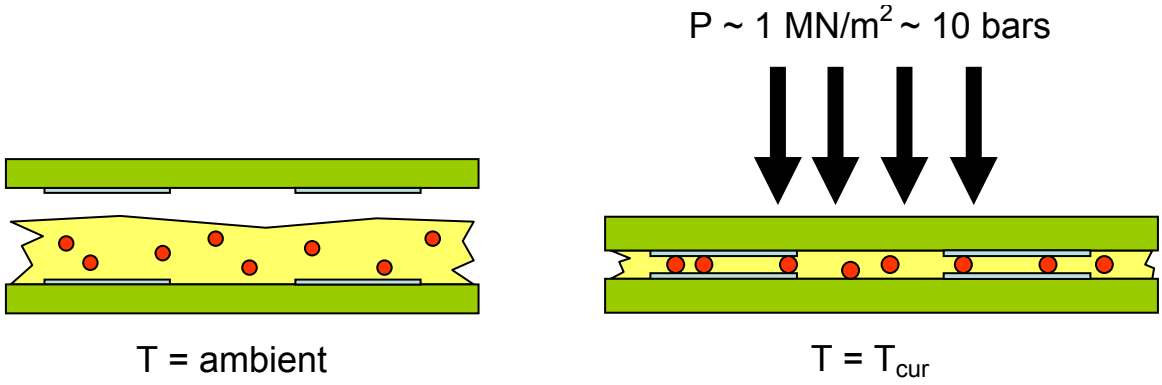
Use of anisotropic glue for electrically conductive connections with fine pitch

(C. Joram, I. Mcgill, 27/09/2004)

Principle of anisotropic glues



A vertically conductive connection is formed by compressing and curing an epoxy glue, which is filled with metal spheres (or metallized plastic spheres), between two flexible printed circuit boards with matched contact pads. The applied pressure reduces the thickness of the glue layer down to the diameter of the spheres. The concentration of spheres in the glue is chosen such, that contacts between spheres are rare; in particular the probability of contacts between adjacent pads is negligible.

University of Siegen has experience in the use of anisotropic glues for the connection of readout electronics to MSGC/GEM detectors built for HERA-B. The pitch / width of the contact pads were 270 / 135 μm on the detector side, and 200 / 100 μm in the side of the readout card. A kapton pitch adapter was used to compensate this difference. The electrical connections between detector / pitch adapter / readout card were established with anisotropic glue.

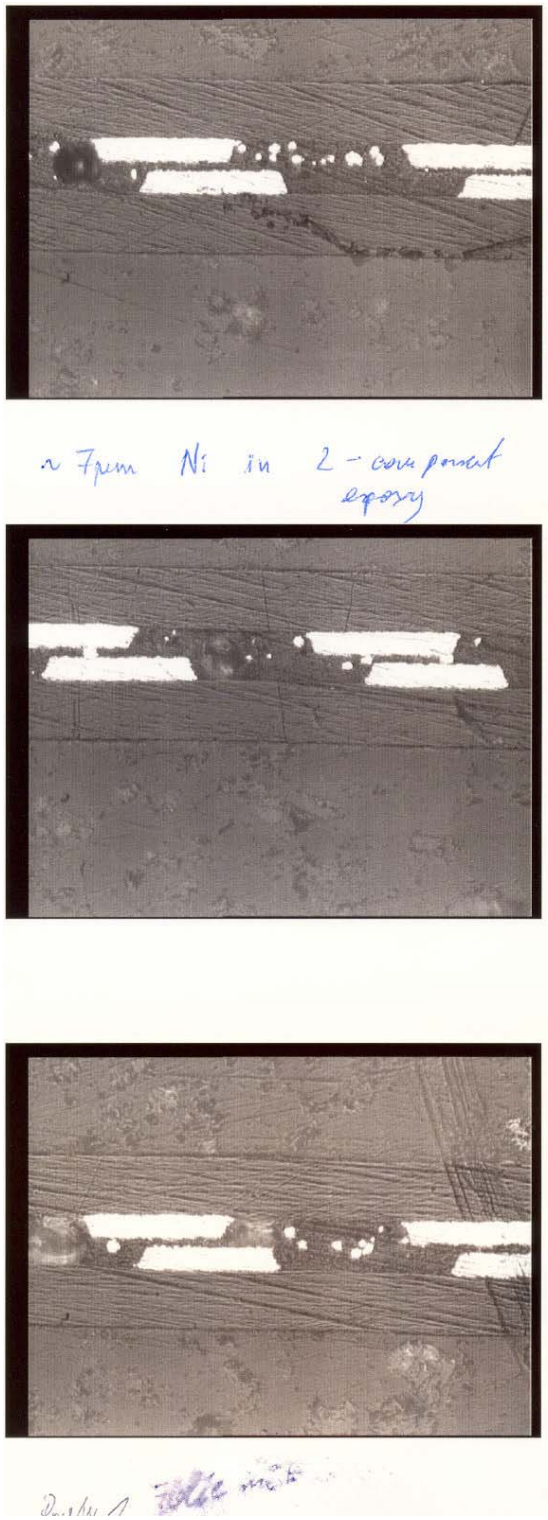
First successful tests were performed by U Siegen with a 2-component epoxy glue, filled with Cu spheres, produced by the company ELATECH, Karlsruhe (D). A second batch of the same glue did however not show an acceptable conductivity (probably due to oxidization of the Cu spheres). From then on Nickel with sphere size in the 7-9 μm range was used with very good results and reliability. The two components are mixed ~ 1:1 by volume. The precise mixing ratio is not of importance. The glue is cured after 1 to 2 hours at 70°C. During the curing process the pressure is constantly applied.

The electrical resistance across a bonded connection is below 1 Ohm, the insulation resistance to the adjacent pads should be well above 1 MOhm.

In the meantime the company ELATECH has disappeared from the market. Currently the availability of a low temperature curing 2-component filled epoxy glue is unclear. Although ELATECH quotes a shelf life of 6 months for this particular glue, U Siegen have used the glue over several years without noticeable degradation. One of our first goals is therefore to verify whether the remaining quantity (ca. 2 x 100 ml) can still be used.

Specific points discussed during our visit:

- The type of the pad metallization is not important. No special preparation (polishing/etching etc.) is required. The bond pads should be dust free. U Siegen have used scotch tape to remove dust particles. Possible oxide films should become cracked under the mechanical pressure which leads to relatively high local forces.
- Planarity of the PCBs is not a major problem, if at least one of them is flexible and therefore able to compensate non-planarity.
- The two flex printed circuit board are aligned by means of mircro positioners. The matching is controlled by just an eye glass. The position of one flex PCB is then fixed with TESA film (not scotch tape!) relative to the other PCB. The upper PCB can then be folded away and the glue can be applied.
- Thorough stirring of the two components before mixing is important. The filler particles sediment due to their higher density. Equal quantities of the two components are then extracted by means of a syringe and mixed on a glass plate (object carrier). The glue is applied to the contact surface by a little (glass) stick. A dedicated dispensing system is not needed. The surrounding surface is protected by a special scotch tape (obtained from Siegen) from excess glue spreading out once the pressure is applied. However, the excess glue is isotropically non-conductive. There is no risk of shorts
- U Siegen built a test board to verify the bonded electrical contacts. The yield was above 99%. No degradation of the contact was observed over 2 years.
- The radiation hardness of the glue has been tested to levels appropriate for the HERA-B environment. Uli Werthenbach could not provide quantitative results.
- The mechanical properties of the glue joints are very good. Peeling off was never observed.
- What is the minimum pitch which can be bonded with this technique ? ELATECH advertises pitches down to 70 μm. U Siegen has very good experience at pitches around 200 μm. The width of the pad should be roughly half of the pitch value.
- The longest row of connections which have been bonded in one step was about 7 cm. There is however no in-principle limitation, as long as the two flex PCBs can be produced with sufficient precision and the mechanics is able to provide the required pressure.
- U Siegen have also evaluated anisotropic conductive tape, however gave up this option after a short time. A main obstacle was the relatively high curing temperature.
- A drawback of the epoxy gluing technique is that it provides very little rework capability. The design of the PCBs should therefore be equipped with a second row of bond pads. The first bonds are removed by cutting the flexible PCB.
- List of anisotropic glue manufacturers:
    - DELO (www.delo.de): DELO-MONOPOX AC, 1-comp. Epoxy, Very fast curing, however $T_{cur} \sim 150°C$
    - Three Bond Int. Inc. (www.threebond.co.jp), TB 3372 C and TB3373 C, fast curing at high temperature.
    - Loctite (www.loctite.com), No. 3441 and No. 3447, fast curing at high temperature (180°C).
    - AI Technology, Inc. (www.aitechnology.com), to be checked !?



The photos show cross-sections of bonded connections with the ELATECH 2-component epoxy, filled with Ni spheres of 7-9 µm size.