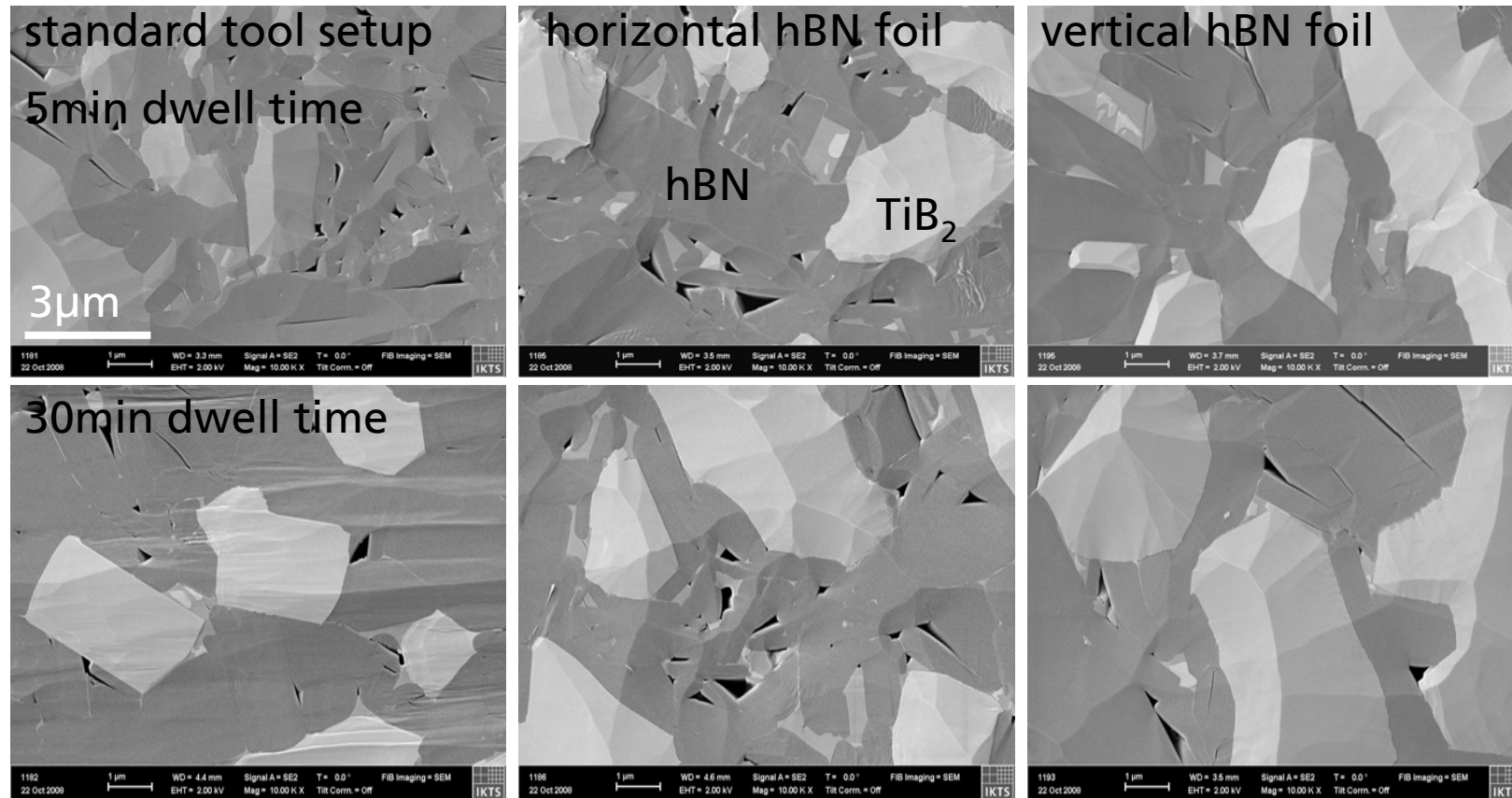


vertical hBN foil
(electr. isolated die)



Temperature measurements – FCT HPD 25/1

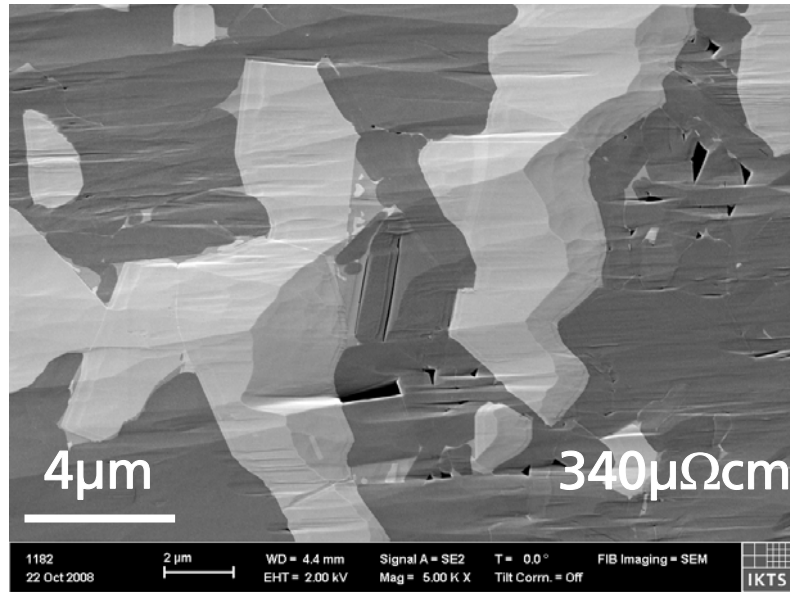
Grain growth of hBN using different tool setups



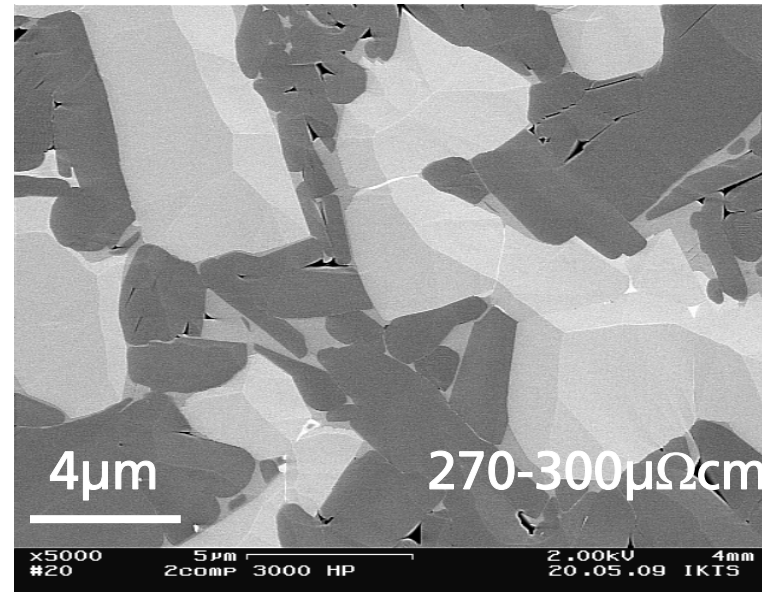
Temperature measurements – FCT HPD 25/1

Comparison of microstructure and properties

FAST/SPS sample



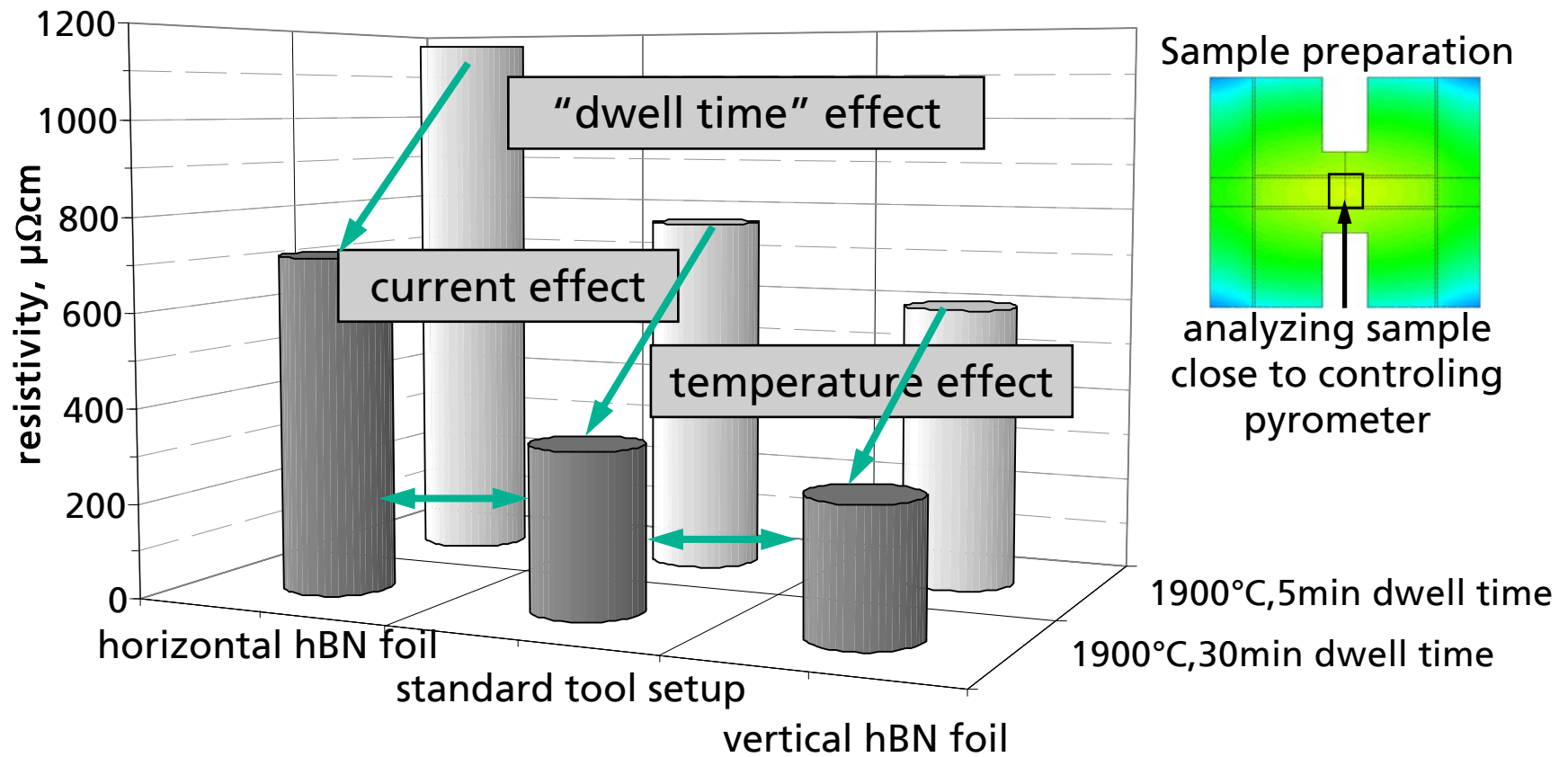
Hot pressed sample



nearly same results for 30min FAST/SPS and 3-6h HP sample at 1900°C

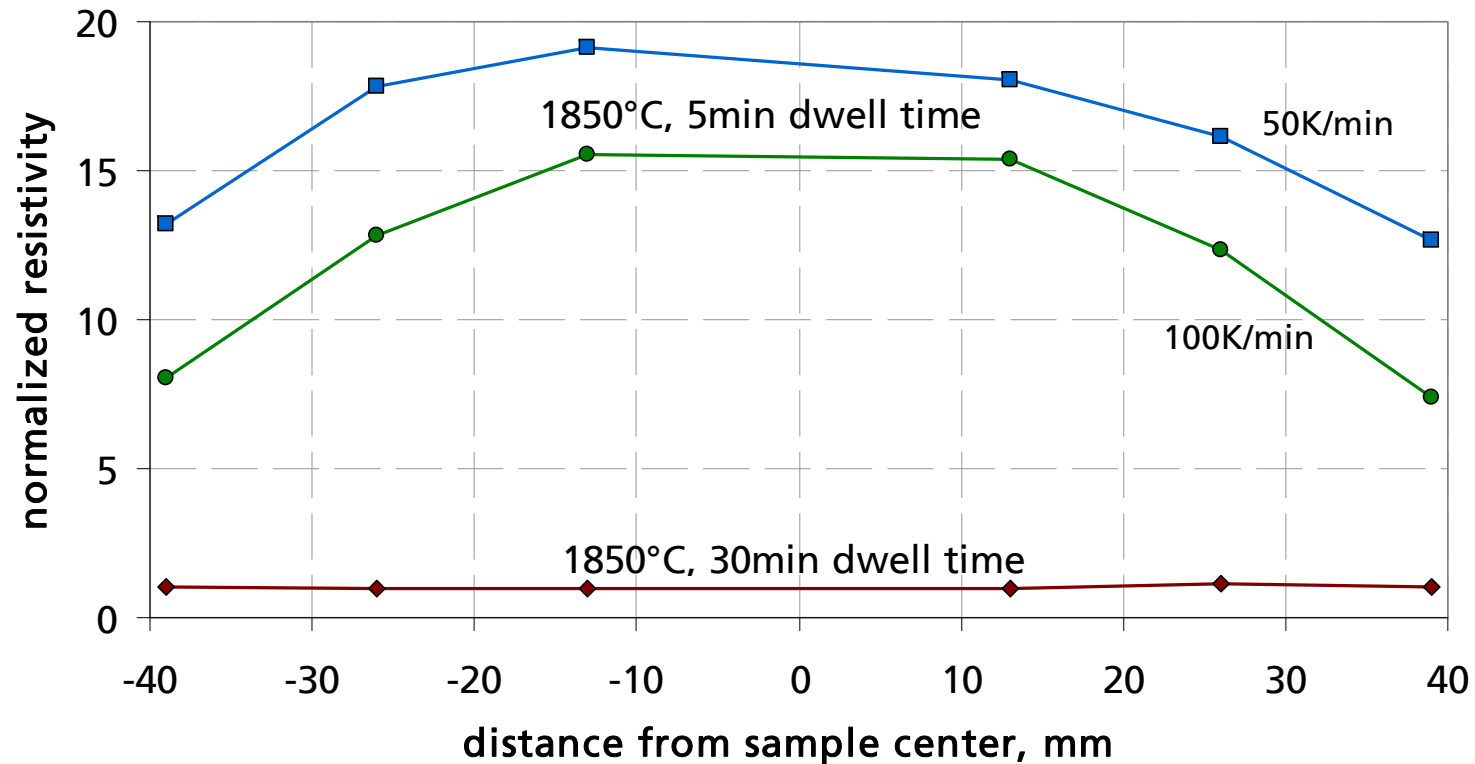
Temperature measurements – FCT HPD 25/1

Change in resistivity induced by tool design



Temperature measurements – FCT HPD 25/1

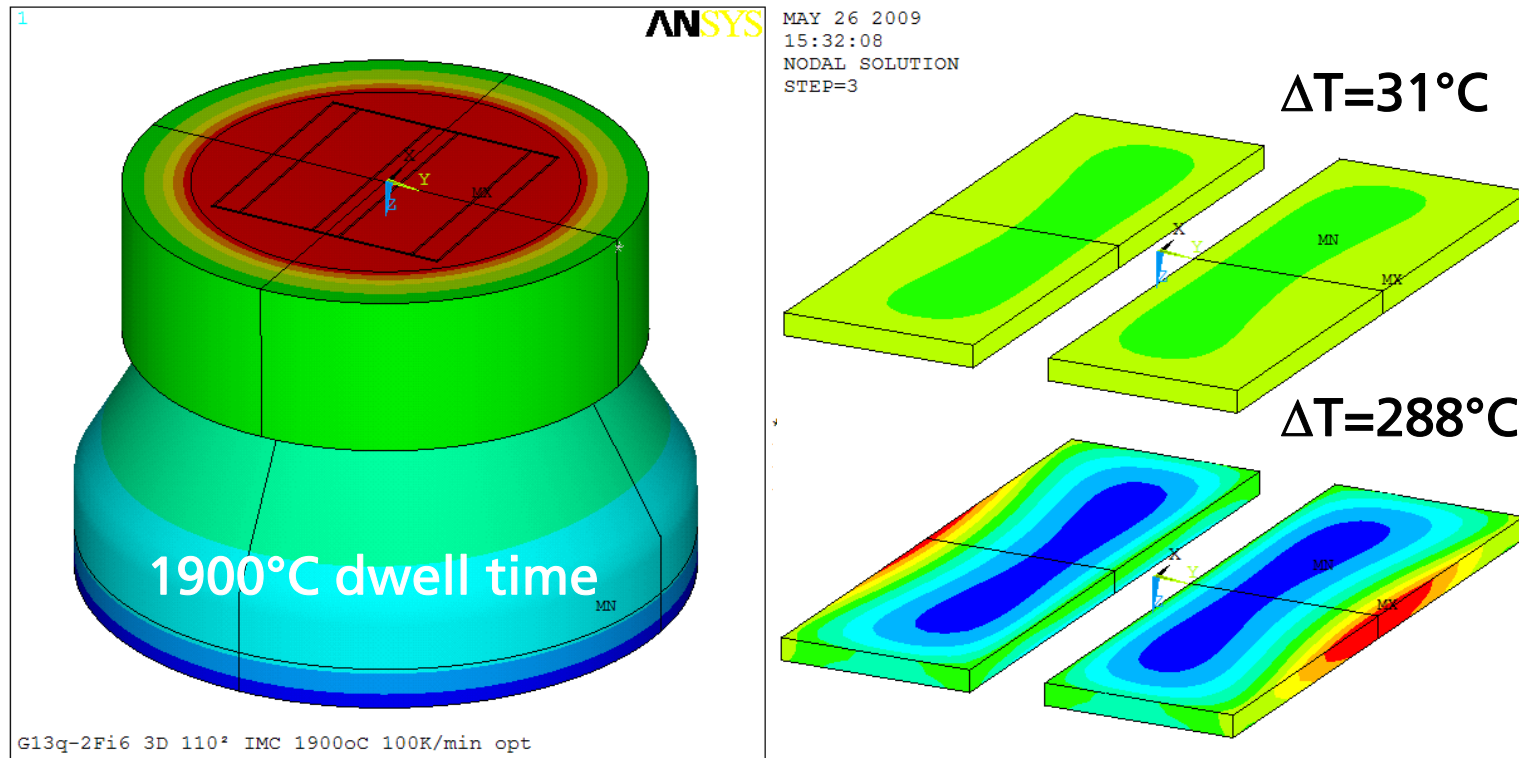
Resistivity as a function of distance from sample center for a standard tool setup $\varnothing 80\text{mm}$



FEM simulation – FCT HPD 250

Multiple pressing tool, near net-shap pressing tool

- Geometry 2x110x50mm for evaporation boats of 110x10x6mm



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Conclusion

Tool design

- Small modification in tool design strongly influencing temperature distribution
- Using simple adaptations the modulation of current path becomes possible

FEM modelling

- Enhances understanding of temperature distribution
- Useful tool, if boundary condition are adjusted well
- Experimental evaluation strongly needed

Conclusion

Composite hBN/ TiB₂

- Preparation of samples with homogeneous resistivity distribution
- Manufacturing of long time stable samples
- Production of near net-shape sample

→ FAST/SPS technique useful for the production of small hBN/TiB₂ batches or test series

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Thanks for your attention!