

Semester Thesis Presentation

Designing a Sample Holder for the MNK-P Measuring Setup

January 23, 2009

Zumbühl group

University of Basel

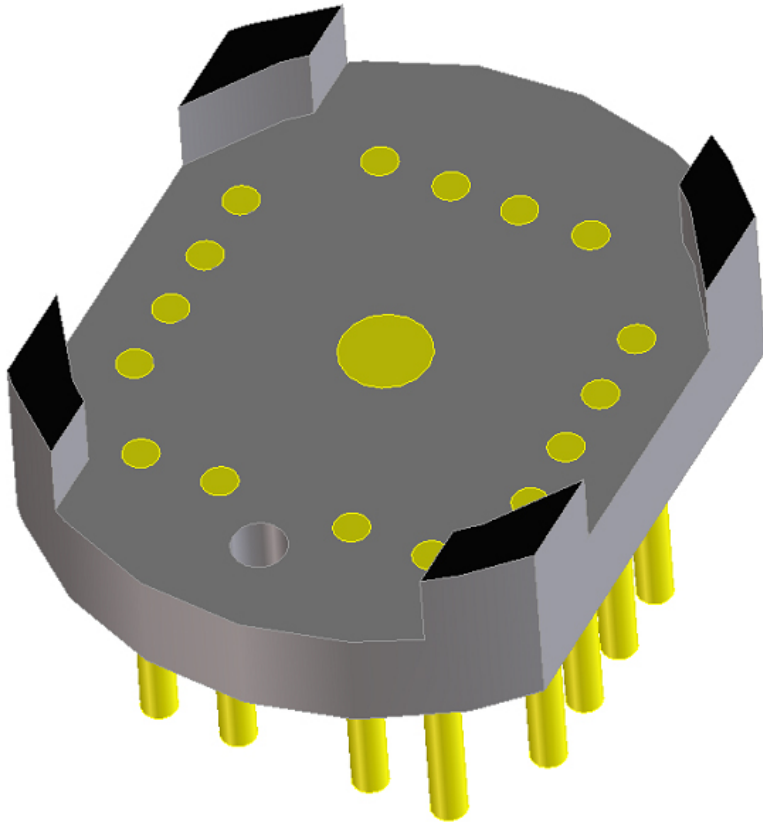
Dario Maradan

Step by Step...

- 1) design a model with a CAD tool
- 2) create a Teflon form to pour the epoxy in
- 3) machining: mill, cut and polish the sample holder
- 4) glue a sample on the sample holder and bond Au wires from sample holder to sample
- 5) measure resistances (triple R values)

- 6) remote control of the GHS system / TCS etc.

Target: Sample Holder



- aim: create a sample holder that fits in the MNK-P measuring setup and fulfills the following needs:

- good thermal conductivity
- insulating
- ~16 contacts
- spacer to protect the sample
- fixation (screw hole)

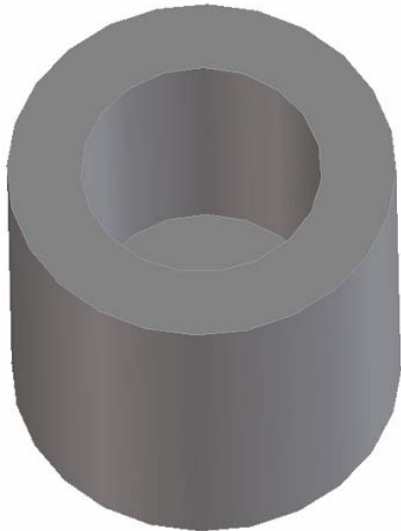
First Ideas...



- upper and lower part

- problems:

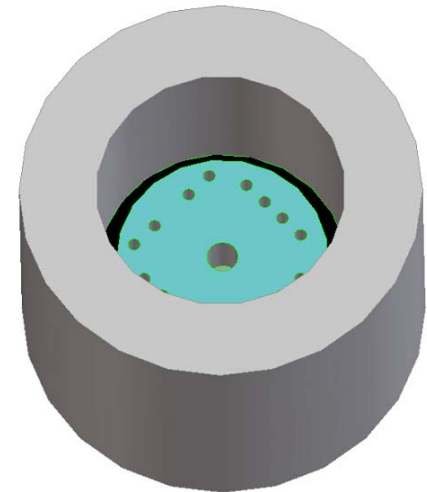
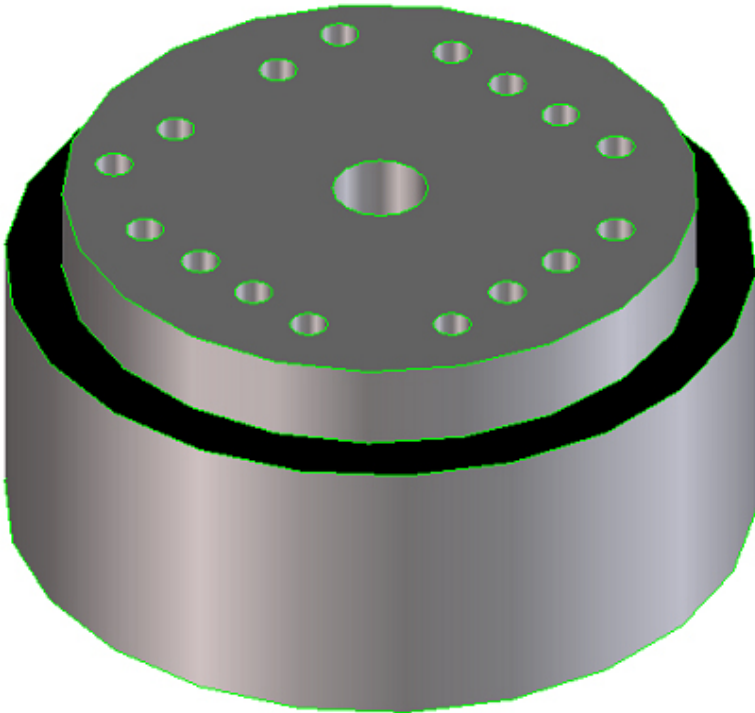
- How to fix the wires?
- air bubbles?
- adjust thickness?



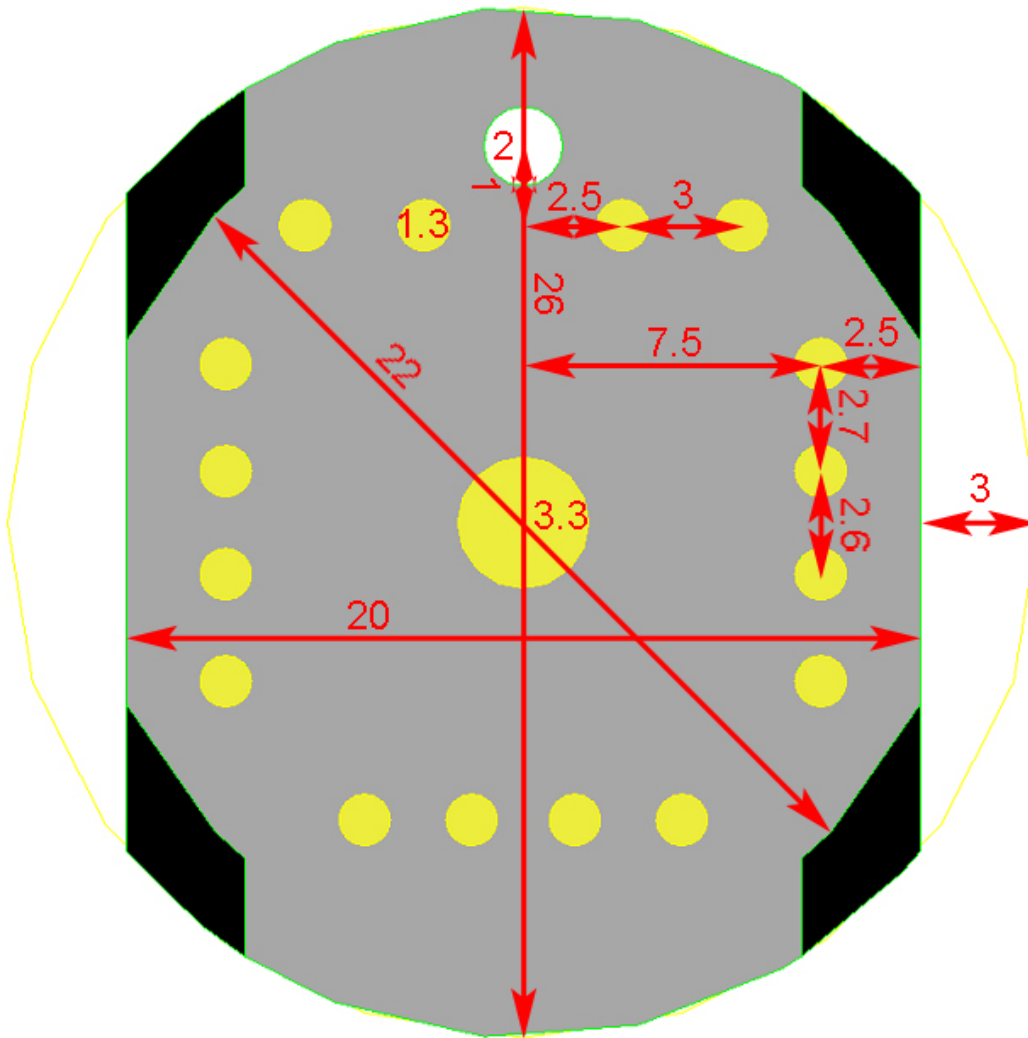
Too complicated...

Final Draft

- two parts: cylinder and bottom
- wires are fixed by the holes (~5mm in depth) in the bottom, spacers are a result from the outer circle after cutting and milling



Sample Holder: Dimensions



- outer diameter: 26mm
- “inner” diameter: 22mm
- width: 20mm
- height of epoxy: ~3mm
- spacer height (black): 3mm
- wire diameter: 1.27mm (hole 1.3mm)
- screw hole diameter: 2mm
- depth of the holes: ~5mm

(numbers in circles are diameters)

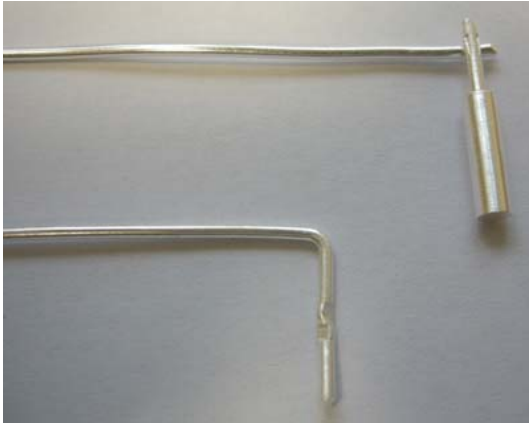
Teflon Form



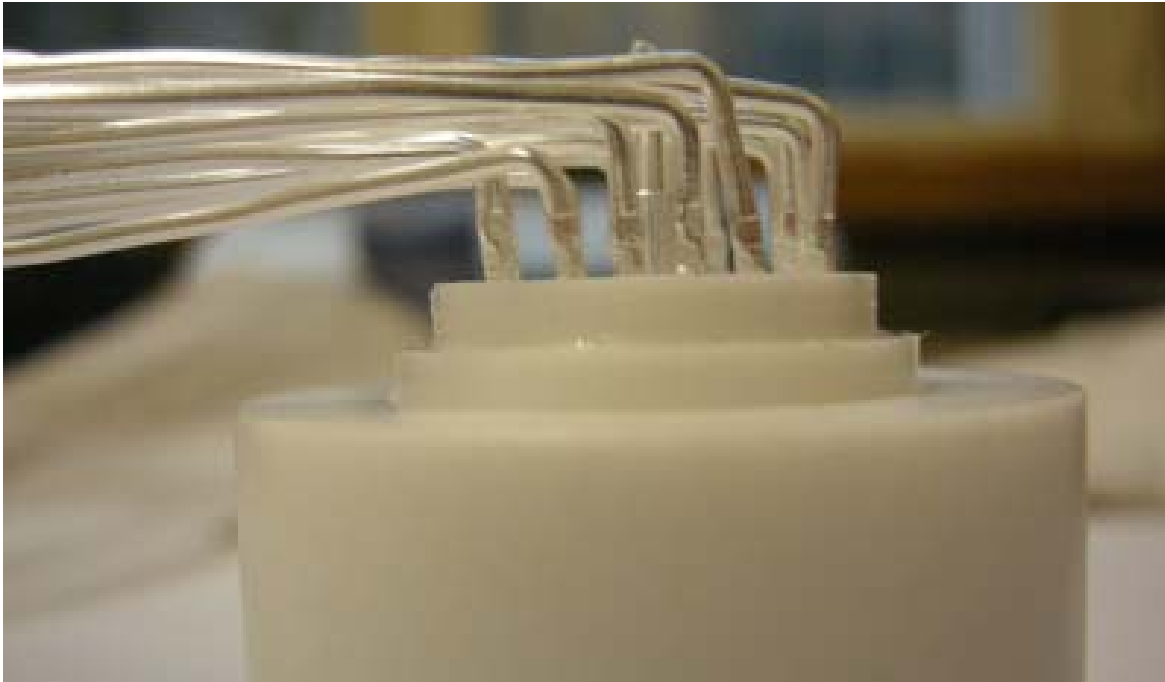
Teflon was lubricated with grease
(Dow Corning high vacuum grease)



Preparing the Wires



- silver wire (5n)
- 16 wires (+1 in the middle that should conduct heat away from the sample)
- wires were bent, squeezed, cleaned with EtOH and annealed at $\sim 800^{\circ}\text{C}$



- squeezes should prevent torsion
- middle wire was cut out of a piece of 4n silver and attached to the wire using spot welding

Epoxy: Stycast 2850 FT

problem: chunks / dry epoxy



solution: heating

(only black part, ~50°C)



Stycast 2850 FT with Catalyst 23 LV (Emerson & Cuming)

- good thermal conductivity
- low coefficient of thermal expansion (low stress on embedded components)
- key features of Catalyst 23 LV: „low viscosity, thermal shock and impact resistance“

After Mixing: Degas the Epoxy



Pour Epoxy in the Form



- epoxy was filled in the prepared Teflon form using a micro pipette: not easy to do because it is quite viscous and there is not much space



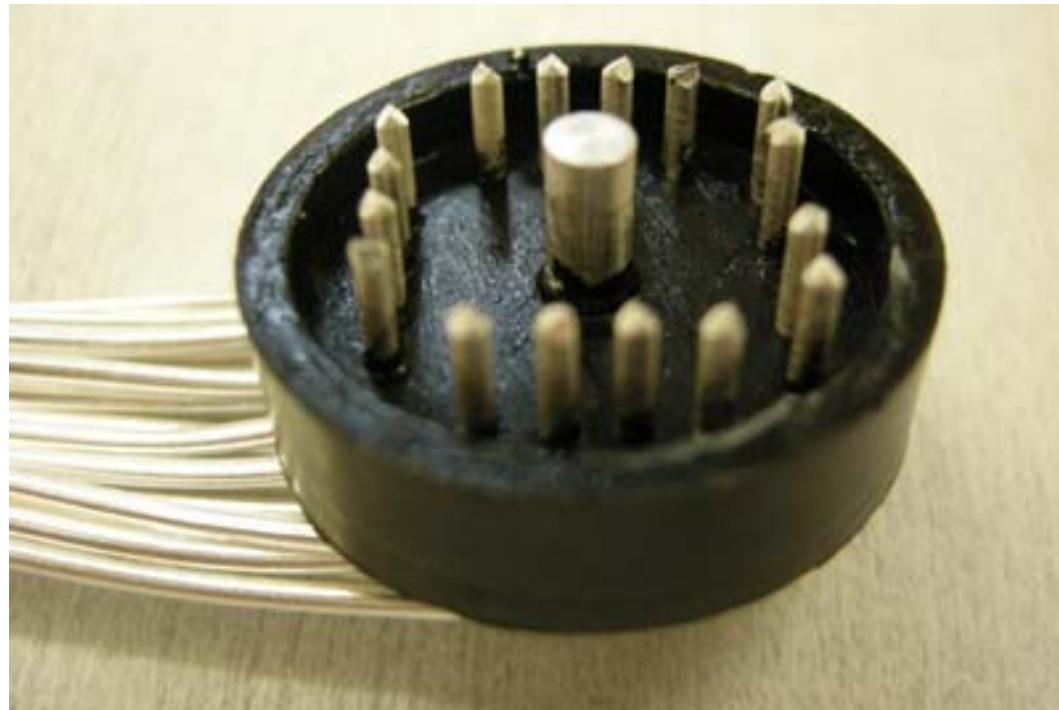
- cured within about 24 hours ...

And Removed...

Step 1



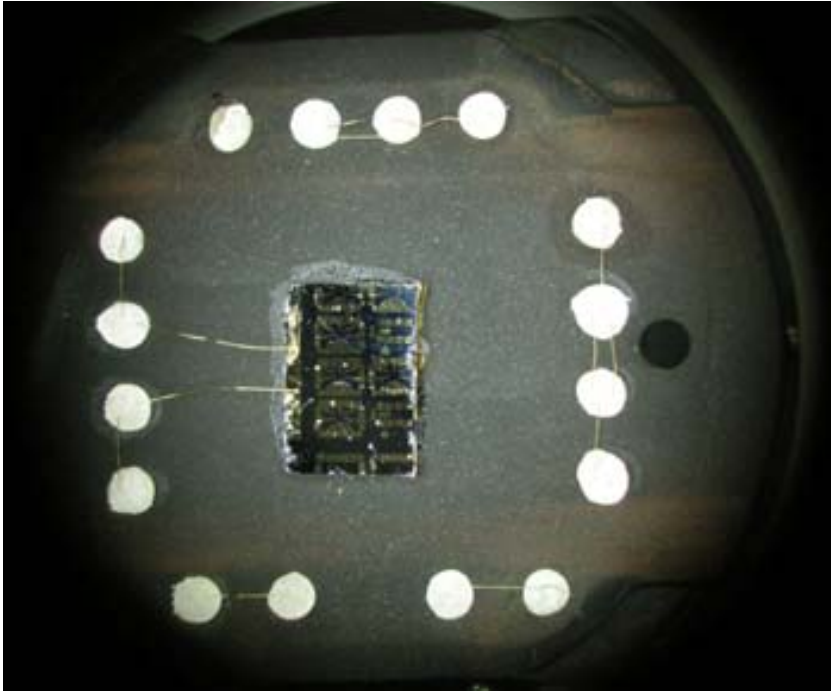
Step 2



Machining

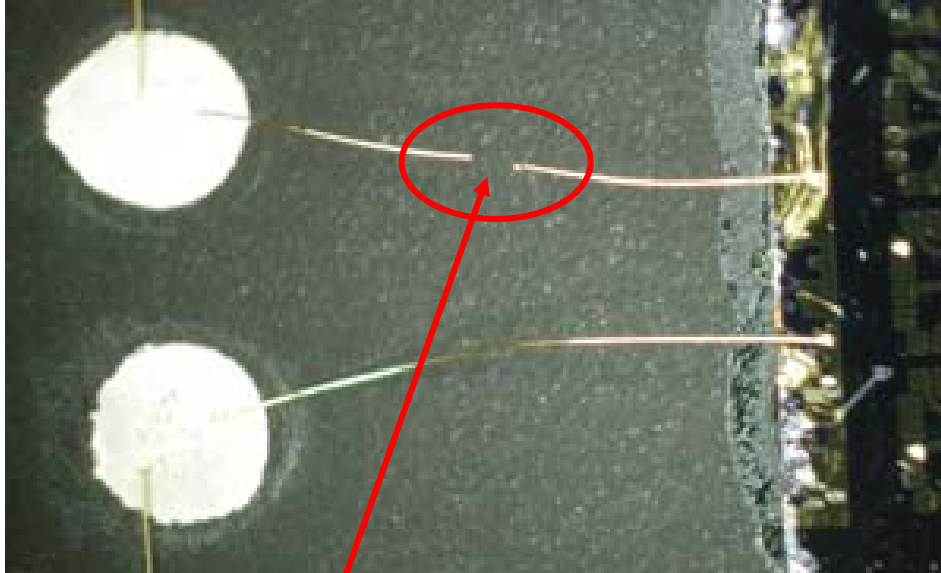
- cut and mill down (shop)
- the screw hole (M2) was drilled
- sample holder was polished and cleaned with ethanol

Fixing and Connecting a Sample



- test sample was glued on sample holder with varnish
- in the real case eventually with Ga?
- Au wires
- wire bonder: using a sample-holder holder (gray tube) with a plate (~5mm thick) to reach the optimal height

Measuring Triple R Values



Too high current?

Possible explanation: heat dissipation too small (wire is longer than from Ag contact to Ag contact)

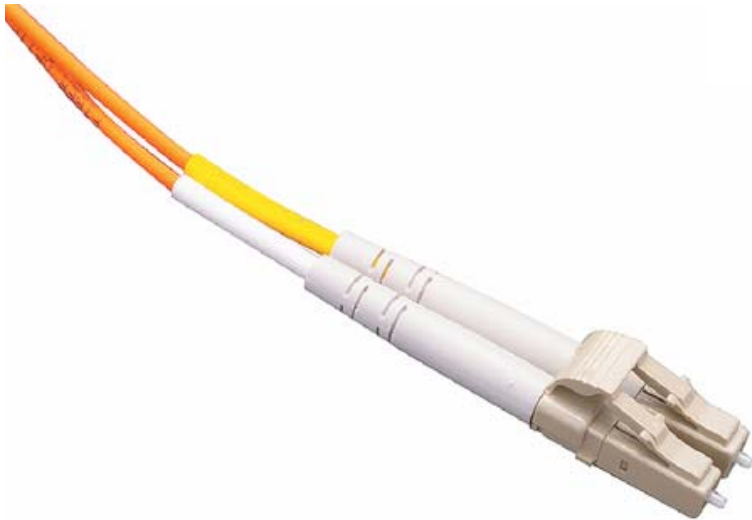
- wire from Ag contact to Ag contact (not shown):
 - at RT: $\sim 90\text{m}\Omega$ ($\pm 5\text{m}\Omega$)
 - at 4K: $\sim 2\text{m}\Omega$ ($\pm 0.1\text{m}\Omega$)
 - \rightarrow RRR ~ 45
- this triple R value corresponds to the value of the Au wire (no influence of the Ag wires; bonds seem to be okay)
- cooling down the sample holder to 4K and warming up seem to be unproblematic

At last: A few words about remote control



- E5805A (*Agilent*): RS232 to USB converter
- 1 USB output for 4 RS232 inputs
- power supply via USB
- painful driver installation: each installation recognizes only 2 of the 4 ports, so you have to install it twice (...?). It's strange, but it works!

Decoupling of the Fridge



- Ranger 442 (*Amplicon*)
- 2 parts: REX (device-side) and LEX (computer-side) connected with fiber-optic cable
- 4 USB plugs (REX)
- 2 separate 5V power supplies
- power available to each USB plug at REX: 500mA
- fiber-optic cable 50/125 μ m duplex LC/LC (*Distrelec*)

I thank everyone of the group for
your help,
useful hints,
your patience
and...

... your attention!

