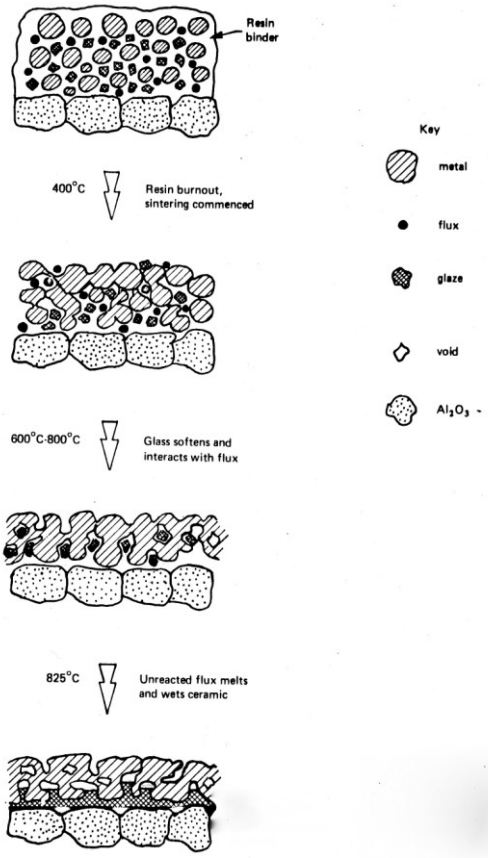
THICK FILM HYBRID MATERIALS, PROCESSING & RELIABILITY

Thick Film Hybrid technology is based on the screen-printing of conductors, resistors and dielectric pastes onto an insulating substrate, and then firing at high temperature to sinter the particulates in the paste to the substrate. Subsequently active and passive components can be soldered to the conductors or bare-chip active devices attached by wire- or tape-bonding. *The Technology should not be confused with the technology of Printed Circuit Boards, which is a subtractive process.*

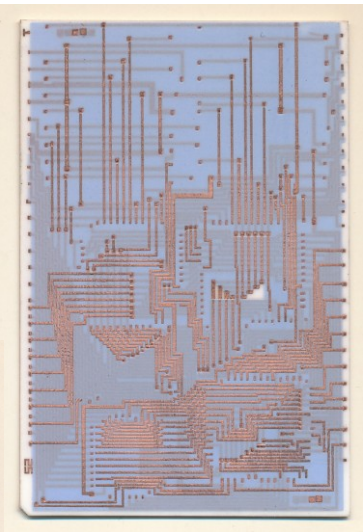
In most cases the thick film paste compositions were purchased from external suppliers such as Du Pont and EMCA.



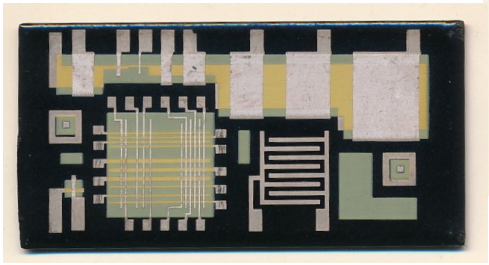
- STC set up a Hybrids Unit at Paignton in the early 1960s and relied for all aspects of pastes on the supplier Du Pont, who guarded their technology very closely. **Bill Crossland** in the MEC started an investigative programme with **Colin Marr** to understand the composition of the pastes and the parameters affecting processing.
- When **Colin Marr** joined ITT Components-Europe, **Larry Hailes** joined **Bill Crossland** and together did pioneering work on the adhesion of thick film conductors to an alumina substrate, leading to one of the first papers to be published in this area.
- In early 1971, **Larry Hailes**, **Geoff Gurnett** and **Frances Norris** joined the newly formed Ceramics Dept run by **Pete Graves**.
- In mid 1971, Larry left to join STC HQ and **Martin Coleman** took over as Group Leader, and in the next 14 years the work on thick film hybrid materials expanded with funding from ITT and UK government sources. Over that period, the STL Thick Film Group supported not only the thick film facility at Paignton, but also at Yarmouth (formerly Erie), BTM Ghent, SEL Nuremburg and North Microsystems (Florida),

and became a world-leader in understanding thick film materials, publishing 17 papers in journals and presenting 35 papers at international meetings, covering:

- Measurement of the surface area and composition of commercially available alumina substrates and their effect on adhesion of the fired pastes.
- Adhesion of fired conductors to alumina substrates, and investigation of silver migration of silver alloy conductors in high humidity conditions.
- Analysis of the Du Pont 7800 resistor system which was found to be based on a mixture of an alloy of silver and palladium, mixed with varying amounts of lead, silicon and boron oxides to achieve sheet resistivities between 40 and 100k ohms/square.
- Analysis and reliability studies of the Du Pont 1100 and 1300 resistor systems, based on bismuth ruthenate ($Bi_2 2Ru_2O_7$). These systems had much improved performance over the 7800 series.
- Effect of industrial atmospheres (SO_2 and H_2S) on the performance of unencapsulated resistors.
- Structure, properties and limitations of reactively bonded thick film gold conductors.
- Effect of firing conditions on copper thick film conductors, requiring a nitrogen atmosphere, work by **Geoff Gurnett** and **Marco Hrovat** of ISKRA (as part of a commercial agreement between ITT Components and ISKRA, a Yugoslavian components manufacturer).



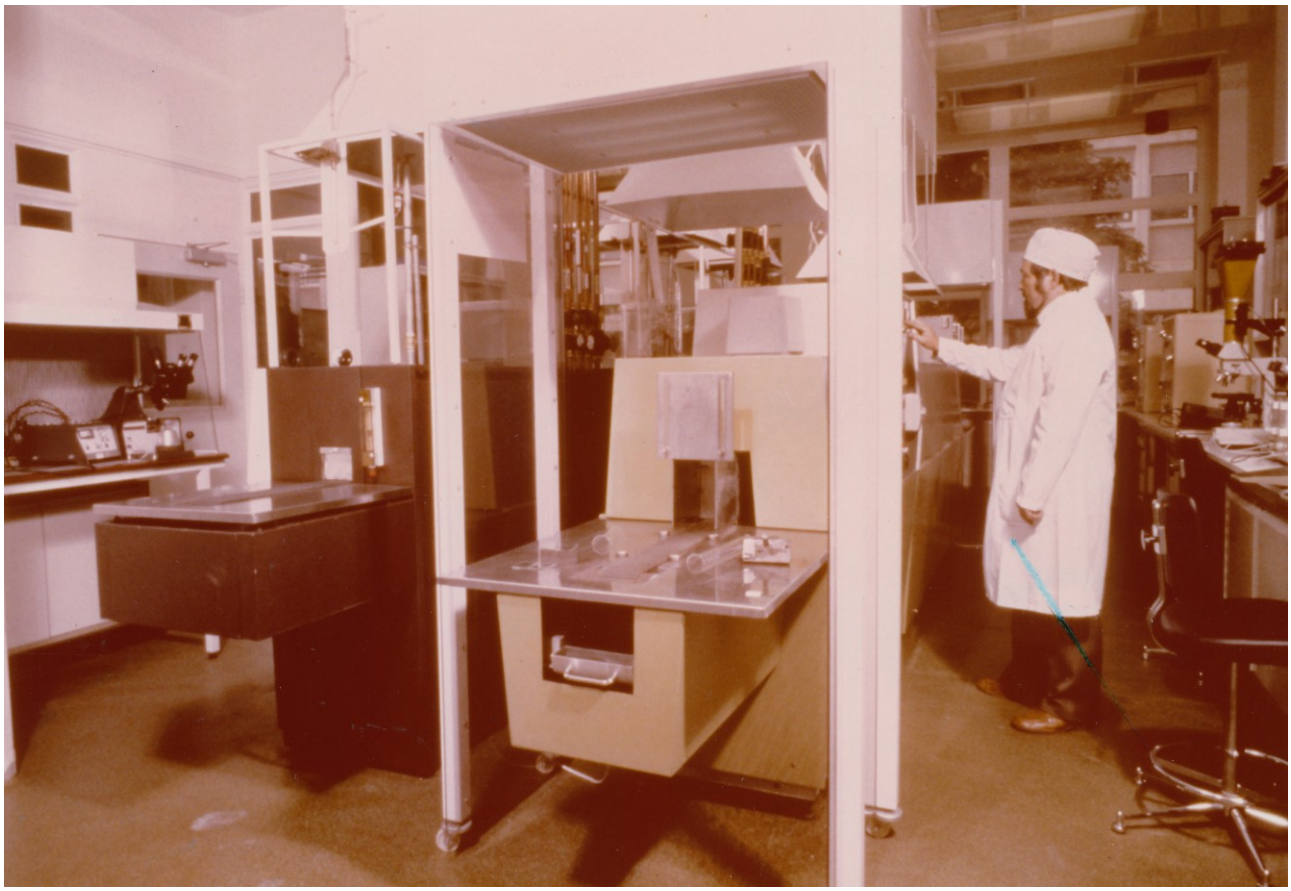
- Processing of thick film hybrids using porcelainised steel as a substrate.



- Analysis and performance of conductive epoxide adhesives used to bond chip components to thick film circuits - work carried out by **David Shenfield**.
- Environmental testing of a composite plastic encapsulation of wire-bonded CMOS chips on hybrid circuits, by **Steve Boyer**.

- **Chris Wright** developed an ultra-thin package (0.95mm thick) and associated circuitry for a Hall effect device for **David Pitt**, as a relay replacement in TXE-4A.
- Development of a fired glass sealing system for large (at the time) liquid crystal displays for **Bill Crossland**'s Group.

NB: the analytical aspects of this work relied on the extensive evaluation facilities of the Chemistry Laboratory and the Materials Evaluation Centre (MEC). Clean rooms were built by STL Site Services so that hybrid processing could be carried out without contamination from particulates, and it was a credit to them and the staff of the Thick Film Group that the clean room achieved Class 100 status - surprising considering 2 belt furnaces were in constant use.



In 1975 the Group was transferred to the MEC where work continued until terminated by Nortel in the early 2000s.

Pete Graves, September 2014