Finding glues for the ATLAS Tracker Upgrade

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Outline

Motivation

Search for possible candidates

Mechanical properties

Performance

Stress tests

Properties

Issues with the current glue

Silver epoxy glue

used to glue read out chips on hybrids

- 6 hrs curing time (problem in mass production)
- silver (Z=47) leads to high radioactive activity
- $>$ 50% (mass) silver significantly reduces radiation length of glue
- silver epoxy glue corrodes aluminium (chip backside)

Requirements for replacement

Hard criteria

- radiation hardness
- good thermal conductivity
- strong connection on gold
- short curing time
- no corrosion of aluminium
- working temperature range from -20 to +100 C

Soft criteria

- no shrinking during curing process
- low cost
- low toxicity
- viscosity similar to currently used glue
- low activatability
- flexibility after curing

Candidates

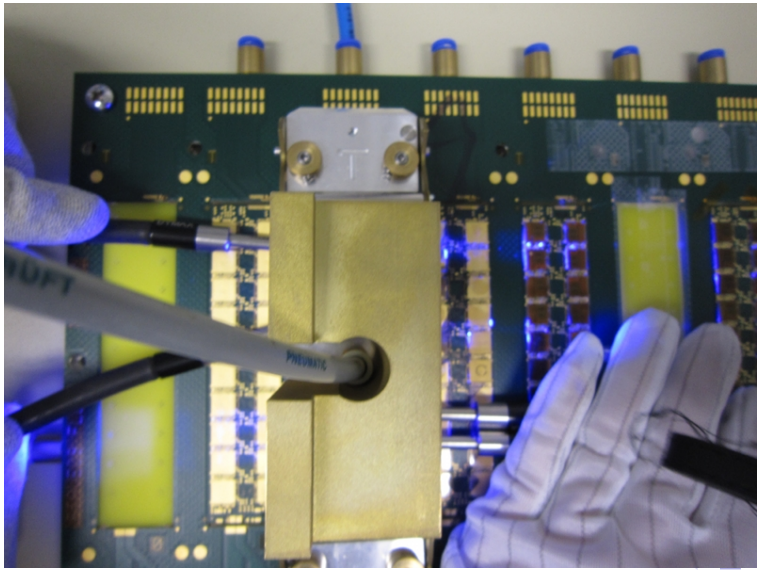
Glues which match the criteria the most

- DYMAX 3013 (UV-curable, highly fluid)
- DYMAX 3025 (UV-curable, highly fluid)
- DYMAX 6-621 (UV-curable, highly fluid)
- Loctite 3525 (UV-curable, viscos)
- Loctite 3504 (UV-curable, viscos)
- Polytec UV 2133 (UV-curable, highly viscos)
- glueing film (no curing needed, thickness 0.3 mm)

1st: Applicability with current glueing setup

Basic Issues

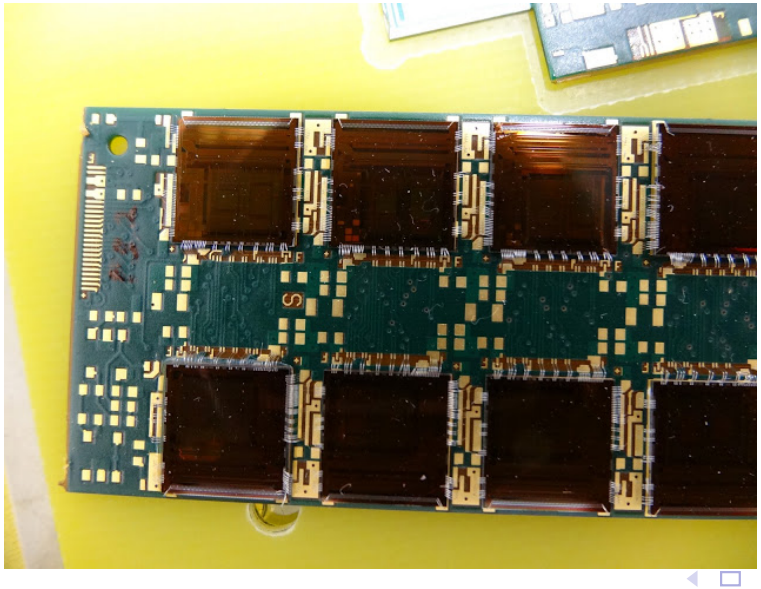
- due to different viscosities glueing tools can not be used
- UV light does not heat up materials dangerously
- glue can be cured completely in current setup
- all glues provide strong connection on gold



2nd: Handling

Bondability

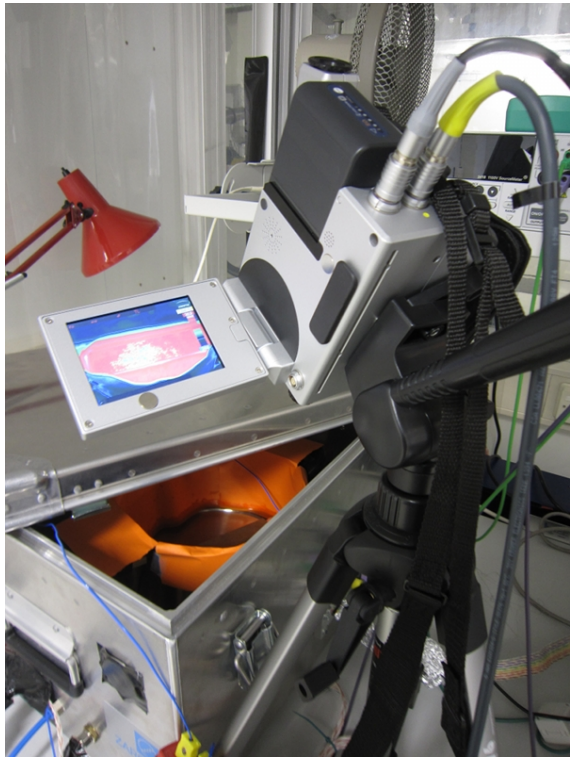
- UV-cured glues more flexible than silver epoxy glue
- bonding on resilient surfaces can lead to weak wirebonds
- ASICs on all tested glue types could easily be bonded



Thermal conductivity tests

Measurement issues

- most crucial: thermal conductivity after ageing and irradiation
- no data given for tested glues
- thermal conductivity of materials difficult to measure
- instead comparison of thermal conduction of silver epoxy and UV curable glues
- tested in setup comparable to operation in detector
- data taken to be analyzed
- supported by finite element method simulation



Irradiation tests

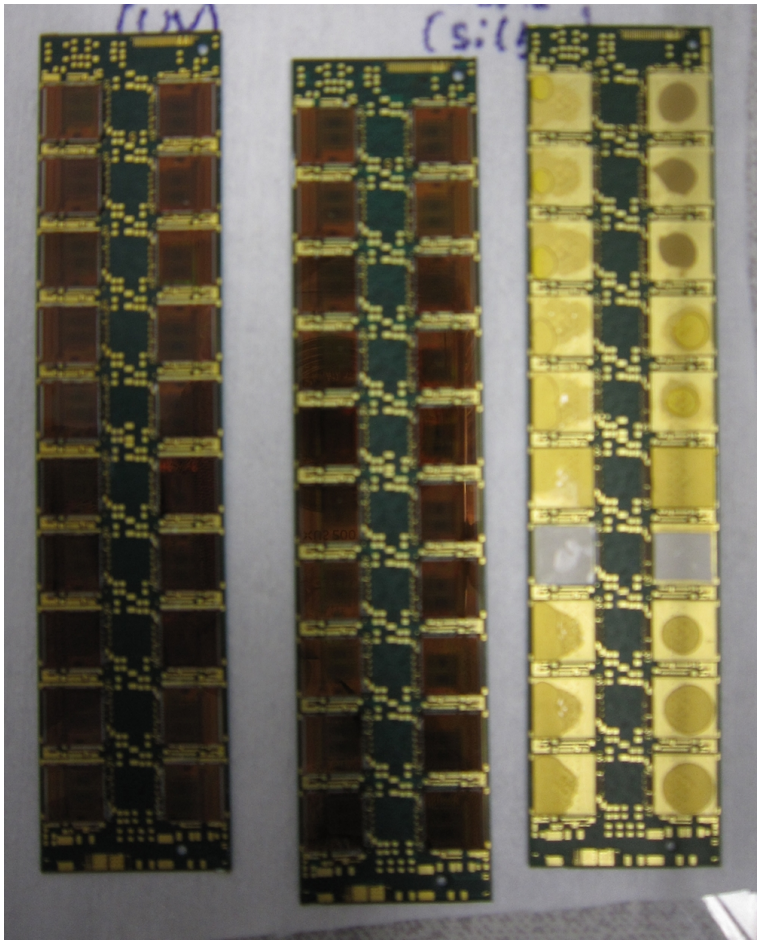
Tests conducted at KIT

- full dose expected in ATLAS Tracker (2e15 neq)
- 23 MeV protons in cooled environment
- three pieces:
  - hybrid with chips, glued with silver epoxy glue
  - hybrid with chips, glued with seven new glues
  - PE plate with samples of seven new glues
- in progress

Ageing tests

Tests conducted in climate chamber at CERN Bondlab

- 100 cycles between -20 and +50 C
- three pieces:
  - hybrid with chips, glued with silver epoxy glue
  - hybrid with chips, glued with seven new glues
  - hybrid with glass chips, glued with seven new glues
- in progress



Pull/Shearing tests

Determine connection strength

- to be performed after irradiation and ageing tests
- direct comparison of silver epoxy glued hybrids and UV-cured hybrids
- arranged at Fraunhofer Institut in Berlin

Aluminium corrosion

Long term tests

1. glues on aluminium foil in clean room climate
   - constant temperature and humidity, light exposure
2. inspection of chips' backsides after irradiation
   - constant temperature and humidity, full ATLAS Upgrade dose
3. inspection of chips' backsides after ageing
   - changing temperature and humidity, no irradiation, no light exposure

Radiation length

To be measured

- radiation length of tested glues unknown
- measurement setup at DESY Hamburg
- glues fulfilling all criteria should have their radiation length determined