# Gluing

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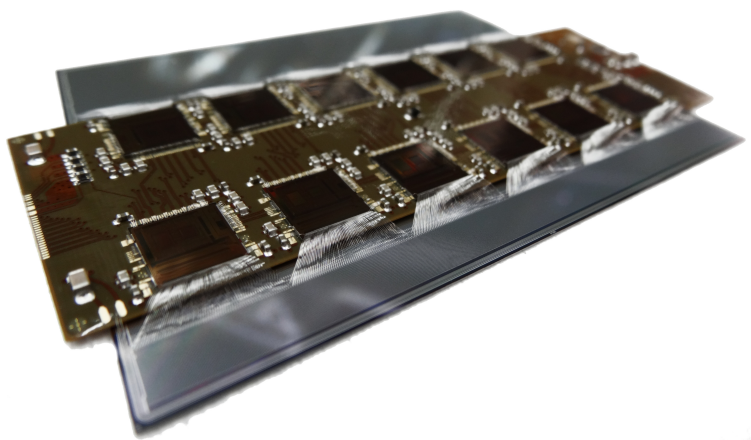
April 6, 2016

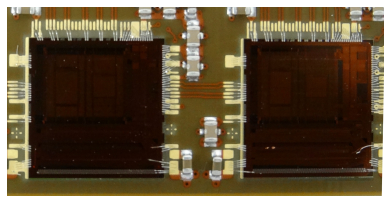


# Why are glues so interesing?

- all components of a module are kept together with glue
- less weight and space than screws or clips (smartphones/tablets ☺)
- but, are we able to qualify a glue for use in the detector upgrades?
  - lightweight
  - easy to handle
  - easy to obtain in all countries related to module production
  - "long" shelf life
  - sticks to: gold, silicon(oxide), Kapton, aluminium(oxide)
  - does not damage ASIC or sensor
  - keeps sticking at $-30\,^{\circ}\mathrm{C}$ for $10+$ years
  - survive thermal cycles down to $-30\,^{\circ}\mathrm{C}$
  - **radiation tolerant** for HL-LHC

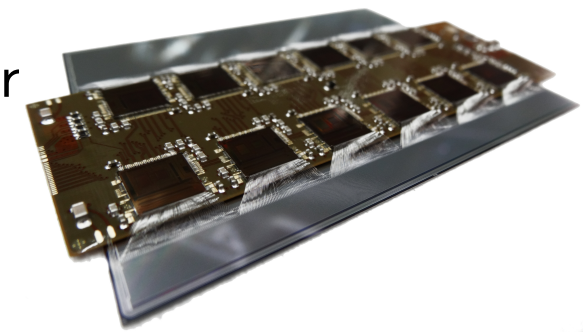
# Glues for different use cases

## ASIC to hybrid



- silicon on one side – gold plated copper on other
- transfers heat from ASIC into hybrid
- does not damage ASIC

## hybrid to sensor



- passivated silicon on one side – Kapton on the other
- transfers heat fram hybrid into sensor
- must not influence electrical properties of sensor
- unusual location of electronics

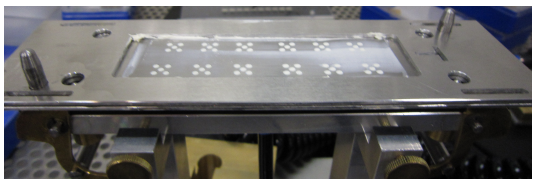
## Features nice to have

- easy + precise application
  - mixing for each module?
  - cleaning of used tools after each module?
- fast curing (components need to be hold in place by vacuum)

# ASIC to hybrid

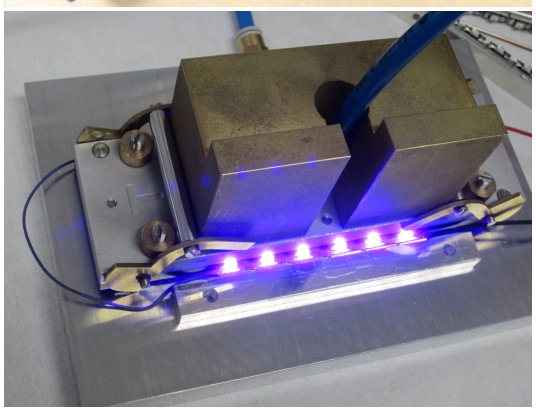
Two choises

## Silverepoxy (TRA-DUCT 2903)



- historical reasons
- electrical connectivity of ASIC substrate
- good thermal connectivity
- high viscosity
- best application with stencil


## UV curing (DYMAX 6-621, Loctite 3525)

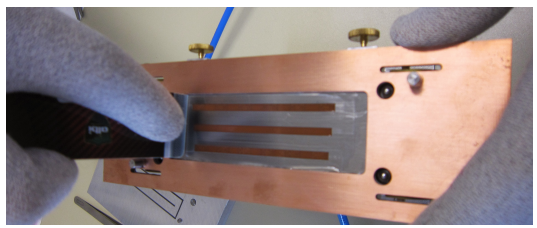


- no electrical connectivity (no influence seen)
- low to medium viscosity (not with stencil)
- best applied with dispenser ((semi)-automatic)
- very fast curing ($\sim 1\,\mathrm{min}$)
- no mixing or cleaning of stencil

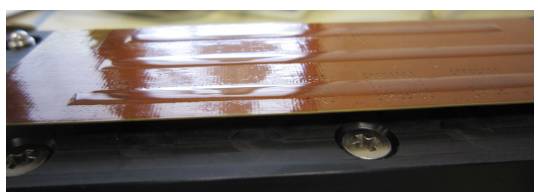
# Hybrid to Sensor

UV glue not yet qualified (being worked on ☺)

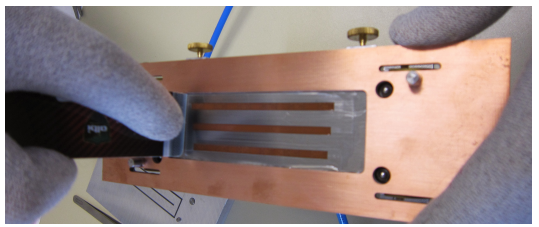
## Epolite FH-5315



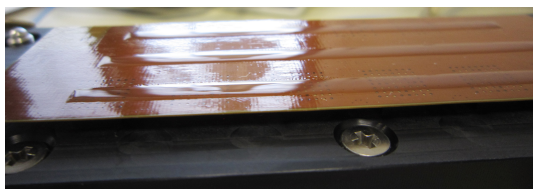
- historical reasons
- electrical grade epoxy
- high viscosity (depends on time after mixing)
- best application with stencil
- cures $\sim 8\,\mathrm{h}$



# Application with stencil



- high viscosity glues only
- uses stainless steel ($\sim 120\,\mu\mathrm{m}$) glue template
- steel sits flat on hybrid/ASIC surface
- glue is scquished with spatula in glue pattern
- creates glue pattern with thickness of steel sheet

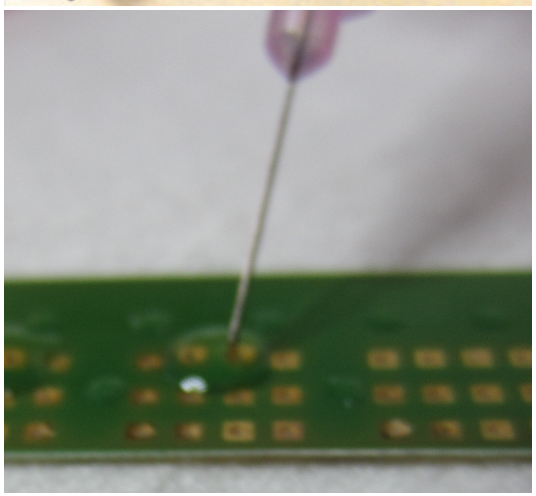


- but
  - no perfect seal between hybrid/ASIC and steel
  - glue wets surfaces very well
    $\rightarrow$ some creeps in between steel and hybrid/ASIC
  - every swipe pushes more glue between steel and hybrid/ASIC
  - if to much, adhesion stroger than holding vaccum
  - stencil needs to be cleaned after every glue application

# Application with dispenser

- wide rage of viscosities possible
- glue in syringe (black for UV glues)
- carefully chosen stainless steel needle
- apply air high pressure ($3\,\mathrm{bar}$) for a defined time ($100\,\mathrm{ms} - 3\,\mathrm{s}$) to back of surringe
- in case of low viscosity glues, hold a small vaccum in case no pressure is applied
- glue amount defined mainly by viscosity, needle diameter and dispensing time
- very small dispensing volumes possible ($\ll 1\,\mu\mathrm{l}$)
- in case of constant viscosity, high volume repeatability





# Curing

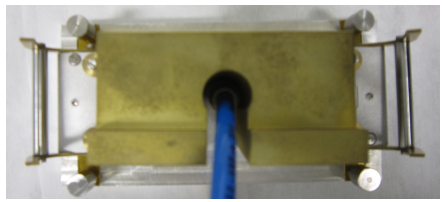
- components held in place by vacuum
  - components are handled with vacuum pick-ups
  - to achieve high dimensional accuracy (especially in z direction)

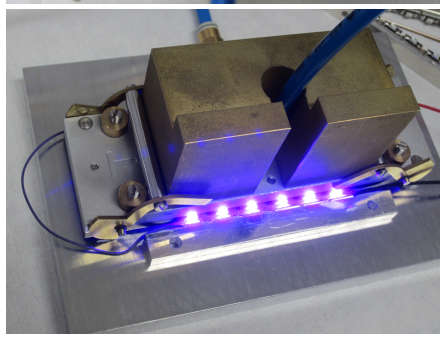
## Convential – Time

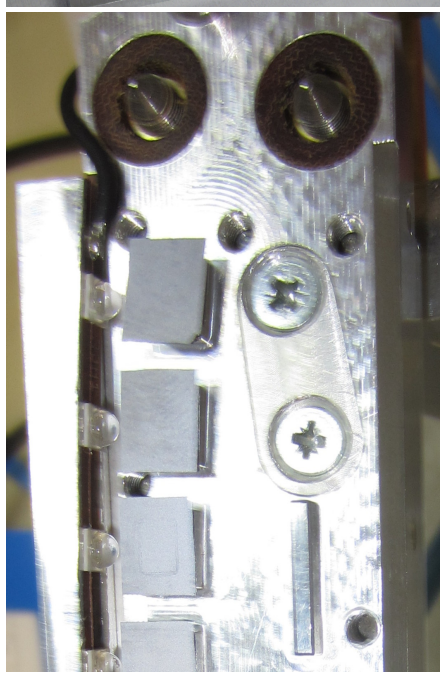
- usually at room temperature to achive maximal dimensional stability
- 2 part glues usually take $\sim 8\,\mathrm{h}$ to set
  - otherwise application would be too time critical

## UV curing

- UV glues requre “high” power “UV” light in the full glue volume
  - “UV” – we use $1\,\mathrm{W_{el}} \sim 200\,\mathrm{mW}$ $405\,\mathrm{nm}$ LEDs
  - “high power” – $1\,\mathrm{W_{el}}$ per chip, but only small cross section into glue $(80\,\mu\mathrm{m} \times \sim 1\,\mathrm{cm})$
  - LEDs as close as possible at glue joint







# Application Video

https://www.youtube.com/watch?v=ypMhwR1vfNg