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Chris Taylor is a Fellow of the IVE with over 35 years enamelling experience and is a lecturer for the IVE Basic Approach Course.

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Official Journal of THE INSTITUTE OF VITREOUS ENAMELLERS

VOLUME 59 NUMBER 3 AUTUMN 2008

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This edition of the Vitreous Enameller will be the last one published in my first year as Editor of the journal, and what an eventful year it has been for us all. We have seen the domestic appliance sector in the UK continue to shrink with the relocation of manufacturing facilities to Eastern Europe and more recently the downturn in the economy has provided additional cause for concern across all sectors of business. The first deadline for the pre-registration of substances for the new REACH regulation was the 1st December and the lead up to this has generated heavy work loads as well as confusion for some unfortunate enough to be given the job of dealing with REACH for their organisations. A few would argue that this is further unnecessary EU intervention for European manufactures to deal with. ECHA claim these measures will provide a high level of protection of human health and the environment from the use of chemicals and also make the people who place chemicals on the market responsible for understanding and managing the risks associated with their use.

This year saw the end of frit production at Escol Products in Huntingdon, and with the subsequent auction and decommissioning of plant, the end of frit manufacturing in the UK for iron and steel enamelling. The Company continues to serve its customers with the same range of products following a successful two year product transfer programme with their joint venture partner Ege Kimya. Escol continues to develop and formulate new materials and retains the responsibility for all quality and service related functions but their action to transfer manufacturing overseas should be acknowledged as an end of an era for British manufacturing.

The speed of the recent changes associated with our industry has been quite remarkable. It would seem that companies have been able to uproot and relocate their operations with incredible ease and continuity in order to balance the books. With this considered, perhaps it’s not too far into the realms of fantasy to envisage a resurgence of enamelling in the UK. It wasn’t so long ago that Japanese car manufacturers found it desirable to open car plants in Britain. Honda opened their factory in Swindon in 1992 to make Civics and now ships cars back to Japan. Global economies and government incentives at the time
made this an attractive option, so if this was the case then, why not in the future for our industry?

I am not going to make any predictions on events in the coming year but I certainly hope I can write another editorial this time next year with considerably more positive content. I’ve never been a fan of pessimism but whenever I set pen to paper for these editorials, I find myself sounding more and more like Victor Meldrew with every sentence. Let’s hope for a better year for our industry next year.

As an endnote, I should mention that it’s not all been doom and gloom over the past year. Some enamelling companies involved in markets other than the domestic appliance sector have been bucking the trend with healthy order books and that’s good news for us all.

MARK MORIARTY
Editor

--ooOoo--
MINUTES OF THE SEVENTY FOURTH ANNUAL GENERAL MEETING OF THE INSTITUTE OF VITREOUS ENAMELlers,
HELD AT THE LONGFORD HOUSE, WATLING STREET, CANNOCK ON THURSDAY 25TH SEPTEMBER 2008 AT 17.00

Present:

In the Chair Mr M A Collins President of Council
Mr C Taylor Deputy Chairman

Twelve Members present

(This number comprising a quorum as required by The Articles of Association)

Also present Mrs A C Nutting Company Secretary

Minutes of the Seventy Third Annual General Meeting

The minutes of the Seventy Third Annual General Meeting of The Institute of Vitreous Enamellers, held at the Black Country Museum, Tipton Road, Tipton on Friday 28th September 2007, published in The Vitreous Enameller”, Vol. 58, Number 3, Autumn 2007, were taken as read. Acceptance was proposed by Mr M. Nutting, seconded by Mr J. Mullis and approved unanimously. The Chairman signed the minutes of the Seventy Third Annual General Meeting.

Annual Report from the Chairman of Council

The Deputy Chairman of Council, Mr C. Taylor, presented the Chairman’s report in his absence. This report is on the activities of Council and of The Institute during the previous twelve months. His report is quoted verbatim:
Chairman’s Report for 2008.

2008 has been a turbulent year for IVE council so far. In January, two former sustaining members elected to withdraw their membership and consequently the decision was taken by the Executive to withdraw the sustaining member grade altogether. This has a significant negative impact on the annual income of the IVE and the VEA.

In late 2007 there was a great deal of discussion within Council on the mission of the IVE, and the benefits it delivers to members. In general it was felt that change was overdue, but discussions were not conclusive at that time. The decision of former sustaining members to withdraw membership (in my opinion) reflects their view that the benefits of sustaining membership no longer represented good value for money. These events have accelerated the process of change within the IVE. At the suggestion of the Executive, a working group was set up as a sub-group of Council, lead by the Chairman and including four other members of Council. The brief set by the chairman was “how to increase the value of IVE membership to members”. Since January this group has been working to generate and collect ideas. This was the first phase. These ideas have since been filtered by grouping and ranking using a simple scoring system. I would like to thank the working group for their efforts so far. The result is four ideas:

1. Build on the success of the journal.
2. Take more advantage of the website as an interface with members (including a Members’ Area, which was already in development)
3. Look at new ways to provide technical support.
4. Better leverage the role of the IVE in understanding Standards.

In addition to ideas on increasing the value of membership, the working group is also looking at the concept of establishing better links with another institute. Such “improved links” could go as far as a full merger if it is decided that such a move would make sense. We need to look more closely at this.

I would now like to move on to other matters. Membership has declined a little due to the loss of three company members (all outside EU) and seven personal members. Former sustaining members have been converted to company members. The overall change represents a decline of 11%, not including Honorary Members and Fellows.
The Basic Approach course was not run this year, due to lack of numbers. Unfortunately, some late bookings were received after the decision to cancel had been made. If received earlier, these bookings would have made the course viable. The next course will be run on 20-23 April 2009.

The Annual Technical Seminar was held in the shadows of the Forth rail and road bridges, in North Queensferry, Edinburgh. Attendance was 22, 10 less than in 2007 but slightly more than in 2006. There were many excellent papers, and a fascinating visit to Pfaudler Balfour nearby, a leading supplier of glass lined equipment for the chemical and pharmaceutical industries. I would like to thank Mr Ron Black and Pfaudler Balfour for their hospitality and for opening their doors to us for this visit. They even arranged the timing of our visit and their production scheduling so that issues over Health and Safety were minimised. The quality of the Seminar was very high and it is a little disappointing not to see more new faces at such a good event.

A technical Seminar for 2009 remains a good topic for discussion.

Finally I would like to thank Council for their support. I thank Mark Nutting, Chris Taylor and Mike Collins for their hard work on the Executive. Also I want to give a special mention to Angela Nutting for all of her excellent work in many and varied areas, particularly organisation and logistics.

Report from the Honorary Treasurer

The Honorary Treasurer, Mr B. Fieldhouse, presented a report on the trading accounts for the period ending December 31st 2007. Copies of the accounts has been previously sent to all paid up and applicable UK and EEC members. The report presented is quoted verbatim:

Financial report for the year ending 31st December, 2007

The Institute has made a loss of £2,792 this loss was anticipated for the year. Transfer of funds from the IVE to the VEA has once again taken place to cover the costs of work carried out on behalf of the IVE by the VEA.

On reviewing the Income and Expenditure account, membership and journal subscription income was lower than anticipated due to a number of members and subscribers not renewing their membership. The income for book sales has dropped dramatically in 2007.
Expenditure costs were lower than anticipated. £2500 was included in the publicity budget for the performance guide, this never went to print, and has been taken out of the 2008 budget and replaced by the website technical zone. The costs for the Annual Technical Seminar were higher than anticipated in 2007. It was hoped that work would have further progressed during 2007 for the Cast Iron Group but this did not occur, this working group has now been put on hold.

The retained funds for the Institute are still healthy at £55,334.

This year is going to be a very tough year not only for the Institute but also for the industry. I trust that you will continue to give us your support for the year ahead

Approval of the Accounts for the period 31st December 2007.

The adoption of the financial report and accounts for the year ending 31st December 2007 was proposed by Mr B. Fieldhouse, seconded by Mr J. Mullis and unanimously approved.

Election of Officers for the year 2009.

The Chairman announced that the President, Mr M. Collins, was willing to continue in office for a further year commencing January 1st 2009.

Acceptance was proposed by Mr C. Oldfield, seconded by Mr J. Mullis and unanimously approved.

The Chairman announced that the Honorary Treasurer, Mr B. Fieldhouse, was willing to continue in office for a further year commencing January 1st 2009.

Acceptance was proposed by Mr M. Collins, Seconded by Mr J. Mullis and unanimously approved.

The Chairman announced that the Company Secretary, Mrs A. Nutting, was willing to continue in office for a further year commencing January 1st 2009.

Acceptance was proposed by Mr S. Ali, Seconded by Mr M. Nutting and approved unanimously.
Report from the President

The President, Mr M. Collins then addressed the meeting. The report presented is quoted verbatim:

Just when we all thought it couldn’t get a lot worse - it just has. The world’s financial system seems to be in a total state of chaos, oil prices are about to go sky high again and house prices are diving. I am sure that all of us sitting at the IVE AGM last year knew it was going to be bad, but I doubt that we would have predicted it would be like this.

However on my theme of last year you are either a survivor or a victim. The only way that we can ensure our survival is to manage it. The working group set up under the head of our Chairman are looking at ways to do just that. Not an easy task, but one which must be successful. A personal thought that may be of some help is to look at managing our resources. It has become obvious that there are too few people with much too little time involved in the IVE. We looked to attend a short one-day seminar on “membership”. There was nobody available with time available to attend. So we have to be realistic. The Institute must be managed to take account of this limitation. We must not set unachievable targets - as failure to achieve is one of the worst motivators.

But there are some successes. Among them, the signage and architectural sectors are still doing some amazing things. The largest hand produced enamel mural is currently being produced by an artist at one of our members. Have a look at our website - follow the links from the headlines on our home page and read her “blog” - I will be amazed if it doesn’t raise a few smiles. Enamel has had a plug in The Times and on Channel 4 and there have been some spin-offs from them.

Another bit of good news - you will recall that last year, I admired the courage of the team who were building a new steam loco which will run at 90mph plus on the main lines. At that time there were still sceptics. But it is now a runner - undergoing running-in trials on the Great Central Railway from Leicester to Loughborough - 250 odd tons of pure power! The way they made this happen was a clear policy - Every decision was taken under the ethic - if the end result isn’t within the mission to build and operate it - then they didn’t do it.
I ask the question and will leave you to answer it - have we learned anything in the last year and if so, have we made it happen?

So to sum up my message for this year- set achievable targets and develop a clear sense of purpose.

Election of Five Members of Council for the years 2009 –2012.

No nominations had been received for Personal Member representation on council.

For Company Member representation on Council, no ballot had been required. The Retiring Members Arcelor Mittal (represented by Mr P. Gousselot), Corus Strip Products (represented by Mr van Duijn) and Trico VE Ltd (represented by Mr C Oldfield) had indicated their willingness to continue and thus no election was necessary. Their re-election was proposed by Mr M. Nutting, seconded by Mr S. Ali and unanimously approved.

The Secretary, Mrs A Nutting was asked to add the full elected constitution and officers of the Council of the Institute for the year commencing January 1st 2009 to the minutes.

Officers

President: Mr M A Collins
Chairman: Mr S Cook (2nd Year)
Honorary Treasurer: Mr B Fieldhouse
Publications Editor: Mr M Moriarty
Company Secretary: Mrs A C Nutting

1 Year period ending 31st December 2009

Company Member representatives:

Ferro (Great Britain) Ltd (Mr M Devey)
Permastore Ltd (Mr S Ali)

Personal Member representatives: Mr C Taylor
2 Year period ending 31st December 2010

Company Member representatives:

Hytech Applications Ltd (Mr M Stickler)
Kingfisher Enamelling Co Ltd (Mr M Nutting)
Rio Tinto Minerals Ltd (Dr S Cook)

Personal Member representatives:

Mr P Bond
Mr M Moriarty

3 Year period ending 31st December 2011

Company Member representatives:

Corus Plc (Mr R van Duijn)
Trico VE Ltd (Mr C Oldfield)
Arcelor (Mr P Gousselot)

Appointment of Accountants

The Honorary Treasurer stated that the accountants were satisfactory and he saw no reason to change. This was proposed by Mr C Taylor and unanimously approved.

Any Other Business

No matters were raised.

The Deputy Chairman thanked all of the Company for their attendance.

This concluded the business of the meeting.

--ooOoo--
FORTHCOMING EVENTS

13 November 2008 - 16 November 2008
Metals Asia 08
Venue: New Delhi, INDIA
Contact: The Indian Institute of Metals
Tel: 91 11 2995 6738

Energy Intensive Industries and Climate Change: Surviving the Threat to Global Competitiveness
Venue: Brussels, BELGIUM
Contact: R.K. Gupta
Tel: +44 (0)20 7503 1265
Web:http://www.integer-research.com/Products/Services/?ServiceID=216&ckIndustryID=3

27 November 2008
Commodities Day - Nickel
Venue: Simmons and Simmons
London, UK
Contact: Liv Carroll
Tel: 020 728 72872
http://www.minsouth.org.uk/html/events.html

21 January 2009 - 25 January 2009
Fabtec India: India’s First Sheet Metal Fabrication Welding, Coats and Paints Technology Exhibition
Venue: Coimbatore, INDIA
Contact: CODISSIA
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Tel: +91 422 2215182
Web:http://www.fabtecindia.com/about_us.html

16 February 2009 - 20 February 2009
World Iron Conference 2009 – WIC
Venue: London, UK
Contact: Xander Veldhuijzen
Email:WIC2009@ironsmelting.net
Web:http://www.ironsmelting.net/WIC2009/

31 March 2009 - 02 April 2009
European Coatings Show 2009
Venue: Nurnberg, GERMANY
Contact: Ulla Kallert, Project Manager
Tel: +49 (0) 9 11.86 06-81 28

--ooOoo--
BUSINESS NEWS

SALES AND PROFITS RISE AT JOHNSON MATTHEY

Advanced materials technology group Johnson Matthey has seen rises in sales and profits, it reported. Announcing results for the six months to 30 September, chief executive Neil Carson said: “Johnson Matthey performed well in the first half of 2008/09. With global car sales expected to fall in the second half we have taken action to reduce costs and protect our margins in emission control technologies. The outlook for our other catalyst businesses remains good underpinned by environmental legislation and concerns over energy security. “The long term drivers for our business remain firmly in place. With our strong balance sheet and investment in new technology the group is in a good position to weather the current economic downturn.” Revenue for the period was up 24% to £4.4 billion as a result of volume growth and higher precious metal prices in the first quarter while pre-tax profit rose 20% to £144.9 million. Looking ahead, Johnson Matthey said global car sales were expected to show a significant decline in the second half of its financial year compared with last year which would reduce sales of autocatalysts. Actions had been taken to reduce costs and benefit operating profit, it said.

Source: http://www.worksmanagement.co.uk/, 26 November 2008

INNOVATION ‘IMPORTANT IN DOWNTURN’

Knowledge Transfer Partnerships – the public funded programme that facilitates innovation-led partnerships between business and higher education – has released the results of a new survey of manufacturers. The research, among 200 manufacturers suggests the subject of innovation is even more important during an economic downturn than in the normal business climate. Almost half of those surveyed said their focus on innovation and product design had increased due to the growth of global markets and respondents acknowledged that strengthening innovation is one of the ways they can compete with low wage economies such as China and India. Over a third of survey respondents were taking steps to build knowledge and innovation within their business by inviting graduates or post graduates to undertake work placements. Some two thirds were also running internal working groups and cross-team meetings to foster a culture of ideas and knowledge sharing. More than two thirds were
also prioritising investment in staff training and skills as a means of ‘future-proofing’ their business against global competition – alongside identifying process efficiencies and negotiating on supplier costs. Dr Debbie Buckley-Golder, programme director at KTP, said: “These are clearly very testing times for the manufacturing sector and businesses must focus both on short term survival, as well as longer term stability in a global marketplace.” The sector’s positive attitude to innovation would help to strengthen sector expertise in the longer term and KTP strongly encouraged more companies to consider collaboration with academic partners, she added. “Our competitiveness in the UK could depend on our ability to share the rich base of knowledge produced by this type of collaboration.”

Source: http://www.worksmanagement.co.uk/, 29 November 2008

ENGINEERING GRADUATES ‘HIGHLY EMPLOYABLE’

A report released at the end of October 2008 found engineering and technology graduates to be highly employable, with 62% entering full time employment after leaving university compared to 58% of graduates from all courses. The report, by the Engineering and Technology Board (ETB), also found that, contrary to popular belief, nine out of ten engineering and technology graduates who enter employment, go on to work in engineering and technology related occupations. The briefing paper “Where do Engineering Graduates go?”, based on statistics from the Higher Education Statistics Agency, also refutes the popular view that many engineering and technology graduates “go into the City”. The paper reports that only 3% of Engineering and Technology graduates go on to work in financial occupations compared to an average of 7% for all subjects. ETB chief executive Dr John Morton said: “In these times of increasing globalisation and environmental change, engineers play an ever more vital role in the economy and society at large. This research shows that graduates understand this and that employers value their contribution.”

Source: http://www.etechb.co.uk, 30 October 2008

TIME TO RETHINK OFFSHORING?

New research has emerged suggesting that rising oil prices alongside wage inflation in places like China, Mexico, Malaysia and Brazil are undermining the reasons that manufacturers moved offshore. Although written from US
viewpoint, a McKinsey quarterly report, ‘Time to rethink offshoring?’ suggests that manufacturers may need to re-evaluate the location of their manufacturing and, says McKinsey, might therefore signal some good news for local UK manufacturing. In the week when the UK government announced its renewed manufacturing strategy McKinsey’s work says the production of high-tech goods has moved steadily from the United States to Asia over the last decade, but soaring oil prices, a falling dollar, and rising wages are undermining some of the reasons manufacturers moved offshore. For managers of global supply chains, the question now is whether or not to consider scaling back offshore production by returning operations to, or closer to, the United States, the report suggests. Although McKinsey’s analysis shows that for a number of high-tech products, costs have changed enough to undermine the benefits of Asian production significantly, the decision to rein back offshoring isn’t straightforward, it says. “In rethinking your global supply chain, you must carefully evaluate the importance of speed, the availability of skilled talent, the potential for further productivity gains in Asia, one-time transition costs, the local import and tax implications, and organizational interfaces,” the report concludes.

Source:http://www.worksmanagement.co.uk/, 12 September 2008

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ISO reviews International Standards at least every five years. This is essential to ensure that confidence is maintained and for the wide and effective use of the standards. Each review includes an assessment of the degree to which the standard has been adopted at national level and applied in practice. In October 2008 the following international standards were due for systematic review and we have agreed for these standards to be adopted for a further period:


- ISO 4530:1983 Vitreous and porcelain enamelled manufactured articles - Determination of the resistance to heat - Implemented by BSI as BS 1344-7:1984

Recent activities have included the following:

- prEN 15711 Vitreous and porcelain enamels - Glass lined flanged steel pipes and flanged steel fittings - Quality requirements. This draft standard has now been approved and has been submitted for formal vote.

- prEN 15286 Vitreous and porcelain enamels - Terminology. Recent activity has revolved around reaching consensus in the European enamelling committee CEN/TC262/WG5 on the comments received from the voting on the draft standard.

- prEN 15771 Vitreous and porcelain enamels - Determination of scratch hardness according to Mohs. This draft standard has now been approved and has been submitted for formal vote.
THE VITREOUS ENAMELLER

The transposition of ISO to EN ISO standards has progressed and the following standards have been published.

- ISO 28722 Vitreous and porcelain enamels - Characteristics of the enamel coatings applied to steel panels intended for architecture.
- ISO 28723 Vitreous and porcelain enamels - Determination of the edge covering on enamelled steel plate to be used in heat exchangers.
- ISO 28762 Vitreous and porcelain enamels - Enamel coatings applied to steel for writing surfaces - Specification.
- ISO 28763 Vitreous and porcelain enamels - Regenerative, enamelled and packed panels for airgas and gas-gas heat exchangers - Specifications.
- ISO 28764 Vitreous and porcelain enamels - Production of specimens for testing enamels on sheet steel, sheet aluminium and cast iron.
- ISO 28765 Vitreous and porcelain enamels - Design of bolted steel tanks for the storage or treatment of water or municipal or industrial effluents and sludges.

These ISO standards will not however be adopted in the UK until they have been progressed into EN ISO standards and this process is underway.

Other activities include the continued liaison with standards committees from the steel industry for the development of EN 10129. The proposed standard for the enamelling of hot rolled steels will be further discussed by the European steel committee ECISS/TC13/WG2 when they meet in Paris in December 2008. STI/36, the UK standards committee on vitreous enamel coatings has also identified an enamelling committee in the US and is in the process of joining this to enhance visibility of developments in ASTM standards.
Finally I would like to ask members to consider the impact on their business if they do not conform to standards relating to their products. A cookery standard, EN 13834:2007 Cookware - Ovenware for use in traditional domestic ovens, was published last year with errors in the performance criteria. The standard was produced by CEN/TC194 and the corresponding UK committee is CW/29 which appears to have no representation from the UK enamelling community! The errors in the standard are causing confusion within the industry sector and this could have been avoided. I therefore ask individuals and organisations who would consider involvement in maintaining and developing standards to contact the IVE.

SAQLAIN ALI
Chairman STI/36
IVE Council Member

--ooOoo--
SMES NEED MORE HELP WITH CLIMATE CHANGE

UK businesses have made £1.1 billion in energy efficiency savings over the last 12 months but, according to the British Chambers of Commerce (BCC), small and medium-sized businesses could do more if they had more support. The BCC’s environment survey of over 3,000 firms found that, with the economy stalling and companies left facing “painfully high” energy bills, one of the few positive developments is the focus businesses are placing on climate change by improving their energy efficiency. However, the report went on, this only emphasises the urgent need for the Carbon Trust to capitalise on this fresh momentum, especially if the UK’s ambitious 2050 carbon emission targets are to be met. The Trust, the Government body established to assist business in the drive towards a low carbon economy, has been too slow to engage with SMEs, the BCC said. It must now take advantage of this energy efficiency push and refocus on assisting more small businesses, the sector most in need of help and one which contributes over 50% of all business energy usage. The report, “Business and the Environment: Challenges Ahead,” surveyed companies nationwide to ascertain the current business opinion on climate change and the environment. It shows that a significant number of those who have engaged with the Carbon Trust were larger organisations. BCC Director General David Frost said: “Over the last year a majority of businesses have shown a real appetite for reducing energy usage and as a result the environment has been pushed to the top of their agenda.” However, he went on, if the Government is going to meet ambitious emissions targets, it needs to refocus the Carbon Trust on to the wider business community.

Source: BCC press release, 3 October 2008

WEB-BASED COMPLIANCE SOFTWARE FOR AIR AND WATER

An Oxfordshire company is achieving export success with a web-based system that makes it easier for managers around the world to comply with legislation pertaining to the safety of the air and water on their premises, across different
jurisdictions. In terms of both UK and EU law, senior managers or directors must demonstrate that they monitor the effectiveness of their health and safety control systems, including those for air and water. Among other legislation, there is a statutory requirement for owners to carry out a Legionella risk assessment on the premises. This includes the inspection of assets such as water tanks, showers, sinks and taps. For businesses spanning multiple premises in many countries, with differing quality systems, this can be a major challenge, particularly if monitoring is paper-based. The new system, produced by Zeta Compliance Technologies Ltd is said to be the world’s first dedicated web-based compliance software for this purpose and is being used extensively in the UK to ensure that good water hygiene is maintained within buildings. It also is being applied to an ever-growing number of environmental, health and safety compliance issues, including air hygiene. In addition, the product can be used to monitor the safety of gas appliances in hospitals, the MRSA bug, and any type of “dumb asset.” Uploading results from a hand-held digital device straight to the ZetaSafe database informs operators immediately if there is an area of non-compliance in the facility they are examining. The device allows the operator to scan a bar code on the asset, which immediately tells them what checks to conduct. The ZetaSafe system is now being used in the US and Europe, with export assistance having been given to the company by the UK’s trade and investment authorities. Further information on the technology can be accessed at: www.zetacomtech.com.

Source: Zeta Compliance Technologies press release, September 2008

BUSINESSES WARNED OVER WASTE BATTERIES

Revised EU legislation that aims to protect human health and the environment by ensuring that waste batteries are properly collected and recycled is now in force. Directive 2006/66/EC also makes producers responsible for the management of batteries once they become waste. Adopted by the European Parliament and Council in 2006, the revised Batteries Directive was due to be transposed by Member States into national law by 26 September. Batteries contain a range of metals which are harmful to human health and the environment, including in some cases the hazardous heavy metals lead, cadmium and mercury. The new legislation revises an existing Directive on batteries (91/157/EEC), which has failed adequately to control the risks they pose or to create a homogeneous framework for their collection and recycling. For example, almost one in two portable batteries (small, sealed batteries, as
opposed to industrial or automotive batteries) sold in the EU in 2002 was sent for final disposal in landfill dumps or incinerators instead of being recycled after use. Under the new rules, national collection targets have to be introduced for portable batteries. These require the collection of at least 25% of the portable batteries used annually in each Member State by 2012, rising to 45% by 2016. There is also a requirement that, in line with the principle of producer responsibility, battery producers have to finance the costs of the collection, treatment and recycling of waste batteries. Detailed guidance on the new Directive is available at: http://ec.europa.eu/environment/waste/batteries/pdf/questions_answersDirective.pdf

Source: http://europa.eu, 26 September 2008

CARBON TRUST DELIVERS CREDIT BOOST FOR SMALL FIRMS

Good news at last after weeks of doom and gloom for the small-business sector: that was the message this week from the Carbon Trust as it announced that it has doubled the maximum size of its interest-free Energy Efficiency loans from £100,000 to £200,000. Small businesses struggling during the credit crunch might also be pleased to hear that it has increased the overall loans pot by 45% to £31 million this year. The loans, which are unsecured, interest-free and repayable over a period of up to four years, provide a cost-effective way for small businesses to upgrade equipment with more energy efficient versions, thereby reducing energy bills and cutting their carbon footprint. The move is in response to the difficult market conditions and will enable small businesses to implement energy saving projects on a far more ambitious scale than previously possible. It is expected that the new scheme will generate 20% more carbon and energy savings this year than would have been possible under the previous limit. Hugh Jones, solutions director at the Trust, said: “We know that SMEs want to play their part in tackling climate change, and reduce their energy costs at the same time. But, in the current economic climate, the tighter credit conditions are making it harder for small businesses to find alternative sources of funding.” He acknowledged that some companies found that the £100,000 limit had made it hard for them to finance the more ambitious projects in which they wanted to invest, such as large lighting installations, boiler projects, or multiple equipment purchases such as variable speed drives with compressors and heat recovery equipment. More information can be found at: www.carbontrust.co.uk.

Source: Carbon Trust press release, 29 September 2008
REVISIONS TO ELCI

The Health and Safety Executive (HSE) has recently updated the information on its website to reflect changes to the Employers’ Liability (Compulsory Insurance) Act 1969 (ELCI) with regard to the requirements for the display of certificates. The Employers’ Liability (Compulsory Insurance) (Amendment) Regulations 2008 amended regulations 4 and 5 of the Employers’ Liability (Compulsory Insurance) Regulations 1998 by removing the requirement for keeping expired ELCI certificates and making the “display” requirements more flexible by allowing businesses to present them in an electronic form. This means that, from 1 October 2008, there is no legal requirement for employers to keep copies of out-of-date certificates and employers now have flexibility with regard to how they display their current certificates, including making the certificates available to employees in electronic form. However, it should be noted that the Department for Business, Enterprise and Regulatory Reform (BERR) has advised employers to keep detailed records of ELCI policies. This is because certain diseases can appear many years after a person has been exposed to their cause, and former or current employees may decide to make a claim against the employer for the period in which they were exposed to the cause of their illness. If employers fail to keep details of historic insurance details, they place the business at risk of having to meet the costs of such claims.

Source: Health and Safety Executive press release, November 2008

ECHA ESTABLISHES BACK-UP FOR PRE-REGISTRATION DEADLINE

The European Chemicals Agency (ECHA) has announced that it has made ready a back-up submission procedure, which, if needed, will ensure that companies can pre-register by the 1 December 2008 deadline under the Registration, Evaluation and Authorisation of Chemicals (REACH) regime. On 16 November 2008, ECHA doubled the capacity of its REACH-IT system, which it says substantially improved the performance of the system during peak hours. Over the coming days, ECHA says that it will implement further technical solutions to enhance the system’s performance. The performance will also be constantly monitored and there will be status updates on the ECHA website each working day. However, ECHA says that, if the REACH-IT system cannot absorb the large number of pre-registrations before the deadline, it will
provide the additional pre-registration submission method in the final days of pre-registration. The Agency adds that the back-up method will be implemented only if absolutely necessary and is also keen to emphasise that the deadline for pre-registration cannot be extended by ECHA. Only a submission via REACH-IT guarantees the receipt of a pre-registration number and direct access to the pre-Substance Information Exchange Forum (SIEF) without delay, which allows pre-registrants to see who else has pre-registered the same substance using the pre-SIEF page on the ECHA website. Due to the lack of flexibility concerning the deadline, ECHA is urging companies not to defer sign-up and pre-registration. Further information on the system can be accessed at: http://echa.europa.eu/pre-registration_en.asp.

*Source: ECHA press release, November 2008*

**NEW CUSTOMS REQUIREMENTS FOR CHEMICALS**

The Health and Safety Executive (HSE) has updated information on its website with regard to the customs requirements for the export and import of chemicals. In 1999 the UK signed up to the Rotterdam Convention on Prior Informed Consent (PIC). This Convention allows countries to monitor and control the trade and use of certain hazardous chemicals. It puts in place a process where countries that are importing certain dangerous chemicals can refuse them or set out conditions that the imported chemicals must meet. The European Regulation creates a Designated National Authority in every Member State; in the UK this is the HSE. A new European Regulation to implement the Rotterdam Convention, EC 689/2008, has recently replaced the previous EU legislation (EC 304/2003), making certain changes in light of experience and following more closely the provisions of the Rotterdam Convention. For example, from 1 November 2008 exporters of chemicals listed in Annex I have the duty to include in their export declaration certain applicable reference numbers associated with the export notification and explicit consent, if applicable. These numbers will be assigned by the Commission in a database that will be publicly available. Changes also relate to a broader definition of “exporter” and new definition of “preparation.” Further information can be found at: www.hse.gov.uk/chip/pic.htm.

*Source: Health and Safety Executive press release, November 2008*
FIRST DANGEROUS CHEMICAL LIST PUBLISHED

The European Chemicals Agency (ECHA) has this week published the first list of what are known as Substances of Very High Concern (SVHC) under the EU’s recently introduced regime for the control of chemicals. The Regulation covering the Registration, Evaluation and Authorisation of Chemicals (REACH) requires all importers and users of chemicals in quantities of one tonne per year or more to register them and provide details of their safe use. This will bring many thousands of small and medium-sized businesses within the control regime. It recognises that certain chemicals are so dangerous that alternatives must be found and it is these that ECHA is including on its SVHC list, after consulting the Member States. This week’s list contains only 15 substances but will continue to be extended as the REACH regime comes fully into operation. ECHA has urged companies to check their potential obligations resulting from the list which can be found at: http://echa.europa.eu/chem_data/candidate_list_en.asp. Executive director Geert Dancet said: “It is critical they know that the inclusion of the substances in the list generates immediate new legal obligations for the communication in the supply chain.” However, the European Environmental Bureau (the Federation of Environmental Citizens Organisations) has described the list as a drop in the ocean when compared to the hundreds of well-known dangerous substances present in products used every day across Europe. While recognising the list as a vital tool in speeding up the substitution of hazardous chemicals with safer alternatives, the organisations said that Member States and the European Commission should have made the list more comprehensive. Bisphenol-A, a well-known endocrine disrupter, has been left out of the list, the Bureau noted, pointing out that the UK was one of only six Member States to have put forward suggestions for the SVHC list.

Source: ECHA and Greenpeace press releases, 29 October 2008

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GLASSY SURFACE FUNCTIONALISATION BY NANO-MODIFIED “SOL-GEL”

The following paper by C. Schlegel of Pemco Brugge was presented at the XXI International Enamellers Congress, Shanghai, China - 2008

1. INTRODUCTION

Glassy surfaces, especially enamels, ceramic glazes and glass, not always present the desired surface properties in order to achieve new performances. The realised investigations clearly show that those properties are not achievable by modifying the composition of those surfaces. That is why it is often necessary to treat them superficially, so that they can obtain the missing property(ies). The superficial treatment in question can be realised by CVD (Chemical Vapour Deposition”), PVD (Physical Vapour Deposition), FS (Flame-Spray), or by Chemical Nano-technology (= Sol-Gel-technology). Below you will find a detailed explanation about this last process, about the multiple functions that can be obtained and more particularly about “NanoClean”, a nano-modified “sol-gel” layer, transforming an enamelled surface into a surface presenting anti-adherent properties.

2. A FEW EXAMPLES OF ACHIEVABLE ADDITIONAL SURFACE PROPERTIES THROUGH “SOL-GEL” TECHNOLOGY

The “sol-gel”-technology allows a lot of additional surface properties without damaging the receiving glassy surface. In this way:
a) A glassy surface (window glass, mirror...) preliminarily treated with a TiO2-based "sol-gel"-layer (hydrophilic), will show a real anti-fogging effect (Fig. 1).

b) A "sol-gel"-layer modified with nanometric mineral pigments, allows to develop coloured transparent layers (majolica effects) (Fig. 2).

c) A glassy surface can develop self-cleaning properties if it has been preliminarily modified by a treatment with a photocatalytic sensitive "sol-gel"-layer (Fig. 3).

Fig. 4: Transformation of the precursor TEOS from a “sol” state into a “gel” state.
Fig. 5: Nanometric additives can be organic or mineral. In case of organic additives, the gels turn into a hybrid material (ORMOCER = Organically Modified Ceramics)

**Step 1:** Application of the “sol-gel” solution on the glassy surface.

- Applied “sol-gel” solution composed by ethanol and 3 components that present the following functionalities:
  - Component, which is chemically reacting with the glassy surface.
  - Inorganic or organic network improving the abrasion resistance.
  - Component, which makes the glassy surface water- and oil-repellent.

**Step 2:** Evaporation of the solvent (ethanol)

- First molecular organisation.

**Step 3:** Polymerisation (curing)

- Final molecular organisation with the creation of a superficial anti-stick layer.

Fig. 6: NanoClean structure
As the glass industry was precursor in the technology, most of the examples have been borrowed from it; however this does not mean that other industries like those of ceramic, paint, cement, ink or porcelain enamels are not involved in the field.

3. WHAT IS MEANT BY “SOL-GEL”-COATING?

- A “sol-gel”-coating is a nano-thick layer, bonding on glassy surfaces, which is either improving one or more of its properties or giving it one or more additional properties.
Those layers are generally obtained by “sol-gel”-technology; a technology, which enables the transformation of molecular precursors reacting with water into oxide materials and that through a “sol” phase (colloidal) and a “gel”-phase (solid material, of which the pores are containing a liquid phase).

Fig. 4 (page 134) shows the transformation of the precursor TEOS (= tetra ethoxy silane), which passes from a “sol” state into a “gel” state by means of a hydrolysis and condensation reaction in the presence of ethanol, water and catalysts.

Those reactions are generally complex and many parameters, like the type and concentration of the precursor, the concentration water-precursor, the type of catalysts (acid-based), the pH value, the type of used solvent, the temperature, the additives...etc... need to be considered. So a basic environment is leading to a particle increase and an acid environment to a three-dimensional network evolution of the particles.
4. A FEW IMPORTANT POINTS CONCERNING “SOL-GEL”-LAYERS

- The solutions of “sol-gel” are generally transparent liquids.
- Their application is highly versatile; based on the form of the piece to be coated, they can be applied by spraying, dipping, flow coating, spin coating, roller coating or silk-screening.
- Independently from the used application method, the applied layer thickness is varying between 5 and 8 nanometres in 1 pass; this implies that “sol-gel”-layers are generally transparent. Higher thicknesses are achievable by repeating the application and drying steps several times.
- The bond of “sol-gel”-layers on a glassy surface is chemical and can be explained by the OH- groups available on the glass, ceramic or porcelain enamel surface. This implies that the more a glassy surface is hydrophilic (rich in OH- groups), consequently free of grease, dust or other residues, the more the bond of the “sol-gel”-film to that surface will be intense.
- The porosity of the “gels” can be extremely important; “gels” can receive in their pores nanometric materials, which can be chemically bound or not to the “gel”-matrix and be at the origin of multi-functionality.
- The “sol-gel” layers sometimes need to be densified (abrasion or corrosion improvement). This will be possible through an “annealing process” at 400-500°C.

5. “NANOCLEAN”

Based on previous considerations and knowledge, has been created:

“NanoClean”

A “sol-gel” layer, organically modified, which enables the enamelled surfaces to obtain anti-stick properties.
5.1 NanoClean - its structure (Fig. 6, Page 135)

As outlined below, “NanoClean” is a silica-based gel, doubly modified, whose easy-to-clean properties and optimal abrasion are originating from the molecular organisation that takes place during the polymerisation process (curing).

The particularity of “NanoClean” is also that its polymerisation (curing) takes place at room temperature, which is a real advantage for the user but which can also limit it in its properties (porosity).

5.2 NanoClean - its action (Fig. 7, Page 136)

NanoClean changes the surface properties:

- a hydrophilic surface is changing into a hydrophobic/oliophobic surface,
- the high surface energy into a low surface energy and
- The smooth surface into a nano-rough surface.

These changes result in the fact that the OH⁻ - groups available at the glassy surface:

- (Figure A) are reacting with the dirt residues and lead to a firmly adhering soil crust.
- (Figure B) are reacting with the “sol-gel” – layer, creating a barrier against the formation of adhering soil crusts (easy-to-clean effect).

5.3 NanoClean - surface roughness (Fig. 8, page 136)

As already mentioned, it concerns a nano-roughness and therefore it is neither visible or tangible.

The graphs below depict the through AFM measured roughness for a non-treated and with “NanoClean” treated surface.
5.4 NanoClean - Hydrophoby and oliophoby definition/Contact angle

The most important criteria for an easy-to-clean surface are its hydrophoby and oliophoby. These 2 properties that are the keys to an easy-to-clean surface, can be defined through respectively the contact angle realised by a water drop and a hexadecane drop.

![Figure 9: NanoClean – Hydrophoby and oliophoby definition/contact angle](image)

5.5 NanoClean - Preparation of the enamelled pieces to be treated

- Our investigations show that the more surface to be treated is hydrophobic, the higher will be the bond between the sol-gel layer and that surface.

- This implies that a surface to be treated needs to be free of grease, dust and other residues.

- This is the case for enamelled parts just fired; their contact angle is generally not higher than 20° but it will fast increase through the deposition of microscopic dust, limiting the OH⁻ groups on the enamelled surface and at the same time the capacity of the later to react with the sol-gel layer.

- In a case of enamelled parts, only stored for some days, it is preferable to preliminarily degrease them using a degreasing agent free of tensides.

- In case of enamelled parts, stored for longer time (weeks, months), it is advisable after a degreasing step, to activate them through a light pickling step or a silanisation operated by flame spray.

5.6 NanoClean - Application process (Fig. 10)

Below the schematic depiction of the different process steps to safeguard an optimal application.
The glassy surface to be treated has to be perfectly clean and free from dust and grease (fingerprints) (see previous paragraph).

There exist different possibilities:
- by rubbing with the “sol-gel”-solution impregnated cloth (microfibre cloth to avoid fluffs).
- by dipping in the “sol-gel”-solution (for pieces with a simple form).
- by aerosol-spraying (for pieces with a complex form).
- by roller-coating or by silk-screening (only for flat surfaces).

Can be divided into 2 steps:
- the initial curing: 10 minutes at room temperature or 2 minutes at 80°C.
- the end curing: after 24 hours.
(Please note that the treated surface can be handled after the initial curing).

The necessity of the last step highly depends on the chosen application (excess of coating material) and process and application conditions (excess of solution).

5.7 NanoClean - Easy-to-clean tests

The cleaning tests being generally customer-specific and often highly subjective in their own evaluation, forced us to chose 2 normal tests and in particular the AHAM-test (USA) and the FAN-test (F), both based on the elimination of baked-on food residues.

5.7.1 AHAM test

- The test is based on the fact that a mixture of 9 different foods (ground beef; grated “Cheddar” cheese; homogenised whole milk; powder sugar; cherry juice; instant tapioca; 1 raw egg; flour; tomato juice) is baked onto an enamelled surface. This mixture can be removed more or less residue-free through defined cleaning processes.
**THE VITREOUS ENAMELLER**

- **Procedure:** The enamelled surface (plate 10 x 10 cm) is soiled on a surface of about 12cm² (4 x 3cm); and installed on a steel wire grid in the middle of a baking oven. The baking cycle consists of a temperature increase of 20 up to 205°C, followed by a pause of 1 hour. The cooling of the plate is occurring at room temperature.

- **Cleaning of the surface:** The cleaning is occurring with the help of a plastic scraper (A), a plastic scouring pad (B) or a metal scouring pad (C) (Copper or steel).

- **Results of the tests:**

<table>
<thead>
<tr>
<th>Cleaning means</th>
<th>A Plastic scraper</th>
<th>B Plastic scouring pad</th>
<th>C Copper scouring pad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of AHAM cleaning cycles</td>
<td>1 2 3 4 5 45 73</td>
<td>1 2 3 4 5 45 79 85</td>
<td>1 2 3 4 5 45 94 96</td>
</tr>
<tr>
<td>1. Standard black enamel</td>
<td>4 4 5 5 5 / /</td>
<td>4 4 4 4 4 / / /</td>
<td>1 1 1 1 2 / / /</td>
</tr>
<tr>
<td>2. Black enamel treated with NanoClean</td>
<td>0 0 0 0 0 0 1</td>
<td>0 0 0 0 0 0 1 /</td>
<td>0 0 0 0 0 0 1 /</td>
</tr>
<tr>
<td>3. Standard grey enamel (poesta)</td>
<td>3 3 5 5 5 / /</td>
<td>3 3 4 4 5 / / /</td>
<td>0 0 1 1 2 5 / /</td>
</tr>
<tr>
<td>4. Grey enamel treated with NanoClean</td>
<td>0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 1</td>
<td>0 0 0 0 0 0 0 1</td>
</tr>
<tr>
<td>5. PTFE</td>
<td>0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
</tr>
</tbody>
</table>

**Explanation:**

- The black enamel could be fully cleaned during 72 cycles with the plastic scraper, during 78 cycles with the plastic scouring pad and during 93 cycles with the metallic scouring pad. Afterwards some residues remained on the plates.
- Both the grey enamel and the PTFE present more or less a similar cleanability.

**Conclusion:** NanoClean presents anti-adherent properties similar to PTFE.

- As previously shown, the coating “sol-gel” NanoClean is as for its cleanability similar to PTFE, with the notable difference that it cannot be visually damaged by kitchen utensils (knives or forks).

- **Evaluation of the cleaning grade:**

<table>
<thead>
<tr>
<th>Residue level</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = no residues</td>
<td>0%</td>
</tr>
<tr>
<td>1 = a small amount of residues</td>
<td>10%</td>
</tr>
<tr>
<td>2 = a few residues</td>
<td>25%</td>
</tr>
<tr>
<td>3 = average residues</td>
<td>50%</td>
</tr>
<tr>
<td>4 = a lot of residues</td>
<td>75%</td>
</tr>
<tr>
<td>5 = all residues are remaining</td>
<td>100%</td>
</tr>
</tbody>
</table>
5.7.2 Test FAN

- Like the AHAM test, it is based on the elimination of the residues of foodstuffs left behind on the enamelled surface: milk + salt; meat extract (Viandox – Maggi); lemon; egg; ketchup (Heinz).

- **Procedure:** The previous foodstuffs are applied on a cold enamelled plate. 1g of each foodstuff is individually put in a stainless steel ring fixed on the enamelled plate by means of a silicone-based adhesive. The prepared plates are put in a hot-air baking cavity; the baking cycle will take 30 minutes at a temperature of 280°C +/- 10°C. The cooling of the plates will occur naturally.

- **Cleaning of the soiled plates:** The plates are preliminary cleaned with a sponge and warm water (40°C). The remaining residues will be eliminated by going 3 times back and forth with an abrasive scouring pad (type VILLEDAGraffix) while exerting an increasing pressure.

- Evaluation of the cleanability grade: if the residues are eliminated at:
  
  - low pressure (1kg) note 5
  - average pressure (3kg) note 4
  - high pressure (5kg) note 3
  - high pressure + detergent note 2

  if the residue cannot be eliminated at:
  - high pressure + detergent note 1

Consequently the note can be contained between 5 and 25.

### RESULTS

<table>
<thead>
<tr>
<th>Food-stuffs</th>
<th>Milk + salt</th>
<th>Meat extract</th>
<th>Lemon</th>
<th>Egg</th>
<th>Ketchup</th>
<th>Grade of cleanability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grey enamel poesta</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Grey enamel treated with NanoClean</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>22</td>
</tr>
<tr>
<td>PTFE</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>23</td>
</tr>
</tbody>
</table>

Like the AHAM test, the FAN test is giving similar results: a NanoClean-coated enamel is proposing similar anti-adherent properties like PTFE.
5.8 NanoClean / Its properties

“NanoClean” does not change the properties of the enamelled surface on which it has been applied; on the contrary, it generally improves them or gives them additional properties, like:

- being optically neutral: “NanoClean” does neither change the colour, nor the surface aspect.

- It proposes a high scratch and abrasion resistance, as shown in the graph above (Fig. 11), which illustrates the low loss of hydrophobic grade (contact angle) in function of the number of exerted abrasion cycles (max. 15% of hydrophoby loss after 100,000 rubbing cycles) (exerted power : 1kg = 1 back – forth).

- By enriching the surface with SiO₂, it increases the acid resistance and it intervenes neither positively or negatively in the alkaline resistance.

- It presents exceptional “anti-stick” properties through its high hydrophobic and oliophobic grade.
  
  * Hydrophobic grade: > 100°
  * Oliophobic grade: > 60°

- It is temperature-resistant up to maximally 300°C (in particular when the surface has been pre-silanised); on the contrary, it is fully destroyed at higher temperatures, however without leaving any visible traces; it can be regenerated by using a NanoClean Duo Set (Fig. 12, page 137).
• It also proposes a good UV-resistance (particularly interesting in case of glass coatings), it is environmentally friendly and is food-neutral approval certificated).

5.9 NanoClean - Some practical information
• NanoClean is a 2-component “sol-gel” system: 1 basic solution + 1 activator.
• The mix of both forms the “NanoClean” solution, which can be stored during 2 weeks (15 days).
• The basic solution can be stored during 2 years, the activator during 1 year.
• Based on the method of application, the NanoClean solution is applied at 10 to 15 ml/m².

5.10 NanoClean - Cost impact
• Based on the overspray, the additional cost is varying between 1.20 and 1.80 Euros/m².

6. CONCLUSION
Like all other coatings on the market, “sol-gel” – coatings present advantages and disadvantages:

* among the advantages, we can note:
  • the numerous possibilities of surface properties modifications (anti stick; anti-fogging; photo-catalytic; UV-protection; electronically conductive..etc..).
  • the simplicity and versatility of application (if the substrate has been prepared correctly).
  • the low energy which is required to cure the “sol-gel” layers (from room temperature up to 400-500°C).
  • the possibility to be regenerated.
THE VITREOUS ENAMELLER

* among the inconveniences, we can note:

- the reduced mechanical properties through the nano-thickness of the layer.
- the required thorough pre-cleaning (if the coating is not realised immediately after firing).

Nevertheless the “sol-gel” layers remain in our opinion one of the most interesting future-directed ways to supply the glassy surfaces and especially the porcelain enamels with specific functional additional properties.

“NanoClean” is illustrating this very well through the change of a simple enamel surface into an easy-to-clean surface and is for that purpose using the same principle as in nature, where dust is dripping from the leaves and flowers surface.

--ooOoo--
THE MATCH BETWEEN DRAWABILITY AND ENAMELABILITY OF COLD-ROLLED ULTRA LOW CARBON SHEET STEELS

The following paper by Quanshe Sun and Weizhong Jiang was presented at the XXI International Enamellers Congress, Shanghai, China - 2008

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2. College of Materials Science and Engineering, Dong Hua University, Shanghai, China

ABSTRACT

The characteristics of chemical composition and production procedure of titanium-bearing ultra low carbon (ULC) steels and rare earth metal-bearing ULC steels are briefly introduced. The types, size and quantity in the steels are analysed by TEM and quantitatively analysis. The hydrogen permeation time and diffusion coefficient are measured by means of electrochemistry experiment. The effects of second phase particle, cold reduction and pre-strain on hydrogen permeation time are studied. The results show that titanium-bearing ULC steel with excessive titanium and RE-Ti-Nb steel exhibit excellent match between drawability and fishscale resistance.

With the development of metallurgical technology and equipment, it is possible to produce clean sheet steels such as interstitial-free (IF) steel. Generally, the decreasing of carbon and nitrogen in steel, the drawability of final sheet steel goes up. IF steel with excellent drawability has been applied widely for automobile parts. The enameling industry can also need this kind of sheet steels with excellent drawability to innovate products. However, the conventional ULC steels cannot satisfy the requirement for enameling because of too much purity and thus poor fishscale resistance. One of the main properties of the enameling steels is the fishscale resistance. It is well known that fishscale
is caused by the hydrogen atoms generated during enameling, and it is related to the hydrogen storage ability. Therefore, the fishescale resistance can be prevented by the improvement of hydrogen storage ability, which can be evaluated by hydrogen permeation time and diffusion coefficient by means of electrochemistry experiment. With the permeation time increasing and diffusion coefficient decreasing, the fishescale resistance improved. Okuyamas reported\(^1\) that when the permeation time is over 5 minutes for the steel sheet in 0.8 mm thick, the fishescale can be prevented effectively, that is, for the thickness of 1 mm, the permeation time is 7.8 minutes. Papp studied\(^2\) the relationship of hydrogen permeation time and fishescale resistance and pointed out that the permeation time is at least 6 to 8 minutes for 1 mm thick of steel sheet, which accords with Okuyamas’ results.

The hydrogen entrapment sites include vacancies, crystal boundaries, phase boundaries and micro-voids in the vicinity of inclusions and precipitates. As far as ULC steels are concerned, the microstructure is pure ferrite, with the grain sizes mainly at the range of 6 to 8; therefore, the most effective measures to improve hydrogen entrapment in steel is to increase the amount of inclusions and precipitates. It was studied\(^3\) that Ti precipitates and RE sulphides can effectively prevent fishescale, but on the other side, the increment of inclusions and precipitates will impair the drawability of the steel sheet. It is important to add proper amount of alloying elements to meet the requirement of both the drawability and the hydrogen permeability.

1. THE CHARACTERISTICS OF CHEMICAL COMPOSITION AND PRODUCTION PROCEDURE

1.1 The characteristics of chemical composition

The development of sheet steels is processing from low carbon steel to Al-killed carbon steel, and till now the ULC steel. For enameling use, different alloying elements are added in the steels to form various types of inclusions and precipitates including: (1) cementite, (2) precipitates of titanium, (3) oxides and (4) boron nitride. The aim is to improve obviously the fishescale resistance due to the presence of fine and dispersive particles and inclusions.
The selection of alloying elements depends on the basic chemical composition to a large extent. For the ULC steels, the decisive elements are carbon, nitrogen, sulphur, and the useful alloying elements are titanium, rare earth metals and boron, which can improve remarkably the final properties. The chemical compositions of ULC sheet steels for porcelain enameling are mainly titanium-bearing ULC steels and rare earth metal containing ULC steels, see Table 1.

<table>
<thead>
<tr>
<th>Element</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>≤0.008</td>
</tr>
<tr>
<td>Si</td>
<td>≤0.03</td>
</tr>
<tr>
<td>Mn</td>
<td>0.10~0.30</td>
</tr>
<tr>
<td>P</td>
<td>≤0.020</td>
</tr>
<tr>
<td>S</td>
<td>≤0.05</td>
</tr>
<tr>
<td>Al</td>
<td>≤0.05</td>
</tr>
<tr>
<td>Ti, RE</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: The chemical composition of cold-rolled ULC steels %

The effect of main elements on the properties is described as follows:

**Carbon:** In titanium-bearing ULC steels, Nilsson et al\footnote{4} studied that carbon can influence the mechanical properties. It is necessary to obtain excellent drawability only when carbon decreases below 0.005 percent. With the carbon content going up, the yield strength increases, and the total elongation and also the n value decreases. In this steel, carbon can mainly combine with titanium to form TiC particles, in favor of hydrogen entrapment during enamel firing. High content of carbon will form pinhole defects during enamel firing to impair the surface quality and the adhesion between steel and enamel. The higher the content of carbon, the more pinholes generate. In that case, it is important to decarbonize the steel in order to obtain ultra low carbon steel. The typical carbon content is below 0.004%.

**Nitrogen:** The role of nitrogen is the same as carbon, i.e., to impair drawability of steel. In a traditional IF steel, the nitrogen content can be controlled as low as possible. With the adding of titanium ULC steel, titanium can form the compound with carbon and nitrogen TiN or Ti(CN) particles. They can also combine with boron to form boron nitride in boron-bearing steel. From one hand, the interstitial atoms, carbon and nitrogen, are fully fixed by excessive amount of titanium and boron to extinguish aging of steel, from the other hand, the dispersive particles improve the hydrogen permeation to prevent fishscale.

**Sulphur:** Sulphur and carbon are able to combine with titanium to form TiS and Ti$_4$C$_2$S$_2$, and exist in global shape in steels, which play the same role as titanium carbide and carbonitride.
Titanium and RE In ULC steel, titanium and RE combine with one or more of carbon, nitrogen and sulphur to form inclusions and precipitates. The possible types of particles are shown in Table 2.

<table>
<thead>
<tr>
<th>Alloys added in ULC steel</th>
<th>Types of second phase particles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Titanium</td>
<td>TiC, TiN, Ti (CN), TiS and Ti₆C₂S₂</td>
</tr>
<tr>
<td>Rare earth metal</td>
<td>RE sulphide</td>
</tr>
</tbody>
</table>

*Table 2 The types of second phase particles in titanium and RE-bearing ULC steels*

Although these particles act as useful sites to entrap hydrogen during the enamel firing, they impair seriously the drawability especially the coarse inclusions.

1.2 Production procedure

The production procedure of ULC steel is as follows:

Steelmaking in LD ➔ vacuum degassing in RH system ➔ continuous casting ➔ hot-rolled by hot strip tandem mill ➔ pickling ➔ cold-rolling by cold strip tandem mill ➔ annealed by batch annealing furnace or continuous annealing furnace ➔ skin tempering, oiling and packaging.

2. THE MICROSTRUCTURE AND MECHANICAL PROPERTIES

2.1 Ti-bearing ULC steels

The typical chemical compositions of cold-rolled steels are shown in Table 3.

<table>
<thead>
<tr>
<th>Steel</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Al</th>
<th>Ti</th>
</tr>
</thead>
<tbody>
<tr>
<td>ULC steel for enameling</td>
<td>0.0030</td>
<td>0.02</td>
<td>0.15</td>
<td>&lt;0.015</td>
<td>&lt;0.035</td>
<td>0.022</td>
<td>0.071</td>
</tr>
<tr>
<td>Traditional IF steel</td>
<td>0.0027</td>
<td>0.02</td>
<td>0.15</td>
<td>&lt;0.015</td>
<td>&lt;0.035</td>
<td>0.027</td>
<td>0.043</td>
</tr>
</tbody>
</table>

*Table 3 Chemical compositions of steels examined (%)*

The specimens for tensile tests were taken from the steel sheets in three different directions, longitudinal, diagonal and transverse according to the rolling direction. The specimens were machined to JIS No.5 (width: 25mm, gauge length: 50mm). The average strength, total elongation, n value and r-value are calculated according to the following formula.

\[ m = \frac{m_{0°} + 2m_{45°} + m_{90°}}{4} \]
The mechanical properties of both steel sheets with different Ti added are shown in Table 4.

<table>
<thead>
<tr>
<th>Steel</th>
<th>$R_{p0.2}$ (MPa)</th>
<th>$R_m$ (MPa)</th>
<th>$A_{50}$ (%)</th>
<th>$n_m$</th>
<th>$r_m$</th>
</tr>
</thead>
<tbody>
<tr>
<td>ULC steel for enameling</td>
<td>140</td>
<td>287</td>
<td>51</td>
<td>0.25</td>
<td>2.24</td>
</tr>
<tr>
<td>Traditional IF steel</td>
<td>142</td>
<td>299</td>
<td>50</td>
<td>0.24</td>
<td>2.21</td>
</tr>
</tbody>
</table>

*Table 4: Mechanical properties of steel sheets*

The total elongations and r-values of both steels exceed 50 percent and 1.8, respectively. This demonstrates that the steel sheets examined have extra-deep drawable quality (EDDQ).

The microstructures were observed by optical microscopy, shown in Figure 1, which are composed of full ferrite, and the grain size is about ASTM 6~8.

### 2.2 RE-bearing steels

<table>
<thead>
<tr>
<th>Steel</th>
<th>C</th>
<th>Mn</th>
<th>S</th>
<th>Ti</th>
<th>RE</th>
<th>Al</th>
<th>Nb</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel RE-Ti-Nb</td>
<td>0.0009</td>
<td>0.18</td>
<td>0.036</td>
<td>0.056</td>
<td>0.023</td>
<td>0.03</td>
<td>0.014</td>
<td>0.0032</td>
</tr>
<tr>
<td>Steel RE-Ti</td>
<td>0.0026</td>
<td>0.18</td>
<td>0.028</td>
<td>0.047</td>
<td>0.035</td>
<td>0.02</td>
<td>-</td>
<td>0.0050</td>
</tr>
<tr>
<td>Steel RE</td>
<td>0.0012</td>
<td>0.20</td>
<td>0.026</td>
<td>-</td>
<td>0.021</td>
<td>0.03</td>
<td>-</td>
<td>0.0045</td>
</tr>
</tbody>
</table>

*Table 5: Chemical composition of tested steels (%)*

The chemical compositions of RE-bearing cold-rolled steels tested are shown in Table 5.

The mechanical properties of final products after cold-rolling and annealing are listed in Table 6.
Table 6 shows that Steel RE and Steel RE-Ti have upper and lower yield strengths, which means the occurrence of yield elongation. Steel RE-Ti-Nb has no yield elongation, and the yield strength is the lowest. It will be certain that after skin tempered, the yield strength will increase slightly. The tensile strength of the three steel grades are almost in the same level. The obvious difference is that the elongation and r-value. Steel RE-Ti-Nb exhibits the highest elongation, 50%, and r-value, 1.88, which reaches the EDDQ level.

The RE-only ULC steel has lowest drawability because there is no addition of titanium, the RE can only form RE sulphide in the steel. Therefore, the interstitial atoms of carbon and nitrogen can not be fixed by alloying elements, and the steel generates yield elongation during tensile test. Meanwhile, the addition of titanium in the steel can improve the drawability, but if there is not enough stoichiometrically alloying element such as titanium, the yield elongation can also occur (for example of Steel RE-Ti). Alloying element titanium is useful in the ULC steel because it can combine with carbon, nitrogen and sulphur.

The microstructure is observed by optical microscopy, shown in Figure 2. The microstructure is fully composed of ferrite, and the grain size is about ASTM 6~8.

<table>
<thead>
<tr>
<th>Steel</th>
<th>Rp0.2 MPa</th>
<th>Rm MPa</th>
<th>A50 %</th>
<th>nm</th>
<th>rm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel RE-Ti-Nb</td>
<td>112</td>
<td>302</td>
<td>50</td>
<td>0.27</td>
<td>1.88</td>
</tr>
<tr>
<td>Steel RE-Ti</td>
<td>252/234</td>
<td>313</td>
<td>48</td>
<td>0.27</td>
<td>1.73</td>
</tr>
<tr>
<td>Steel RE</td>
<td>227/221</td>
<td>311</td>
<td>46</td>
<td>0.27</td>
<td>1.49</td>
</tr>
</tbody>
</table>

*Table 6 Mechanical properties of annealed steel sheets*
3 HYDROGEN PERMEABILITY IN ULC STEELS

3.1 Effect of precipitates on hydrogen permeability

Precipitates in the steel are excellent irreversible traps to hold hydrogen. It was studied\(^5\) that precipitates such as TiC and TiN particles can improve the hydrogen entrapment and suppress the hydrogen diffusion in the steel.

The morphology of precipitates was observed by transmission electron microscope (TEM). The TEM photographs were used to determine quantitatively the volume fraction, \(V_f\) and numbers of particles, \(N_v\) according to the following Fullman’s formula\(^6\).

\[
V_f = \frac{\pi}{6} \cdot N_s \cdot d^2 \quad (2)
\]
\[
N_v = \frac{N_s}{d} \quad (3)
\]

The hydrogen diffusion coefficient, \(D_{eff}\) and permeation time, \(t_b\) are measured by hydrogen permeation experiment.
3.1.1 Ti-bearing ULC steels

TEM examinations show that the types of precipitates are mainly TiN (or TiCN) and Ti₄C₂S₂ in the examined steels, and the typical examples of precipitates are shown in Figure 3.

The average diameters, particle numbers in every cubic meter and volume fraction of TiN (TiCN) and Ti₄C₂S₂ are calculated, as shown in Table 7.

<table>
<thead>
<tr>
<th>Steel</th>
<th>Type of precipitates</th>
<th>Average diameter, d</th>
<th>Particle number in m³, Np x 10²⁰/m³</th>
<th>Volume ratio of precipitate, Vf x 10⁻³ m³/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>ULC steel for enameling</td>
<td>TiN+Ti (CN)</td>
<td>39</td>
<td>1.90</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>Ti₄C₂S₂</td>
<td>79</td>
<td>0.35</td>
<td>0.90</td>
</tr>
<tr>
<td>Traditional</td>
<td>TiN+Ti (CN)</td>
<td>24</td>
<td>3.50</td>
<td>0.25</td>
</tr>
<tr>
<td>IF steel</td>
<td>Ti₄C₂S₂</td>
<td>64</td>
<td>0.27</td>
<td>0.37</td>
</tr>
</tbody>
</table>

Table 7 Results of quantitative analysis of precipitates
It is confirmed that titanium will combine with C, N and S to form precipitates. The particles in higher Ti-bearing steel are coarser than those in lower Ti steel. Accordingly, in higher Ti steel, the volume fraction of particles is greater although the particles number per unit is lower.

Table 8 shows the permeation times and diffusion coefficients of hydrogen in sheet steels (with the thickness of 1.0mm) at room temperature determined by the method of hydrogen permeation experiment.

<table>
<thead>
<tr>
<th>Steel</th>
<th>Permeation time, $t_b$ (s)</th>
<th>Diffusion coefficient, $D_{eff} \times 10^{-6} \text{ cm}^2 / \text{s}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>ULC steel for enameling</td>
<td>580</td>
<td>0.62</td>
</tr>
<tr>
<td>Traditional IF steel</td>
<td>282</td>
<td>2.32</td>
</tr>
</tbody>
</table>

*Table 8: Hydrogen permeation time and diffusion coefficient in steels*

It is shown that the permeation time of the steel with higher Ti added is longer than that of the lower Ti steel, on the contrary, the diffusion coefficient becomes lower.

The increasing of particles volume in steel improves the hydrogen permeability remarkably. The increasing amount of precipitates is crucial to improve the hydrogen permeability and prevent fishscale, see Figure 4. With the increasing of product between volume and number of all particles, the hydrogen permeation time prolongs obviously, which reveals that the precipitates as the irreversible trap sites to improve the hydrogen permeability.

![Image of graph showing relationship between permeation time and product of volume and number of particles](Image)

*Fig. 4: Relationship of hydrogen permeation time and product of volume and number of particles in Ti-bearing steels*
3.1.2 RE-bearing ULC steels

The analytical results of precipitates are listed in Table 9.

<table>
<thead>
<tr>
<th>Steel</th>
<th>Type of particles</th>
<th>Average diameter, (d), nm</th>
<th>Particle number in (m^3), (N_x \times 10^{20} /m^3)</th>
<th>Volume ratio of precipitate, (V_f \times 10^{-3} m^3 / m^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel RE</td>
<td>MnS</td>
<td>45</td>
<td>1.8</td>
<td>8.6</td>
</tr>
<tr>
<td>Steel RE-Ti</td>
<td>Ti(CN)</td>
<td>32</td>
<td>1.5</td>
<td>2.6</td>
</tr>
<tr>
<td>Steel RE-Ti-Nb</td>
<td>MnS</td>
<td>64</td>
<td>0.39</td>
<td>5.4</td>
</tr>
<tr>
<td>Steel RE-Ti-Nb</td>
<td>MnS</td>
<td>58</td>
<td>0.57</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td>Ti(CN)</td>
<td>27</td>
<td>3.1</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>MnS</td>
<td>58</td>
<td>0.57</td>
<td>5.8</td>
</tr>
</tbody>
</table>

Table 9 Quantitative analyses of second phase particles in the steels

In RE-only steel, the precipitate is mainly observed manganese sulphide (as shown in Figure 5(a)), and a few RE sulphide and its compound, see Figure 5(b). In Steel RE-Ti and Steel RE-Ti-Nb, a large amount of dispersive and fine particles are observed, as shown in Figure 6 and Figure 7, which are identified as Ti(CN). Meanwhile, there are inclusions, which are identified as the sulphide of titanium and manganese, and RE sulphide.

(a) MnS
(b) RE sulphide

Fig. 5: Morphology of precipitates in Steel RE

(a) Ti (CN)
(b) (Mn,Ti) S

Fig. 6: Morphology of precipitates in Steel RE-Ti

(a) Ti(CN) (b) (Mn,Ti) S

Fig. 6: Morphology of precipitates in Steel RE-Ti
Fig. 6: Morphology of precipitates in Steel RE-Ti

(a) Ti(CN)  
(b) (Mn,Ti)S

(c) RE-Ti (S)

Fig. 7: Morphology of precipitates in Steel RE-Ti-Nb

(c) RE-Ti (S)

Table 10: Permeation time and diffusion coefficient of hydrogen in sheet steel at room temperature

<table>
<thead>
<tr>
<th>Steel</th>
<th>Permeation time, $t_b$ (s)</th>
<th>Diffusion coefficient, $D_{eff} \times 10^{-6}$ cm$^2$/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE</td>
<td>165</td>
<td>3.968</td>
</tr>
<tr>
<td>RE-Ti</td>
<td>259</td>
<td>2.525</td>
</tr>
<tr>
<td>RE-Ti-Nb</td>
<td>353</td>
<td>1.851</td>
</tr>
</tbody>
</table>

Table 10: Permeation time and diffusion coefficient of hydrogen in sheet steel at room temperature.
The permeation time and effective diffusion coefficient of hydrogen in sheet steel at room temperature are shown in Table 10. From Table 10, three grades of the steels have different permeation time and diffusion coefficient of hydrogen. With the increasing addition of alloying element such as RE, Ti and Nb, the permeation time goes up and diffusion coefficient goes down. The permeation time and effective diffusion coefficient of hydrogen represents the hydrogen entrapment ability, which can qualitatively reflect the fishscale resistance of the steels during enameling and firing, i.e., the longer the permeation time, the stronger ability to store hydrogen and the better to resist fishscale. Therefore, the steel co-added with RE, Ti and Nb features the best fishscale resistance.

Figure 8 shows the test temperature can also affect the permeation time and diffusion coefficient of hydrogen in steels. With the temperature going up, the permeation time decreases and diffusion coefficient increases. The reason is that with the temperature goes up, the diffusion of hydrogen atoms in steels will be accelerated.

**Fig. 8: The permeation time and diffusion coefficient of hydrogen in steels at different temperatures**
3.2 Effect of pre-strain on hydrogen permeability

The tensile examples taken from Steel RE-Ti-Nb were strained by uniaxial tensile, and the strains are 0, 16, 29 and 38 percent, respectively. The permeation time and effective diffusion coefficient of hydrogen in the strained steels are measured at room temperature, as shown in Figure 9. For the convenience of comparison, all the data are computed to be at the same thickness, i.e., 1mm. With the pre-strain increasing, the permeation time goes up obviously, and the effective diffusion coefficient decreases.

![Graph](image)

*Fig. 9 The permeation time and effective diffusion coefficient of hydrogen in the strained steels at room temperature*

As we know, the hydrogen entrapment traps are divided two types: reversible and irreversible. The steel sheets generate large amount of dislocation after drawing, and also micro voids. The dislocation is regarded as reversible trap, and void as irreversible trap. These hydrogen traps can be helpful to store hydrogen during enameling and firing [6].

3.3 Effect of cold reductions on hydrogen permeability

The annealed steel sheets were cold-rolled with reductions of 18.7, 38.7 and 58.7 percent, respectively. The cold-rolled steel sheets were used to examine the hydrogen permeation time and diffusion coefficient, as shown in Figure 10.
It is shown that the hydrogen permeability in sheet steels is affected by the cold reductions to a great extent. With the increasing of cold reductions, the permeation time prolongs, but the diffusion coefficient decreases. When the cold reduction goes up to 58.7 percent, the permeation time of hydrogen in sheet steels gets to as long as 27.7 minutes.

It was reported [7] that both dislocation and grain boundary are reversible hydrogen traps. The effect of dislocations on hydrogen permeability depends on the density of dislocations. The permeation time increases and the diffusion coefficient decreases by the increment of the density of dislocations resulted from cold deforming, as shown in Figure 10. It can be predicted that the steel sheet will have better hydrogen permeability after forming such as punching, bulging, etc. Therefore, cold deformation creates the hydrogen entrapping areas in the steel and improves the hydrogen permeability of steel sheets.

---

Fig. 10: Hydrogen permeation time (a), and effective diffusion coefficient (b) in steel sheet with different cold reductions.
4. CONCLUSIONS

The ULC steels for enameling use are different from the traditional ULC steels. In order to improve the drawability and fishscale resistance of enameling steels, it is necessary to add adequate amount of titanium and rare earth metal. Titanium and RE combine with one or more of carbon, nitrogen and sulphur to form second phase particles.

(1) The types of precipitates in Ti-bearing ULC steels are mainly TiN, TiCN and Ti₄C₂S₂. With the increasing of Ti content the fraction of precipitates in the steel increases. In RE-bearing ULC steels, RE mainly combines with sulphur to form inclusions of RE sulphide and compound of RE and manganese sulphide, and titanium to form dispersive and fine particles of titanium nitride and carbonitride.

(2) Ti-bearing ULC steel and RE-Ti-Nb steel both exhibit extra deep drawability.

(3) Precipitates as irreversible traps in the steels affect greatly the permeation time. With the product of volume and number of particles the permeation time prolongs.

(4) The pre-strain and cold deformation generates dislocation and microvoids to be the reversible traps to hold hydrogen. With the increment of cold reduction and pre-strain, the permeation time prolongs and the diffusion coefficient decreases.
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