CERN Mechanics

Project meeting 6.9.2011, Geneva

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Project plan for CERN secondment at Metso

- Markus Aicheler will stay at Metso Tampere site on 10-11.2011.
- The main target is to investigate whether HIP-processing would be suitable for CLIC copper parts.
  - Diffusion bonding by HIP
  - Copper preforms by HIPing from powder
  - Brazing tests by various surface roughness and brazing material
- HIPing will be done by VTT's small size HIP unit at Espoo.
- Capsule making is probably done by VTT also but can be done at Tampere as well.
- Sampling, mechanical testing and characterization at Metso Foundry lab.
- SEM-time is easily available from TUT if needed.

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HIP-unit available for testing

At VTT, Espoo

- In HIP encapsulated and vacuum degassed metal and ceramic powders are densified with high gas pressure at high temperature
- HIP facilitates almost unlimited material compositions and versatile structures
- Composite materials (MMCs, CMCs) and compound structures are produced with mixing and layering different powders or solids in the capsule

VTT's HIP-facility:

- chamber size Ø130 x 300mm
- Tmax=2000°C
- pmax=207 MPa

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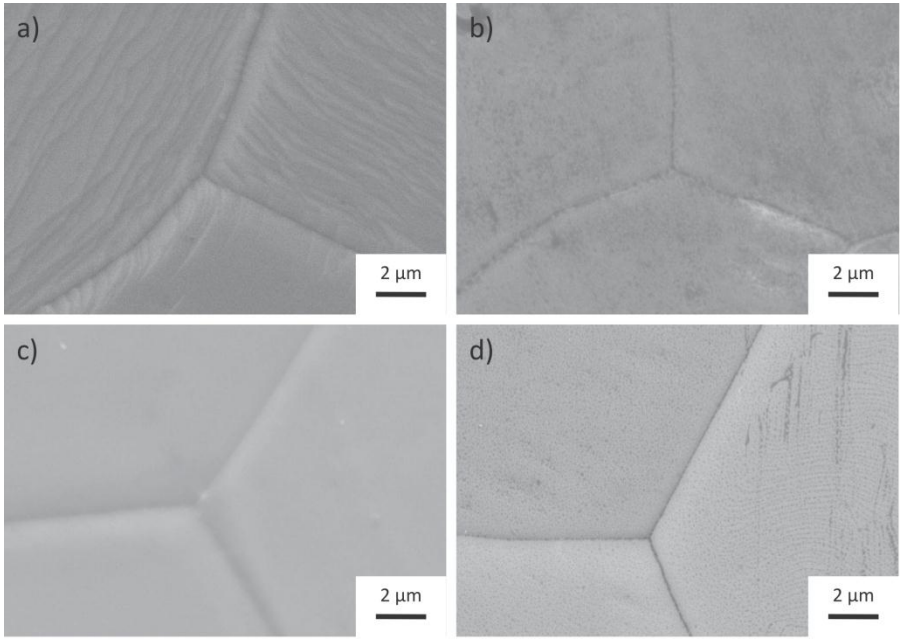
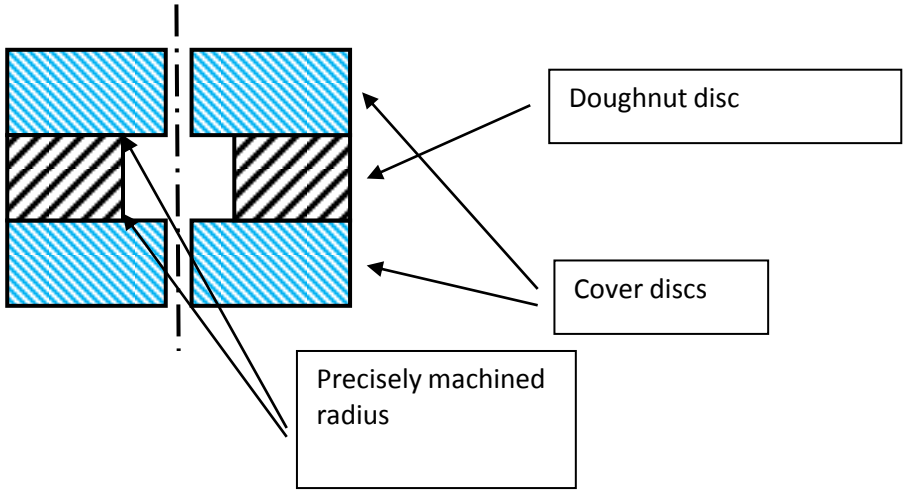
Work package 1

- **Study of influence of HIP diffusion bonding process on grain size and mechanical properties of OFE copper and the resulting surface roughness on diamond turned discs.**
- Individual raw discs will undergo HIP diffusion bonding cycle with various pressures (1, 100, 200 MPa).
- Metallographic characterization of grain size (on witness discs) and hardness measurements.
- Tensile test (test specimen machined from discs).
- **Prerequisites:** 3 sample discs + 3 witness discs; diamond turned and cleaned.



Work package 2

- **Work on innovative possibilities for enhancement of joining through HIP diffusion bonding process and study roughness requirements for ensuring good bonding quality including potential half-notch reduction (outer wall - iris wall).**
- Three sets of three stacks of sample discs (doughnut disc + 2 covers; only feature radius precisely machined, three different surface roughness) undergo HIP diffusion bonding cycle with various pressures (1, 100, 200 MPa).
- Cutting open of structure and optical microscopy and potentially SEM.
- **Prerequisites:** 3 x 3 sets of discs machined to different surface roughness.



Work package 3

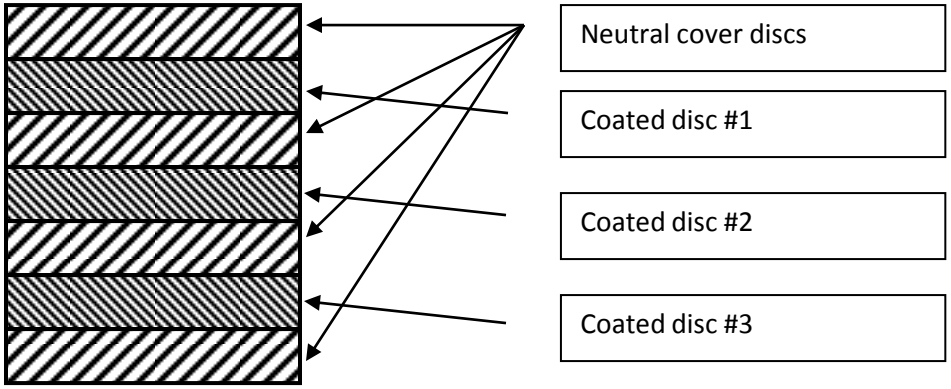
- **Study of feasibility of HIPing a CLIC AS disc from powder.**
  - Characterization of chemical, mechanical, electrical and microstructural properties of HIPed material.
  - Study of possible encapsulations for near-net-shape HIPing
- **Prerequisites:** identification of a supplier for copper powder.
  - Electrolytic powder
  - REP-powder
  - Gas-atomized powder + hydrogen treatment

Work package 4

- **Study of brazing of parts pre-coated with enabling layers.**
- HIPing or vacuum brazing of 1 stack (3 pre-coated discs + 4 neutral discs) of bonding test of pre-coated samples:
- Details about the layer system see below
- Cutting open of stack and optical microscopy.
- **Prerequisites:** 1 set of pre-coated discs, cleaned.

Three sets of layer systems should be conducted (all thicknesses in µm):

	Set 1	Set 2	Set 3
Ni diffusion barrier	10	10	10
0th Cu layer	25	20	17.5
1st regular Au layer	20	10	5
1st regular Cu layer		5	2.5
2nd regular Au layer		10	5
2nd regular Cu layer			2.5
3rd regular Au layer			5
3rd regular Cu layer			2.5
4th regular Au layer			5
Total thickness	55	55	55



Summary of sample discs needed and HIPing cycles conducted for program

- Roughness, hardness and tensile test at 3 different pressures:
  - 3 discs (diamond turned; Ø95 x 25 mm);
  - 3 witness discs (diamond turned; Ø12 x 3 mm);
  - 3 HIP cycles;
- Roughness requirements for HIPing at 3 different pressures:
  - 9 doughnut discs (3 pressures x 3 different roughness; Ø80 x 15 mm, hole Ø40, radius precisely machined!)
  - 18 cover discs (9 x 2; Ø80 x 15 mm); same roughnesses as doughnut
  - 0 HIP cycles (can be done together with point 1.)
- Feasibility of HIPing a disc
  - Powder; 1-3 Hip cycles
- Brazing with pre-coated discs
  - 3 pre-coated discs (no diamond machining!, Ø40 x 15 mm; 1 eccentric hole 3 mm)
  - 4 neutral discs (no diamond machining! Ø40 x 15 mm)
  - 1 low temperature HIP cycle

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METSO motivation for CERN/Mechanics

- End-covers was a large powder metallurgical project or Metso (then Powdermet) in both reference and economic wise:
  - Good relations wanted to be maintained by practical co-operation, person-to-person networking etc.
- CLIC structures need huge amount of very high-tech components:
  - Possible large commercial possibilities
  - High demands force technological development that can be used for other products also
  - CERN is a huge research lab, new technologies are developed and new ideas spread -> maybe something useful for Metso as well
  - Personal development of the secondmend people