Journal of the

Institute of Circuit Technology

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.
18th March	12.00 Council Meeting London Canal Museum
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*
28th April	*SMART Group, PCB Materials+Finishes - What Assemblers Should Know, The White Swan - Arundel*
5 - 7th May	*CWIEME Berlin 2009 - Electrical Insulation Materials, Electromagnetic Coil, Electric Motor, Transformer Manufacture & Repair.*
4th June	35th Anniversary Annual Symposium Bletchley Park, Milton Keynes
10 - 11th June	*IMFAIR09 - Institute of Metal Finishing RAF Museum, Cosford, Shropshire*
16 - 18th June	*National Electronics Week, Earls Court*
4th August	Joint ICT/MRC/EY Event at Rotherham
6th October	17.00 Evening Seminar, - Norfolk Hotel, Arundel
3rd November	17.00 Evening Seminar, Davenport Hotel, Darlington

2010 Events

2nd Febuary	AGM 17.00 Evening Seminar, Norfolk Hotel, Arundel
2nd March	17.00 Evening Seminar, Davenport Hotel, Darlington

Contents

vol.2 no.2 April 2009

Editorial

The Editorial in the 1st issue of 2009 prompted some 14 Members to e-mail their comments on *The Journal.* They were all very polite and complimentary.

It appears from this small sample that the majority do not print out, but prefer to file digitally for future reference. Our present intention is to provide a simple accumulative index in the last issue each year.

There were also comments on the inconvenience of reading the 3 column newspaper style layout on a VDU - (a single column is much easier to read on screen). It is not our intention to make a change at present, but your comments have been noted.

Please consider writing papers for publication in *The Journal.* The effort can be rewarding and lead into channels not previously thought worthy of exploration.

Papers on subjects such as "Green issues", (like the Ultrasound paper in this issue, where there are potential savings in use of water, energy and cleaner effluent), would be most welcome.

Bruce Routledge

Membership

New members voted into membership by the Council

17th March 2009

Members (**M.Inst.C.T.**)

Don Glenister	10124
Neil Chamberlain	10125
Dane Mills	10126
Mark Merifield	10127
Pat Mannion	10128
Dr Neil Kirby	10129

Corrections and Clarifications

3 Members reported editorial errors in the "Embedded Passive Components" paper in vol.2 no.1 : -

P.6col.1bottom, sentence should read- This needs to be followed by a qualification process with development samples.

P.7col.3 - " ranging from 50Ω to 15kΩ" - NOT Watts

P.8col3 - the last but 3 & 2 of the bullet points should have been one item - " Resistors can be manufactured and tested by many PCB fabricators".

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

The Journal of the Institute of Circuit Technology is edited by Bruce Routledge on behalf of the
Institute of Circuit Technology.
30 New Road, Penn. High Wycombe, Buckinghamshire, HP10 8DL
E-mail : bruce.rout@tiscali.co.uk

Technical News

Len Pillinger F.Inst.C.T.
(The Institute of Circuit Technology representative at REACh)

My ramblings in the Institute's *Journal* over the last year have been mostly about the latest EU Eco-legislation. The last twelve months have seen the introduction of the REACh Regulation and a new Battery & Accumulator Directive plus reviews of the RoHS and WEEE Directives. This year is likely to be quieter on the European front due to the distraction of the European parliament elections mid-year followed by the appointment of new Commissioners.

I have therefore neglected passing on information about standardisation activities. It is not a case that nothing has been happening; rather that the EU regulation has taken priority.

There is such a confusing array of prefixes: BS, IEC, ISO, EN, CECC and of course IPC. Some are even used in combination: BE EN, BS CECC etc. This needs some explanation. The 'top dogs' are the International Electrotechnical Commission (IEC) and the International Organisation for Standardisation (ISO). Although a small number of documents are published jointly, IEC looks after electrical and electronic Standards in the number range 60000 upwards, whereas ISO publishes general industrial / commercial standards in the range 1 to 59999.

ISO's most ubiquitous offerings are ISO 9001, ISO 14001 and ISO 27001 for quality and environmental management and information security respectively. IEC 60950-1 is a best seller for IT and telecoms safety and the IEC 61249 series exists to cover PCB laminates. However, all attempts by IEC to create PCB requirements / certification documents appear to have been abandoned. Ray Pattinson from Marconi at Great Baddow championed these in the 1980s and I took up the baton in the 1990s but the early 1990s recession had a dramatic impact on the number of those contributing to the documents and the work stalled.

At the risk of being labelled a total anorak, I happen to have a copy of BS 4025 published in 1966 and entitled "The General Requirements and Methods of Test for Printed Circuits". It cost the princely sum of 15 shillings plus another 2 shillings per amendment. To my surprise it is not the first BSI Standard for our industry; BS 3081: 1959 was "Basic Dimensions for Printed Wiring". It alarms me to note how much of the 1966 content is still around in current BS 123000. Is this because the 1960s authors did such a good job or that subsequent contributors have been lazy?!

Remarkably few British Standards are now the result of solely British authorship. Almost without exception BSI's electronics Standards are developed by IEC Technical Committees made up of delegates from member countries. Ten years ago the dominant countries at PCB committees were Japan and the USA with a fragmented European attendance. Recent meeting minutes reveal a much larger Chinese and Korean presence reflecting the way that the industry has moved east. Throughout this time, the USA's delegation has been IPC-centric and, in particular, Dieter Bergman (IPC Technology Transfer Director) has been at the centre of most things. My personal view is that IEC TC91 (to give it the designation used by IEC) has always set itself too many goals; tried to develop too many Standards instead of targeting a smaller prioritised set to achieve. However, Dieter's remarkable drive and energy can not be questioned.

Standards developed by IEC will usually be adopted by BSI and in a minority of cases are published as BS IEC. More often, however, they will appear as BS EN, the *EN* standing for European Norme, to reflect pan-European acceptance as a 'Harmonised Standard'.

So why bother with the *BS* bit? IEC Standards are usually bi-lingual English / French and the UK clearly can manage without the French pages! There is often a *National Foreword* expressing any strong opinion that the BSI Technical committee has about the document. For instance, the UK may disagree with some of the content but be obliged to publish due to European harmonisation rules. There may also be an annex detailing *national deviations* due to local conditions. We do not suffer from this in the PCB industry, but equipment manufacturers are familiar with having to comply with national deviations when considering local mains frequencies and voltages or plug and socket systems.

The most recent offering from this formal Standards route is the BS 123000 series; note the BS *only* aspect. The previous BS CECC offerings hit a brick wall when Brussels decided that all European work on PCB certification Standards must cease in favour of IEC Standards. The UK successfully argued that IEC was inactive in this area and BSI was therefore allowed to develop its own versions. Towards the end of my employment at BSI product Services, I surveyed the UK PCB suppliers regarding their preferred certification Standards giving them a choice of BS 123000, IPC-6010 and IPC-A-600. There was an even split between IPC and the traditional documents suggesting a similar split between end-user requirements.

This year's ICT / NUKCG Foundation Course at Loughborough includes a session by Dennis Price from Merlin Circuit Technology called "IECQ using IPC Standards" which I presume will detail how BSI Product Services can now offer a 'traditional' BSI certification against the latest IPC requirements. I will try to persuade my former colleagues to provide some details for the next newsletter.

It is often necessary to ascertain the general content of a Standard before going to the expense of a purchase. I find the 'BSI Shop' web page very useful for this:

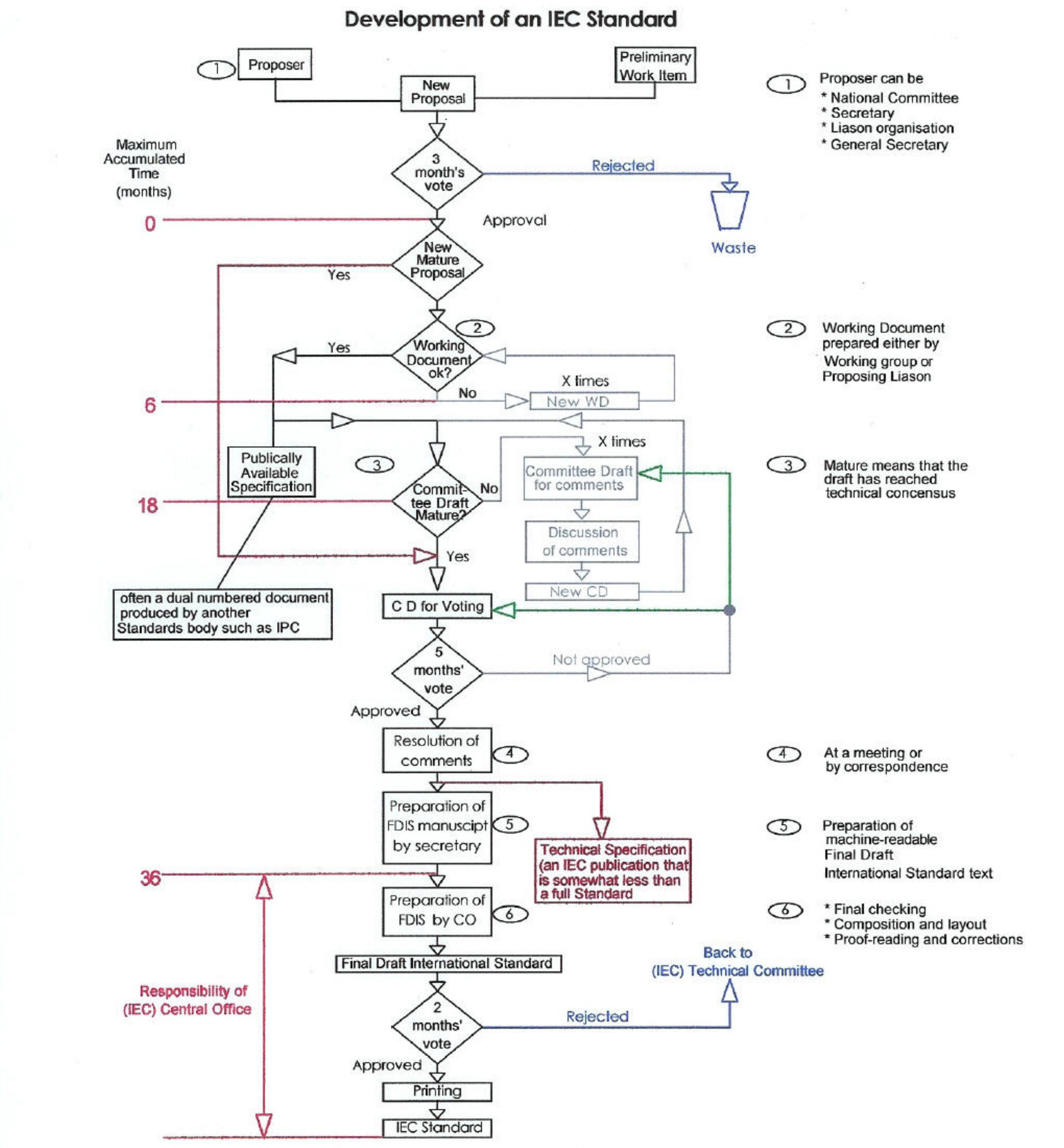
www.bsigroup.com/upload/Standards & Publications/shop.html

Whilst it is not possible to view the entire Standard, an explanation of the content is given with further details such as whether it is current, superseded etc.

Entire American military specs can be downloaded free of charge from:

www.dscc.dla.mil/Programs/MilSpec/DocSearch.asp

The criticism levelled at formal Standards is the time taken to develop them and therefore their (un)timeliness. It is easy to see why industry looks to IPC when IEC have a much more elaborate development cycle. Although there is a 'fastrack' process for some documents; this graphic illustrates the standard process.



Don't try to follow the diagram; you may go mad, but it certainly illustrates the lengths needed to reach an international consensus.

Standards are an irritation to industry but try to imagine having no agreed definitions, test methods and acceptance criteria or having each customer defining their own.

Len Pillinger F.Inst.C.T.

March 2009

Institute of Circuit Technology Darlington Seminar

3rd March 2009

A bit of history: The world's first permanent steam-locomotive-hauled public railway was built between Darlington and Stockton in the north-east of England and opened in 1825. And the first locomotive to run on the Stockton and Darlington Railway, Stephenson's Locomotion No.1, is preserved at the Darlington Railway Museum.

Such is the heritage of the venue for the Institute of Circuit Technology's seminar on the theme of **Supporting Industry Needs**, introduced by Technical Director **Bill Wilkie**, who reported that the ICT's ASPIS research project proposal under the European Commision FP7 programme had met all evaluation thresholds and could proceed to the second stage of submission.. This project, in co-operation with a European consortium, *sought to determine the definitive causes of black pad effects in electroless-nickel-immersion-gold finishes, and to evaluate viable alternative finishes based on ionic-liquid chemistries.*

This scene was set for **Dr Andy Cobley**, sonochemistry specialist at the **University of Coventry**, to explain how ultrasonic techniques could be applied to some of the surface treatment and metal finishing processes involved in printed circuit manufacture, to bring about improvements in energy-efficiency and to enable environmentally benign alternatives to the hazardous chemistries traditionally employed for surface modification of dielectric materials.

He demonstrated the effects of ultrasound on the surfaces of FR4, polyimide, Noryl and liquid-crystal polymer materials. The effects were not just physical–mass spectrometric analysis had revealed chemical evidence of new functional groups being formed. In electroplating, low frequency ultrasound had dramatic effects as a consequence of disruption of the Nernst Diffusion Layer. Limiting current densities were greatly increased and grain sizes reduced. Current efficiencies were enhanced and, in the case of gold plating, porosity significantly decreased. In electroless nickel plating, 38KHz ultrasound brought about an increase in deposition rate and when applied to the activation stage of the electroless copper process, 530KHz ultrasound caused more efficient catalyst pickup with the consequence of more rapid metal deposition.

When additionally introduced into the electroless copper bath, ultrasound further increased deposition rate and gave benefits in grain structure and degassing – of particular significance when metallising blind holes.

A prospective area of investigation was to exploit the capability of ultrasound to break chemical bonds in facilitating the replacement of formaldehyde, the standard reducing agent in electroless copper, with safer but less reactive alternatives.

Cobley's message was that ultrasonics were not just for cleaning, but opened-up a whole new toolbox in the broader field of surface finishing.

Electroplating is the basic technique used to manufacture copper foil, and **Geoff Layhe** of **Lamar Group** described the details and critical features of foil for high-end circuitries. Starting by dissolving copper wire in sulphuric acid to form a copper sulphate electrolyte, the metal was then electrodeposited on to a rotating stainless steel drum cathode, the speed of rotation determining the thickness of foil and the polished surface of the drum being replicated in the smooth surface of the foil. The foil had a natural columnar grain structure, and was characteristically rough on the non-drum side, the degree of roughness being determined by deposition parameters and inhibitors, and the micro-roughness by subsequent treatment to form a nodular surface. Foils designated "low-profile" had a surface roughness of less than 10.2 microns, and "very-low-profile" less than 5.1 in accordance with IPC-4562.

Because of surface roughness, it was difficult to quote meaningful thickness measurements for foil, and it was better specified by weight per unit area. Reverse-treated foil was given a slight roughness on the drum side, which facilitated photoresist adhesion with minimal surface preparation, leading to yield improvements in fine-line etching. Reverse-treated foil appeared more popular with US manufacturers than with their European counterparts.

Since the introduction of "lead-free" laminates, peel strength had again become an issue. Layhe commented that "peel strength" as determined by the IPC-4562 test could result in misleading conclusions. Failure was predominantly cohesive rather than adhesive, and was closely related to the bend-radius of the foil. Although measured peel strength apparently increased in approximately linear proportion to roughness, the actual mechanism was a cohesive failure within the resin, influenced by stress distribution related to a combination of foil thickness and roughness. Failure at the interface between foil and resin was rarely observed.

Final presentation of the seminar came from **Gavin Barclay** of **ACS Industries** with a practical reality check on drill shop procedures. He commented upon the tendency to focus too much on the high end of PCB manufacturing technology and lose touch with the basics of good practice in the drill shop.

Speaking from a background of many years as a leading provider of subcontract drilling services, and as a supplier of carbide tools, he addressed the fundamental aims and objectives: -

1). reduced costs,
2). increased productivity and
3). improved quality.

He demonstrated how to calculate tool parameters: -

a). chip-load,
b) cutting speed,
c). spindle RPM,
d). in-feed,
e). retract rate,

and discussed:-

i). stack heights
ii). hit counts,
iii). depth compensation
. iv). peck drilling.

Remarking that too many PCB fabricators had a "one size fits all" attitude to drill selection, he listed the characteristics and applications of micro drills, standard drills, inverse diameter drills, web-thinned drills, slotting drills and emphasised the importance of choosing the correct tools for the job, even if it meant keeping a diverse range in stock.

He showed examples of what could go wrong when simple principles of cleanliness, handling and machine maintenance were not observed, before focusing on the monitoring of tool performance, and the inspection and measurement of drill wear. Proper drill categorisation and effective re-point management, together with good process engineering and regular process audit, could result in more productive use of drilling equipment and full utilisation of drill bits, enhanced hole-wall quality, improved positional accuracy and reduced expenditure. In his closing remarks,

Bill Wilkie acknowledged the generosity of Flex-Ability for supporting a successful and well-attended event.

Pete Starkey F.Inst.C.T.
ICT Council 3rd March 2009

Degradation of chemical water pollutants using ultrasound

L Paniwnyk,
On Annong Larpparosudthi,

The Sonochemistry Centre
at Coventry University,
Faculty of Health and Life Sciences,

Abstract

The effluent from Printed Circuit Board manufacturing plants contains a range of organic chemical species. Various techniques have been used to treat this waste water and a further alternative might be the use of ultrasound. To illustrate the efficacy of ultrasound to degrade various organic species the decolourisation of four dyes, namely Methyl Orange, Reactive Orange 16, Direct Orange 31 and Direct Red 81 in aqueous solution was investigated in the presence and absence of sonication. The ultrasonic equipment used was a 20 kHz probe, 40 kHz bath, 512 kHz bath and 850 kHz bath. The efficiency of the decolourisation was monitored using the change in UV absorbance of the dye solutions. For all four dyes decolourisation was found to be difficult using ultrasound alone at 20, 40 and 512 kHz however at the highest frequency, 850 kHz, decolourisation was achieved. Thermal refluxing of the dye solutions did not result in any decolourisation and addition of hydrogen peroxide decolourised only Direct Orange 31. This suggests that the mechanism for ultrasonic decolourisation is not thermal and is also not due to direct action by hydrogen peroxide in the case of three of the dyes investigated.

Introduction

The manufacture of Printed Circuit Boards (PCBs) produces a cocktail of chemicals in waste water effluent from inorganic compounds to organic species used as additives in electroless and electroplating solutions. In addition resist strippers can introduce a range of dyes and ink based compounds into the effluent stream.

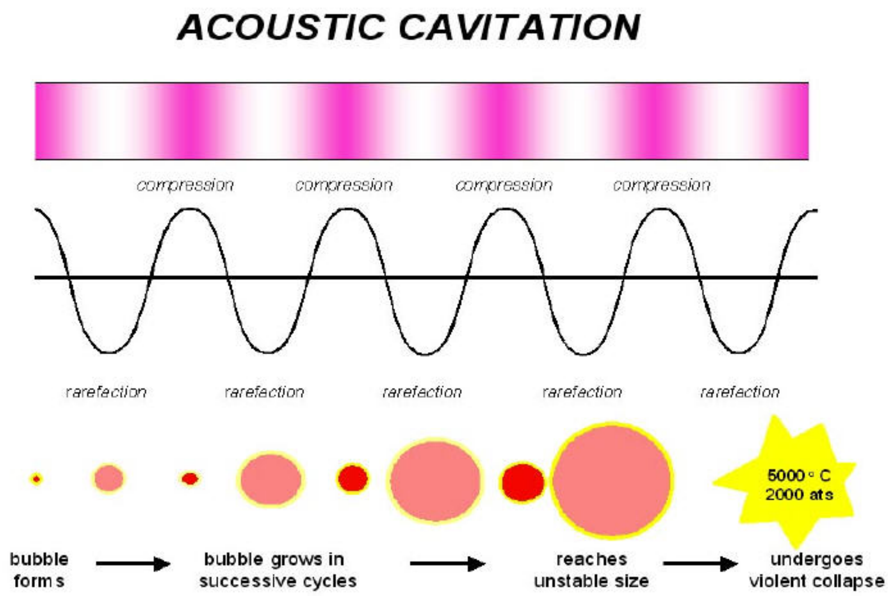
With environmental legislation becoming ever stricter it is imperative that the industry keeps abreast of new techniques for waste water treatment, one of which is the employment of ultrasound.

The use of ultrasound to treat industrial effluent is an area which has been relatively unexplored by industry to date. Currently, effluent is chemically treated with either high levels of UV light (Oliver 1975), chlorinated using various agents such as sodium hypochlorite, or oxidised via the addition of hydrogen peroxide or a combination of all the above (I.T. Miettinen 1998).

Chemical treatment may be combined with biological treatment involving either aerobic or anaerobic metabolisation (G Britton 1999). Advanced oxidation processes (AOPs) using ultraviolet light and oxidizing chemicals such as ozone, hydrogen peroxide and Fenton's reagent (Bains 2003, Yasman 2006, Hulsun 2007) have been found to be extremely effective when used with chemicals that are difficult to degrade. Ultrasound can be used to aid chemical degradation, either as an alternative more environmentally friendly technique to those currently used, or in addition to those techniques thus making the existing processes more effective.

Ultrasound is simply the introduction of high frequency sound to a medium through which it can travel, often this medium is water. There is a common misconception that for ultrasound to work effectively extremely high power low frequency approximating 20 kHz must be employed. In reality however the low power high frequencies of 850 kHz are proving to be the most effective for generation of hydroxyl radical (OH) and/or hydrogen peroxide.

Ultrasound appears to act via the introduction of oxidising free radicals such as the hydroxyl radical (OH). These radicals can act directly upon the target chemical or may combine to form hydrogen peroxide, itself an extremely efficient oxidising agent. As free radicals such as these are extremely short lived there is no possibility of chemical contamination. As ultrasound moves through a medium, such as water, a series of compression and rarefaction cycles results in the formation of cavities within the solvent. Solvent vapour enters these cavities and, as they become compressed during the next compression cycle, high temperatures and pressures result causing the vapour to undergo homolytic fission, forming free radicals such as the hydroxyl radical (OH). (Mason 1999)



(taken from Mason (1999) Sonochemistry Oxford University Press)

If the free radicals remain in close proximity to each other they will react to form hydrogen peroxide and this often happens with long cycles such as those at 20 kHz. If the radicals are expelled from the cavity during an extremely short cycle, such as those found with 850 kHz, then these radicals go on to attack the target chemical directly.

To illustrate the effectiveness of using ultrasound to waste treat an aqueous effluent this study investigated the efficacy of the process to degrade a range of chemically persistent dyes. Recently there has been much work investigating the use of ultrasound and its ability to degrade dyes. (Robinson *et al* 2001, Vinodgopal *et al* 1998, Ince and Tezcanlí 2001, Rehorek *et al* 2004) and there is enough evidence to suggest that use of ultrasound to degrade dyes is a viable process on a laboratory scale.

Experimental

The decolourisation of four dyes (Methyl Orange, Reactive Orange 16, Direct Orange 31, Direct Red 81) in aqueous solution was investigated in the presence and absence of sonication. Ultrasonic equipment employed included a 20 kHz probe, 40 kHz bath, 512 kHz bath and 850 kHz bath. The efficiency of the decolourisation was monitored using the change in UV absorbance of the respective dye solutions

Results

In order to determine whether decolourisation of the dyes under study could be a simple result of thermal degradation or direct degradation from hydrogen peroxide as series of experiments were performed. Thermal degradation was investigated by refluxing the dyes under study for 2 hours and their decolourisation determined. It was found that none of the dyes under study exhibited any thermal degradation.

Degradation via hydrogen peroxide was monitored by the direct addition of a solution of 30% H_2O_2 and the resultant decolourisation monitored using UV. Reactive Orange 16 and Direct Red 81 did not exhibit any decolourisation with hydrogen peroxide. This demonstrated, therefore, that if these two dyes showed any decolourisation with sonication it will not be due to the presence of hydrogen peroxide.

With Methyl Orange the addition of a solution containing 30% H_2O_2 resulted in a absorbance peak shift of the ëmax with a change in pH, however decolourisation was not observed

When 30% hydrogen peroxide solution was added to a solution of direct orange 31 it appeared to decolourise significantly. Here the degradation mechanism appears to be due to presence of H_2O_2. See Fig. 1 below.

Ultrasonic Decolourisation of dye

Methyl Orange

From Table 1, it can be observed that the 20 kHz ultrasonic probe and 40 kHz bath were not effective in decolourising Methyl Orange. The 512 kHz Ultrasonic bath was more effective but the most effective, with an 81% reduction in dye colourisation, was the 850 kHz bath. This is thought to be due to the 512 and 850 kHz baths being able to generate more hydroxyl radicals in the bulk solution

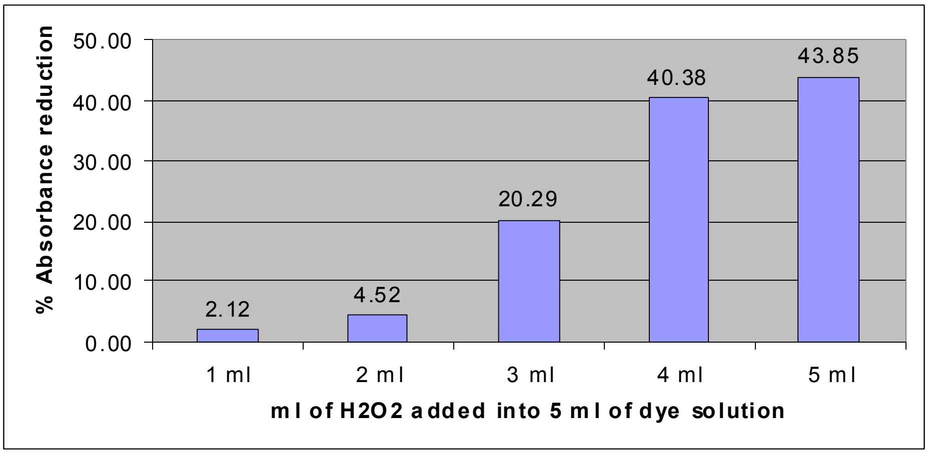


Fig.1 % absorbance reduction of 100 mol/l Direct Orange 31 at 430 nm after adding H_2O_2

Equipment	Freq KHz	Vol (cm)	% Dye reduction 1 hr	2 hr
Ultrasonic probe	20	100	1.89	3.11
Ultrasonic bath #1	40	100	0.00	0.42
Ultrasonic bath #2	512	500	9.44	19.29
Ultrasonic bath #3	850	200	25.00	51.95

Table 1 % absorbance reduction of 10 mol/l Methyl Orange at 464 nm after sonication

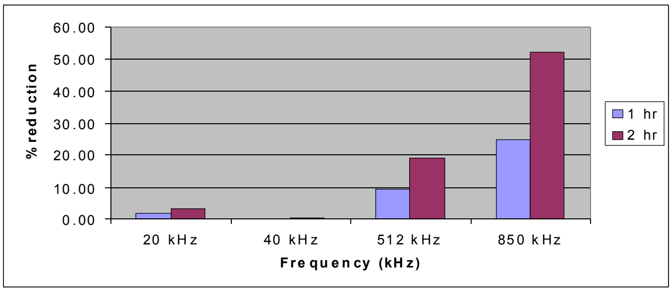


Fig.2 % absorbance reduction of10 mol/l Methyl Orange at 464 nm after sonication at different frequencies

Reactive Orange 16
In Table 2 below similar results are observed with the 850 kHz bath again producing the greatest levels of dye decolourisation observed with Reactive Orange 16. Direct Orange 16 is not susceptible to decolourisation with hydrogen peroxide suggesting ultrasonic decolourisation is due to radical attack

Equipment	Freq KHz	Vol (cm^3)	% Dye reduction 1 hr	2 hr
Ultrasonic probe	20	100	3.84	6.64
Ultrasonic bath #1	40	100	0.16	0.24
Ultrasonic bath #2	512	500	2.29	4.95
Ultrasonic bath #3	850	200	19.92	32.14

Table 2 % absorbance reduction of 100 mol/l Reactive Orange 16 at 494 nm after sonication

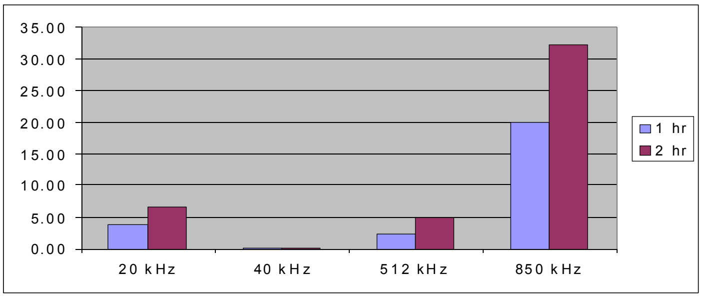


Fig.3 % absorbance reduction of 10 mol/l Reactive Orange 16 at 494 nm after sonication at different frequencies

Direct Orange 31
Direct Orange 31 is susceptible to direct decolourisation with hydrogen peroxide. On addition of a 30 % solution of H_2O_2 to a solution of this dye the absorbance reduced by 43.85 % with a ratio of dye solution:H_2O_2 of 1:1 by volume.
The Direct Orange 31 solution was not bleached either by the 20 kHz ultrasonic probe or 40 kHz bath. The slight increase of the absorbance after sonication for 2 hours may be the result of evaporation although cooling measures were taken to prevent this. Again the highest levels of dye decolourisation were observed with the 850 kHz bath with a 45.43% reduction observed after irradiation for 2 hours.

Equipment	Freq KHz	Vol (cm^3)	% Dye reduction 1 hr	2 hr
Ultrasonic probe	20	100	- 0.51	- 0.61
Ultrasonic bath #1	40	100	- 0.84	- 1.36
Ultrasonic bath #2	512	500	0.71	1.23
Ultrasonic bath #3	850	200	10.22	45.43

Table 3. % absorbance reduction of 100 mol/l Direct Orange 31 at 430 nm

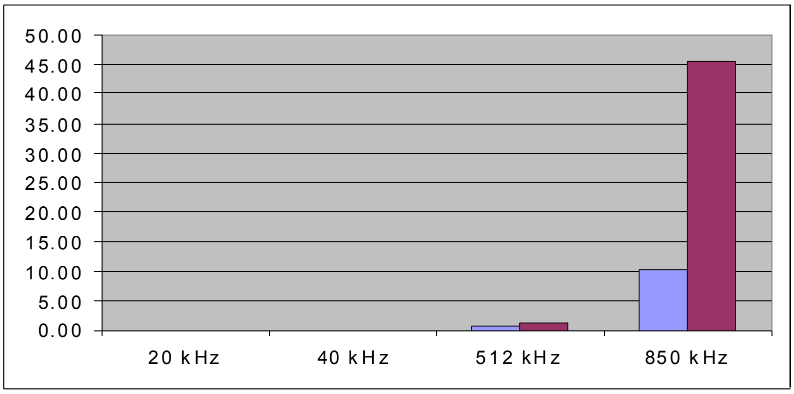


Fig. 4 : % absorbance reduction of 10 mol/l Direct Orange 31 at 430 nm after sonication at different frequencies

Direct Red 81
Direct Red 81does not appear to be susceptible to direct decolourisation with hydrogen peroxide and therefore the decolourisation of this dye may be entirely due to the radicals formed by sonication which attack the dye directly rather than the result of any peroxide they may form. Again 850 kHz proved to be the most effective decolourisation frequency.

Equipment	% Dye reduction 1 hr	2 hr
Ultrasonic probe	2.23	3.14
Ultrasonic bath #1	0.17	- 0.48
Ultrasonic bath #2	1.57	1.94
Ultrasonic bath #3	18.05	32.31

Table 4. % absorbance reduction of 100 mol/l Direct Red 81 at 508 nm after sonication

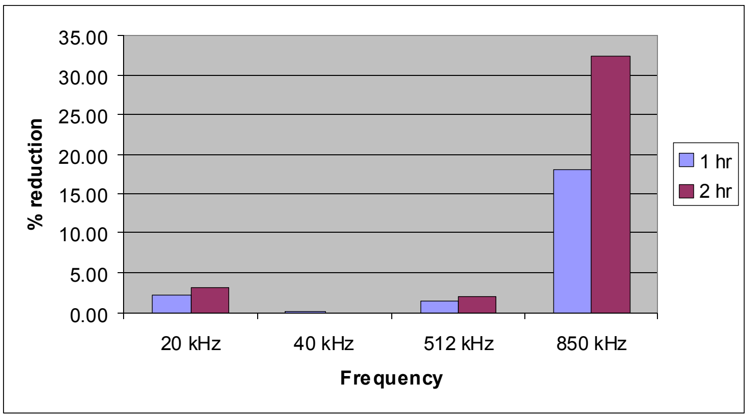


Fig.5 : % absorbance reduction of 10 mol/l Direct Red 81 at 508 nm after sonication at different frequencies

Conclusion

Thermal refluxing of the dye solutions did not result in any decolourisation and addition of hydrogen peroxide decolourised only Direct Orange 31. This suggests that the mechanism for ultrasonic decolourisation is not thermal and is also not due to direct action by hydrogen peroxide in the case of three of the dyes investigated. For the dye solutions, decolourisation was found to be difficult using ultrasound alone with long treatment times required. However, at the highest frequency of 850 kHz, decolourisation was achieved with ultrasound alone and this opens up the possibility of using ultrasound as part of a water treatment process rather than as a treatment process alone. Large scale ultrasonic equipment is becoming more freely available and if ultrasound acts synergistically to increase the efficiency of decolourisation of dyes, as it has been shown to do in other processes, it may then be possible to achieve dye control at faster processing times but also at possibly lower processing temperatures using fewer environmentally damaging chemicals.

L Paniwnyk,
On Annong Larpparosudthi,

The Sonochemistry Centre at Coventry University,

Faculty of Health and Life Sciences,

References

1. B. G. Oliver, E. G. Cosgrove, The Disinfection of Sewage Treatment Plant Effluents Using Ultraviolet Light, *The Canadian Journal of Chemical Engineering*, 53, (1975), 170-174
2. I.T. Miettinen, T. Vartiainen, T. Nissinen, T. Tuhkanen, P. J. Martikainen, Microbial Growth in Drinking Waters Treated with Ozone, Ozone/Hydrogen Peroxide or Chlorine, *Ozone Science and Engineering*, 20, (1998), 303-315
3. G. Bitton, Wastewater Microbiology, 2nd Edition, *John Wiley & Sons*, (1999), ISBN: 0- 471-32047-1

Attracting Students to the PCB Industry

These are difficult times in the PCB and wider electronics industry in the UK and further afield. However, for the industry to survive and grow in the future it is imperative that 'fresh blood' is attracted to an industry which many young people don't even know exists. This is, however, extremely difficult at a time when most companies are not recruiting and trying to keep costs to a minimum. One way to overcome these problems might be to take on a one year placement student. Several UK and European Universities run such schemes. The key objectives of them is to prepare students to enter the working environment by helping them identify and develop key skills such as interpersonal, communication, time management etc.

For more information on the above programmes please contact Andy Cobley using the following contact details:

E-mail – a.cobley@coventry.ac.uk
Mobile – 07706 955 901
Office – 02476 888 624

Group Members of The Institute of Circuit Technology April 2009

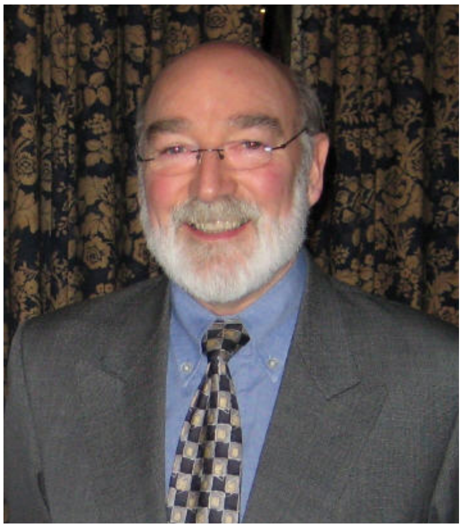
Organisation	Address	Communication
Anglia Circuits Ltd.	Burrel Road, St.Ives, Huntingdon PE27 3LB	01480 467 770 www.angliacircuits.com
Artetch Circuits Ltd.	Riverside Ind. Est. ,Littlehampton BN17 5DF	01903 725 365 www.artetch.co.uk
Atotech UK Ltd.	William Street, West Bromwich. B70 0BE	01210 067 777 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

News from the Membership Secretary

The **2009 ICT Annual Foundation Course in PCB Design and Technology** is taking place once again at Loughborough University with 19 delegates from the PCB and related Industries. This course was begun in the early eighties by the Northern UK Circuit Group, which held its own inaugural meeting in September 1979 – and I was there! The original Syllabus for the course and considerable assistance was provided by two ICT stalwarts, Brian Pledger and Pat Kirby, who were involved in the running of various courses at Slough Technical College and also a one-week course at the University. Initially, the course was held over two weeks, with practicals on each subject and ending on a high note with an examination based on multichoice questions. Changes in the Industry were reflected in the course and gradually, the examination ceased and the course was whittled down to one week.

It started in 1981 in the Galashiels College of Technology and then moved after eight years to the Herriot Watt Campus, also in Galashiels. It missed a year in 2003, but since then has been run at Loughborough University.

We actually start the course at Invotec, Tamworth, who host the first day and a facility tour before we recommence at Loughborough Uni versity for the rest of the course. With eighteen lectures, it is a stiff test of concentration, but has stood the test of time, reflecting the mood of our Industry for over a quarter of a century.



Bill Wilkie
Technical Director
Institute of Circuit Technology

Email bill.wilkie@InstCT.org
Tel +44(0)1573 226131
Fax +44(0)1573 226131
Web www.InstCT.org

The Journal of the Institute of Circuit Technology is edited by Bruce Routledge on behalf of the
Institute of Circuit Technology.
30 New Road, Penn. High Wycombe, Buckinghamshire, HP10 8DL
E-mail : bruce.rout@tiscali.co.uk