Journal of the

Institute of Circuit Technology

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vol.2 no.1 January 2009

2009 Events

21st January	*A ~ Z of Lead-Free Reliability, Smart Group, NPL, Teddington*
3rd February	18.00 Evening Seminar - 3 Papers around Laminates. Pike and Eel at St Ives, Cambridgeshire. Supported by Anglia Circuits
12 - 13th February	*EIPC Winter Conference, Amsterdam*
3rd March	17.00 Evening Seminar, Davenport Hotel, Darlington.
24th March	*PCB Inspection & Quality Assessment ITRI innovation , St Albans*
25th March	*Troubleshooting Your Assembly Yields ITRI innovation , St Albans*
30th March – 2nd April	Annual Foundation Course , Loughborough University
22nd April	*Step by Step Electronics Failure Analysis ITRI innovation , St Albans*
4th June	35th Anniversary Annual Symposium
16 - 18th June	*National Electronics Week, Earls Court*
? August	Afternoon Seminar with LeMRC at Loughborough University
? October	17.00 Evening Seminar, Davenport Hotel, Darlington.
? November	17.00 Evening Seminar, - Norfolk Hotel, Arundel

Editorial

I am writing this on Boxing Day 2008, and looking back on our first year of the *Journal*. Numerous questions come to mind :-

Are members bothering to open the .pdf files in which it's distributed ?
Having open the files, do members print them out ?
Are the subjects of the papers we have included been of interest to our members ?

It is very difficult to have satisfactory answers to these questions when only fellow Council Members and Maurice Hubert give reassuring comments.

Best wishes for a rapid restoration of the economic climate and a peaceful New Year to all who have bother to open this file.

Bruce Routledge

Membership

New members voted into membership by the Council
18 th November 2008

Members (M.Inst.C.T.)

Angus Brunton 10122
Taff Keegan 10123

Corrections and Clarifications

No items have been submitted for correction.

This is the fifth issue of the Journal, and to date no items, untruths, or spelling mistakes have been submitted for correction - doesn't anybody even glance at the Journal ?

It is the policy of the Journal to correct errors in its next issue.
Please send corrections to :-
bruce.rout@ tiscali.co.uk

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Technical News

Len Pillinger
(The Institute of Circuit Technology representative at REACh)

Legislation & Standards Digest (January 2009)

EU Publishes Draft of RoHS v2.0

The proposed revision of the RoHS Directive was published on the 4th of December and at first viewing it appears to have been an early Christmas present for the industry. You will recall that much dismay was expressed about the list of forty-six candidates for restriction that had been assembled by the Öko Institut. These were subsequently whittled down to eight, of which only four have made their way into the final proposal. Early reaction from the environmental lobby suggests that they are most disappointed and will continue to campaig vigorously to regain their lost ground.

The four additional materials are only candidates at this stage, and their introduction into RoHS appears to be coupled into the timetable of the REACh Regulation. Our work-horse flame retardant for PCB base materials, Tetrabromobisphenol-A, has again escaped. So too has Arsenic and its compounds which is a relief for the semiconductor industry. The four substances listed in 'RoHS 2' are (with observations as given on uk.farnell.com):

Hexabromocyclododecane (HBCDD)
Only 2% of HBCDD produced is used in electrical equipment, mainly as a flame retardant in HIPS (High Impact Polystyrene). This flame retardant is a PBT (persistent, bio-accumulative, toxic) and so clearly is a dangerous substance. There are alternative flame-retardants suitable for HIPS but all are brominated compounds.

Diethylhexyl phthalate (DEHP),
These are classified as category 2 carcinogens and are mainly used as plasticizers but also in inks and adhesives. There are alternative plasticizers including other phthalates. As with most chemicals, however, most of these have not been thoroughly tested and so their environmental and health effects are not fully known.

Butylbenzyl phthalate (BBP Dibutyl phthalate (DBP)
At this early stage, the impact that a future ban will have on the electronics industry can not be quantified. However, protracted timescales suggest that any effects will be mitigated by substitution before they become a problem.

Other changes may have more impact on the enforcement authorities and certification bodies:

- RoHS will have its own scope of affected products rather than relying on the scope of the WEEE Directive. There is a "binding list of products" as well as the previous list of ten product categories.
- Medical Devices lose their exemption on the 1st January 2014, except for in vitro devices which lose their exemption on the 1st January 2016.
- Monitoring and control equipment lose their exemption on the 1st January 2017.
- Listed exemptions will only be valid for 4 years before review. This is to stimulate innovation and substitution.
- RoHS becomes a CE marking Directive. Manufacturers will be obliged to draw-up a formal CE Declaration of Conformity, the contents of which are listed in the proposed Directive.
- RoHS compliance data is to be retained for ten years rather than the previous four (or six in the case of the Irish Republic's Legislation!).
- Manufacturers are obliged to demonstrate compliance by compiling 'technical documentation' and employing 'internal design and production control' (such as ISO 9001). There is no obligation to involve a Notified Body. This is analogous to the EU Low Voltage Directive (LVD).

The last bullet-point is likely to mean that OEMs will require more detailed information and assurances from their supply chain when assembling their documentation, following the current LVD practice.

The revised RoHS and WEEE Directives are to be introduced into the Member States' law within eighteen months from their formal publication.

EU Publishes Draft of WEEE v2.0

I first read an early draft of the WEEE Directive about ten years ago when I was still at BSI Product Services. Unused at that time to deciphering the Euro babble that the Commission writes; I googled for 'weee' to see if there was a clearer explanation on the internet. I leave you to imagine what material the search results included. Suffice it to say that I immediately told my boss that she might be contacted by the IT department demanding to know what I had been up to!

The WEEE Directive included RoHS elements at that stage and although the Directives then separated, they remain linked by cross-references.

The principal proposals in the new WEEE draft include:

- The scope of WEEE now refers to the RoHS Directive rather than vice-versa.
- Several new definitions.
- A WEEE collection rate of 65% is to be achieved by Member States by 2016.
- WEEE Registration is to be harmonised. Registers will be interoperable which presumably ends the need to register in

each Member State individually. I know of one power tool manufacturer who operates in each of the twenty seven EU Member States and therefore had to register twenty seven times!

- Enforcement requirements have been added.

The Commission is concerned about the improper treatment of waste electrical and electronic equipment. This is the fastest growing waste stream in the EU, producing 8.3-9.1 million tonnes in 2005, growing to 12.3 million tonnes of WEEE by 2020.
To download copies of the RoHS and WEEE drafts and the impact assessments, go to http://ec.europa.eu/environment/waste/weee/index_en.htm (note the underscore).

REACh taking (a different?) Shape

The window for pre-registration of substances closed at the end of November. Any substance within the scope of REACh that was not pre-registered can no longer be legally manufactured or supplied within the EU. The good news is that over one hundred thousand substances were pre-registered; half of these in the last four weeks!

The numbers of substances involved suggests that fears for security of supply of the least 'popular' substances was largely unfounded, although there may be withdrawals later in the REACh process.

If you need to view the list of substances; they can be downloaded in a searchable (comma separated values) format from http://aps.echa.europa.eu/preregistered/pre-registered-sub.aspx
where you will also find links to pages explaining the finer points of REACh.

There is a danger of a RoHS : REACh paradox. Where substances are restricted or regulated by both RoHS and REACh there is a common maximum concentration value of 0.1% (other than for Cadmium). However, this applies to the entire article in the case of REACh, but to each homogeneous layer in the case of RoHS. A recipe for confusion?

This is intended to be a legislation and Standards digest, but if I have neglected Standards during 2008 it is because of the weight of new and proposed regulation that has come out of Brussels throughout the year and the impact that it can have on the electronics supply chain. Let's hope for a lower word count in 2009.

Len Pillinger F Inst CT
December 2008

List of Acronyms and Abbreviations

ATE	automatic test equipment
BBP	Butylbenzyl phthalate
BERR	Department of Enterprise and Regulatory Reform (Previously DTI)
BSI	British Standards Institution
CAD	computer aided design
CAM	computer aided manufacture
CE	The 'CE' of CE Mark of the European Union has no formal definition, but is commonly regarded as having originally stood for Conformite Europeenne
CMRs	carcinogenic, mutagenic or toxic
CSR	Chemical Safety Report
DBP	Dibutyl phthalate
DEHP	Diethylhexyl phthalate
DICY	dicyandiamide
ECHA	The European Chemicals Agency
EINECS	European inventory of Existing Chemical Substances
EPL/501	A BSI Standards Technical Committee concerned with Standardisation in the area of PCBs and PCB Assembly
EU	European Union
EuP	Energy-using Products Directive
FAQs	Frequently Asked Questions
FR4	The designation given by the (US) National Electrical Material Association (NEMI) to a PCB base material comprising a reinforcement of woven glass with a UV stabilised tetrafunctional epoxide resin and meeting the flammability requirements of Underwriters Laboratory standard UL-94 with a rating of V - 0
GEL/111	A BSI Standards Technical Committee concerned with Standardisation in the area of EU eco-Drectives such as WEEE, RoHS and EuP
HASL	Hot Air Solder Leveling (May be SnPb based or Pb-free)
HBCDD	Hexabromocyclodecane

List of Acronyms and Abbreviations *(cont.)*

HIPS	High Impact Polystyrene
HPA	Health Protection Agency
HSE	Health and Safety Executive
ICNIRP	International Commission on Non-Ionising Radiation
IEC	International Electrotechnical Commission. (The formal international Standards body based in Geneva responsible for electrotechnology.
IECQ	IEC Quality Assessment System for Electronic Components
IPC	Association Connecting Electronic Industries.
ISO	The International Standards Organisation. (The formal international Standards body based in Geneva responsible for non-technology specific Standards.
IST	Information Systems and Technology
KPMG	An international auditing and consultancy firm
LVD	EU Low Voltage Directive
MCVs	Maximum Concentration Values
NGOs	Nongovernmental Organisations (the term given to quasi-political lobbying organisations such as Greenpeace and Friends of the Earth)
OSP	Organic Solderability Preservative
PBTs	persistent, bio-accumulative and toxic substances
POPs	Persistent Organic Pollutants
REACh	Regulation concerning the Registration, Evaluation. Authorisation and Restriction of Chemicals (REACh) (1907/2006)
RoHS	Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (2002/95/EC)
SIEFs	Substance Information Exchange Fora
SVHCs	Substances of Very High Concern
TBBA	Tetrabromobisphenol-A
WEEE	Directive on waste electrical and electronic equipment (2002/96/EC)

Please send corrections and additions to :- bruce.rout@ tiscali.co.uk

Embedded Passive Components – A Simplistic View

Steve Payne
Cirflex Technology Ltd

Over the next few issues I intend to provide some basic experiences of embedding passive components, explained in a fairly simplistic way. I'll start by considering embedding resistors. My experience has been primarily from the PCB fabricators point of view. However, through collaborative research programs with Alcatel Bell, IMEC, University of Hull, NMRC (now the Tyndall Institute), Isola and others I gained, as project coordinator and exploitation manager, an invaluable insight into design, electrical testing, thermal modeling and high frequency characterisation.

Part 1 - Resistors

Soldering discreet resistors, capacitors and inductors to the surface of PCB's is the established norm and anything else may seem highly specialist and fraught with unnecessary risks. Yet, manufacturing PCB's with embedded passive components is a mature technology and has been used in many instances from aerospace to mobile phones. Current demands of dense electronic packaging including SiP (system-in-package) technologies require that we should not forget this technology and be willing to embrace at least certain aspects as and when required.

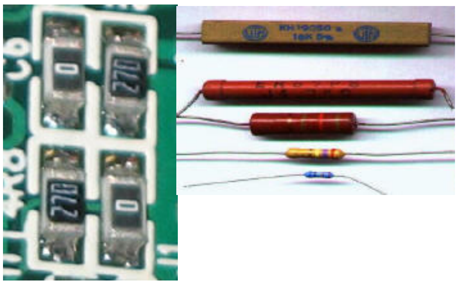
Resistors

How a designer reaches a point when he decides to first consider embedding passive components is dependent upon each unique application and cost expectations.

A typical decision process may include the following:

1. Consider the device or system performance including miniaturisation, weight, signal speed etc.
2. Are quantity and range of component values suited to embedded component technology?
3. Select best-fit technology; liaise with PCB supplier.
4. Design assessment considering size of PCB, construction, number of layers etc.
5. Cost assessment. This needs to

We are all familiar with discrete resistors, including very small chip resistors, and are comfortable with their use in our PCB designs



For the purposes of this paper, embedding resistors does not mean burying discreet resistors inside a multilayer board, although in certain circumstances this can be done. What this paper will discuss is using either special laminate which has a resistive foil, (typically nickel-phosphor), in addition to the standard copper foil, and through selectively etching patterns into the resistive foil a variety of values of resistor can be fabricated; or alternatively applying a thick film paste of resistive ink onto a layer in a suitable size, thickness and pattern to give the approximate value required. These resistors can be defined on inner layers of a multilayer PCB, and as is normal, plated via holes can interconnect the resistors.

The use of embedded resistors requires new design rules and techniques. A CAD system's capability for designing embedded resistors varies from system to system. Typically the large systems have more automated capability whereas for many of the smaller system you may be required to calculate the shape required for a particular value and then manually draw it into the layout design. Of course, you could build up a library of embedded resistor values and shapes to save time with future designs.

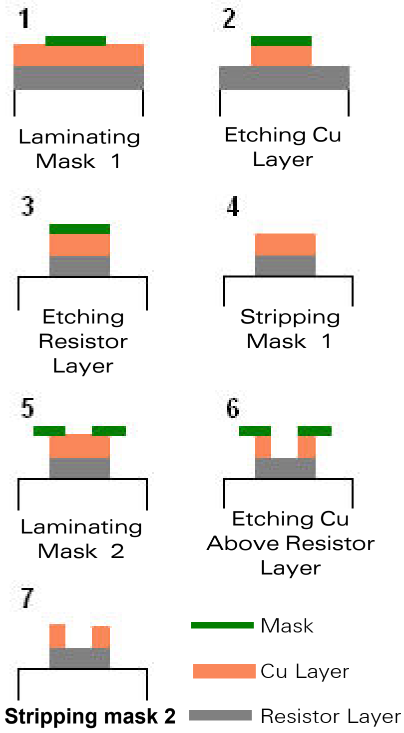
So, does the PCB designer need to know about the method of manufacture of resistors? Well actually he should do – at least to some extent.

Thin Film Resistive Foil.

My experiences in the early 70's were in manufacturing our own resistive foil laminate; we bonded a resistive foil to pre-preg materials to form the laminate. However, for many years a PCB fabricator has had a choice of laminate materials available from several suppliers.

Let us first look at the specialist laminate type of resistor.

A commonly used type is made by Ohmega Technologies, Inc. and is known as OHMEGA-PLY®. Their web site gives plenty of details about the range of material; suffice it to say that it comes in various sheet resistance values(10W/R to 250W/R) and on various types of dielectric (base laminate). The resistive foil is nickel phosphor and this layer is sandwiched between the dielectric and a normal copper foil. By a multiple etch process various values can be achieved. The typical process is shown below:



The mask referred to above is typically a normal photoresist; an etch resist. The process seems straight forward but there are some tricky process operations with, for example, registration and control of etching and also careful handling is important.

Discussing yields is always a difficult subject, however in my experience problems can mainly lay in 2 key areas. The physical handling of the layers at various process stages can cause problems; occasionally I have known this to cause almost complete batch failure. Additional problems can lay with control of the etching process, in particular the repeatability of the process from batch to batch which comes down to process control; the control of the etch chemistry and the performance of the etching equipment.

Laser trimming – getting an accurate resistance value

To consistently achieve tolerance of 2% or better laser trimming is probably the best option. Laser trimming is a specialist operation, with specialist equipment, which measures the resistance during the laser trimming operation. If you are going to trim then it is best to design you resistors with a 20-30% lower value than required and the trimming process, which cuts a slot in the resistor pattern, increases the resistance value to typically +0 / -2% (or even better with multiple cuts), although the 2% tolerance is usually acceptable for most applications. For most PCB manufacturers this process means sub-contracting with the associated additional cost and logistics problems – but the effort can be worthwhile to achieve a higher yield if close tolerance values are required.

How do we measure the resistance value in production?

This can be easier than one may imagine. Many flying probe ATE (automatic test equipment) systems can undertake this on an inner layer prior to lamination. In addition to the ATE systems standard continuity and isolation testing, it often can perform a following test sequence when individual resistors are measured and compared to their design values and permitted tolerances. The CAM engineer can provide the information for the ATE or it could be entered on the system by the ATE operator.

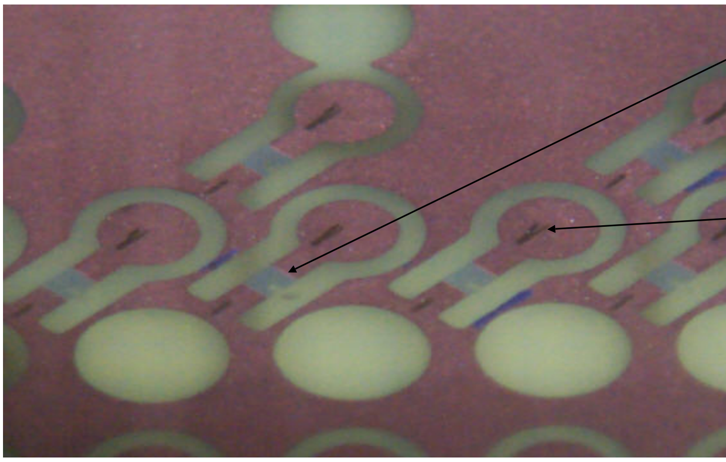
While we are talking about value let's be sure we understand about ohms per square,

PCB Designers and fabricators must be clear about this concept – easy to understand and
easy to confuse.

The sheet resistance and the dimensions of the etched resistor material determine the resistor value. The resistance is proportional to the ratio of the length to the width according to this formula

$$R = Rs \times \frac{\text{length of the resistor element}}{\text{width of the resistor element}} = Rs \times \frac{L}{W}$$

Where Rs is the sheet resistance (/), which is determined by the resistively () of the material divided by its thickness. Depending on the application, the power dissipation



and the available space, different shapes such as rectangular, serpentine, round shapes etc. can be designed.

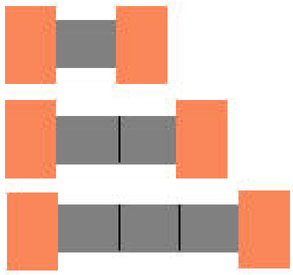
It is often easier to look at the following examples:

The following basic formulae can be used:

$$P(\text{Watts/cm}^2) \times L \times W = I^2(\text{Amps}) \times R(\Omega)$$

or

$$P(\text{Watts/cm}^2) \times L \times W = V^2(\text{Volts}) / R(\Omega)$$



With the length (L) = width (W) for a 25 Ω/ square material the resistor value = 25 Ω

With L = 2 times W for a 25 Ω/ square material the resistor value = 50 Ω

With L = 3 times W for a 25 Ω/ square material the resistor value = 75 Ω

Now let's look at resistor pastes

An alternative to thin film resistive foil laminates is to print, usually screen print, a resistive thick film paste (typically carbon): a paste applied onto an inner layer (or outer layer) in a suitable size, thickness and pattern to give the approximate value required. It is then cured (by infra-red or convection oven) and the inner layer proceeds to subsequent processing to produce the finished multilayer board. It will most likely require laser trimming to bring the value within the required tolerance. The paste usually has a wider range of resistance values than the thin film foil; for example from 1W/R to 1MW/R

When size does make a difference – Power.

An important consideration is power density or current carrying capability; this can be a limiting factor for the application of embedded resistors. Maximum power dissipation depends on the designed continuous operating temperature of the circuit board, its thermal properties, ambient temperature and resistor size.

Maximum power density (P) is specified for the resistor material, current (I) is specified by the circuit design. The equations define the resistor dimensions (L and W). Remember that it's not just about maximum power density but about temperature rise of the resistor.

A previous edition of the ICT *Journal* (vol1no 4), included a paper on thermal modeling of embedded resistors, I recommend that the reader refers to this paper for further information.

Evaluation and characterisation of embedded resistors

Most of my experiences revolve around a collaborative R&D project supported by the EU, it was known as COMPRISE. The project finished several years ago, however the work completed is still being quoted.

Considerable testing was carried out including reliability and environmental stress tests on Ohmega-Ply® material. Various multilayer test boards were designed and fabricated and various resistor designs achieved different resistor values, ranging from 50W to 15kW Deviations from the original resistor values were determined and compared very favourably with discrete 0805 resistors. The table below summarises some of the results of the various environmental stress tests. Three types of material were used, designated as A, B and C, with sheet resistance from 25Ω to 250Ω

Test	Measured max./ min. Ω R	Specification	Thick film Chip R (0805)
Humidity test 40 ºC / 93 % RH	*After 21 days* 0.22 % for A 0.07 % for B 0.10 % for C *After 56 days* 0.74 % for A 0.14 % for B 0.22 % for C	*After 10 days* 0.5 % for A 1.0 % for B	*After 56 days* Ω ± 1.5 %
Thermal cycling -25 ºC / 125 ºC	*After 100 cycles* - 0.03 % for A + 0.03 % for B - 0.08 % for C	*After 25 cycles* -0.5 % for A 1.0 % for B	Ω ± 0.25 %
Solder heat 260 ºC, immersion 20 s	-0.02 % for A -0.01 % for B 0.01 % for C	0.5 % for A 1.0 % for B	Ω ± 0.25 %
Ageing without load 125 ºC, 1000 hours	0.10 % for A 0.08 % for B -0.13 % for C	Not specified	Not specified

A - 25 Ω/☐, B - 100Ω/☐, C - 250 Ω/☐,

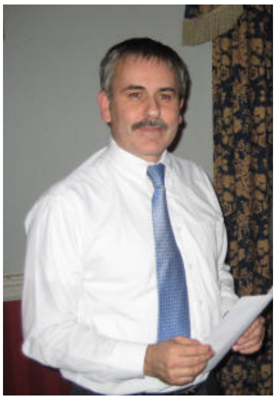
A comparison of the measurements for integrated resistors and the characteristics of discrete resistors show that, in terms of reliability, the integrated parts can compete with discrete resistors.

In addition to the tests shown in the table above, an ageing test under loading conditions was performed. For this purpose all resistors were connected to a voltage of 5V for 2000 hours at a constant temperature of 70 C. This test was severe for small resistor areas. The results showed that the relative change of the resistance for heat dissipation densities lower than 8 mW/mm^2 was in the range of 0.1%; lower than specified by the supplier (2 – 3%). If a heat dissipation of 100 mW/mm^2 was not exceeded, the deviation was less than 1%. This was comparable to the specifications of an 0805 resistor declaring a maximum change of 1% after 1000 hours of ageing with load at 70 C. These are results obtained on boards designed without any special thermal precautions; an appropriate thermal design could improve the performance.

Summary.

- Embedding resistors in multilayer PCB's is a mature technology.
- The decision making process to embed resistors can be complex but there is plenty of information available to assist in the decision making process.
- Many large CAD systems can design in embedded resistors; smaller systems should not be a significant problem, just more labour intensive.
- There are 2 main methods of manufacture – a proprietary laminate with resistive foil a and resistive thick film inks
- There are several sources of material available.
- The choice between methods of fabrication should be made with your PCB supplier, it can include various factors including range of values and other performance criteria.
- Resistors can be Manufactured
- and tested by many PCB fabricators
- Thermal modelling tools exist for embedding resistors, and significant work has been carried out to characterize performance of embedded resistors.

It can be worthwhile considering using embedded resistors. They're not for every application but may have an important benefit to your next design. If further information is required, please contact the author.



Steve Payne

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Institute of Circuit Technology Seminar on Imaging

The Norfolk Arms, Arundel

18th November 2008

The ICT revisited the historic West Sussex town of Arundel for its November evening seminar on 'imaging'. With almost forty registrants, the meeting was particularly well attended, with some ICT members having traveled from as far away as Scotland.
The seminar was opened by the ICT's Chairman, Steve Payne, who welcomed everyone to the splendid Norfolk Arms Hotel. Steve also thanked Global-Ventek Laminates UK Ltd, who had kindly sponsored the seminar.

The first presentation of the evening was given by **Grant Bradley** of Electra Polymers and his chosen theme was on 'The Chemistry of Imaging'. Grant began by asking what was actually meant by the term imaging and how images could be created. The wide range of possible techniques included screen printing, laser ablation, ink jet deposition and imprinting, but the process most important in the PCB industry was photoimaging. (Laser Direct Imaging (LDI) was described as being a subset of photoimaging). The positive and negative working resist approaches were described and it was stated that negative working resists could be divided into two types, namely those based cationic processes and those employing free radicals. The cationic type of process used direct epoxy polymerisation, was relatively slow and typically included an extensive dark reaction. Conversely, free radical polymerisation processes were faster and exhibited little dark reaction. The key to successful free radical polymerisation was to use the appropriate photoinitiator and some key examples were illustrated. A resin binder and a monomer were also needed and chemical structures such as the novolac binders were shown. In addition, a range of specialist and often proprietary additives was also needed for a specific successful resist formulation. The reactions taking place during the exposure process were then detailed. Grant described the significance of exposure in terms of time and light intensity. Sidewall definition was also critical, since the lower light dosage at the bottom of a layer of resist could lead to undercutting. This could be improved by keeping the polymerisation time down. Adhesion was another critical issue and it was stated that acrylate polymerisation could often exhibit a shrinkage of up to 30%, with faster curing compounds actually shrinking the most. One way of improving the adhesion was by reducing the level of acrylate present in the formulation. Another way was to use monomers that were more flexible. The acrylate polymerisation process involved the formation of peroxides which could cause copper corrosion and also contribute to plating failures. The resolution achievable was complex and influenced by a number of factors in addition to the imaging chemistry. It could be enhanced by careful development control and by optimising the glass transition temperature of the formulation. The resist chemistry also had a large impact on solder and plating resistance, as well as on legend adhesion and conformal coating compatibility. The ultimate resist formulation was typically based on a number of compromises in order to offer good processability over a wide range of conditions and equipment types. However, formulations could also be customised as required for specific equipment requirements.

Between the two presentations, Steve Payne announced that the ICT's 2009 Annual Symposium would be a special event as it marked the Institute's 35th anniversary.

The second presentation was given by **Russ Crocket** of DuPont Circuit Materials and was entitled 'Imaging in a Tsunami'. Russ gave an overview of DuPont's electronics technologies. DuPont was a science based company operating in five specific sectors. One of these was 'electronics technologies'. The Chinese were currently describing what was happening across the world in the electronics industry as a tsunami; plants were being mothballed and there was a dramatic reduction in orders. In Europe, there was also a significant slowdown in orders and the economic view was that the recession would be worse than the one that occurred during the 1981 to 1982 period. On the positive side, inventories were relatively lean compared to previous downturns and oil prices were still falling, which would offer some help.

Russ then moved on to discuss dry film resists and he stated that Riston had now been available for 40 years. He said that, in the current circumstances, it was very important for suppliers to secure their own supply chains. Dry film resists had now gone below 10 micron resolution and could also give high productivity and lower processing costs at these fine resolutions. For high volume and high productivity, dedicated dry films were required for plating or etching, as good adhesion on all copper and direct metallisation surfaces was required. There should also be no leaching during plating and the resist must have good stripping characteristics, even if over plated. In tent and etch applications specialist dry films were also needed, although applications were still somewhat limited in Europe (but not in the Far East and the USA). Clearly, good adhesion on fine lines and annular rings was critical. The drive to laser imaging was continuing because of the promise of artwork elimination and reduced process costs and times. LDI was very sensitive to 'dust imaging' and thus good panel cleaning was essential. However, it could offer significantly increased resolutions and yields with higher photospeeds. The newer resists also had better adhesion and flexibility along with enhanced plating resistances and faster, cleaner stripping. A common problem with high resolution resists could be sludge formation. Russ then emphasised the importance of process control, especially in environments where there were reduced staffing levels, such as might occur during the current downturn. Factors that were also important were cleaning, lamination temperatures, development conditions and the use of proper drying. Examples of fine line features produced using Riston dry film were shown.

There were then questions from the audience about the conditions needed for producing 10 micron lines. These would need a collimated light source and, although the resolution could be achieved, the biggest challenge was to get resolution with the required yields. For this type of resolution, the resist would typically be in the region of only 15 microns thick. For very fine lines in high volume production, most manufacturers were using wet lamination, although this was not taking place much in Europe. Russ also stated that exposure was typically performed with the Mylar coversheet in place. The LDI resists didn't normally contain any fillers and this helped with light transmission to the base.

This was another very successful, well attended and useful seminar that illustrated the value the ICT brings to its membership. Steve Payne concluded the seminar by thanking the speakers and the sponsors.

Martin Goosey
18th November 2008

Arundel Castle

Group Members of The Institute of Circuit Technology December 2008

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Atotech UK Ltd.	William Street, West Bromwich. B70 0BE	01210 067 777 www.atotech.de
CCE Europe	Wharton Ind. Est., Nat Lane, Winsford	01606 861 155 www.ccee.co.uk
Electra Polymers & Chemicals Ltd.	Roughway Mill, Dunks Green, Tonbridge TN11 9SG	01732 811 118 www.electrapolymers.com
Faraday Printed Circuits Ltd	15-16 Faraday Close, Pattinson North Ind. Est., Washington. NE38 8QJ	01914 150 567 www.faraday-circuits.co.uk
Flex-Ability Ltd	Prospect Way, Park View Ind. Est., Hartlepool TS25 1UD	01429 860 233 www.flex-ability.co.uk
Graphic plc	Down End, Lords Meadow Ind. Est., Crediton EX17 1HN	01363 774 874 www.graphic.plc.uk
Invotec Group Ltd	Cunliffe Rod, Whitebirk Ind. Est. Blackburn BB1 5TD	01254 661 321 www.invotecgroup.com
Kelan Circuits Ltd	Wetherby Road, Boroughbridge. YO51 9UY	01423 321 100 www.kelan.co.uk
Stevenage Circuits Ltd	Caxton Way, Stevenage. SG1 2DF	01438 751 800 www.stevenagecircuits.co.uk
Teknoflex Ltd	Quarry Lane, Chichester PO19 8PE	www.teknoflex.com
Tru-Lon Printed Circuits (Royston) Ltd.	Newark Close, York Way Ind. Est., Royston SG8 5HL	01763 248 922 www.trulon.co.uk

Please send corrections to :- bruce.rout@ tiscali.co.uk

News from the Membership Secretary

The ICT are involved in a consortium to submit a proposal under the European FP7 Framework.. The project is based around Electroless Nickel Gold, and will look at quality issues and the application of non-destructive test equipment as well as testing alternative surface treatments using normal and Ionic Liquids. Ionic liquids operate at a neutral pH and offer less aggressive operating conditions. My thanks to those members who helped with the endless paperwork!

After many years, we have changed our Arundel venue to the Norfolk Arms Hotel in the centre of Arundel. Our first meeting there in November was a great success and I would encourage members and guests to come along for the next event.

We are looking forward to a re-launch of our website next year and we will also start uploading the slides from our David Kingsley bequest.

You may also have noticed that communications from the ICT are now coming from our InstCT.org address. The changeover should have been seamless, but please check your browser/SPAM settings if there is a problem.

It only remains for me to thank all the members who have attended our events and helped out during the year and to wish you a

Happy Christmas and a prosperous New Year

Bill Wilkie

The Journal of the Institute of Circuit Technology is edited by Bruce Routledge on behalf of the
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