Conformal Coatings For The Future

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Over the last few years the industry has been dominated by the challenge of complying with the WEEE and RoHS directives and the implementation of Lead-free manufacture. With the deadline for Lead-free implementation having now passed, many in the industry can now get back to building their businesses and moving forward. However, Lead-free issues have over-shadowed other legislative measures that will have a profound impact on manufacturing especially in the automotive sector. We explore the next big environmental issue facing the electronics industry and outline what it means to electronics manufacturers. The legislation we refer to is the 1999 European Council Solvent Emissions directive.

Europe has a well-established automotive industry and electronics manufacturing is a growing part of this sector. Vehicles are increasingly dependent on electronics to deliver new technology and functionality.

New environmental legislation from the EU is making the use of solvent-based compounds more and more difficult as it starts to be aggressively enforced. The race has been on to develop viable alternatives that are able to offer the same levels of protection, as well as ease of application and long-term performance.

EU VOC regulation requirements

So what does all this mean for Europe? This legislation was passed on March 11th 1999. Its aim is to achieve a European-wide regulation that governs and implements the reduction in emissions of volatile organic compounds (VOC). These compounds tend to be released quickly into the air depending on the vapour pressure and can have a two fold impact on air quality: firstly, by contributing to smog at the point it is released, and secondly in the depletion of ozone in the upper layers of the earth's atmosphere.

At present around 52 per cent of the one million tonnes of solvents currently emitted per year is not affected by this regulation, open applications applied to buildings being one example. Of the remaining emissions, approximately 18 per cent fall below the threshold values of the regulation, the result being that around 300,000 tonnes of VOC emissions per year need to be reduced by 50 per cent. This all sounds very dramatic but how much of an impact will this have on the manufacture of PCBs?

By its very nature, the EU-VOC regulation will have most impact on large and medium-sized companies because their solvent consumption exceeds the lower limits of the legislation. Since these are the largest and most prominent producers, they will be the first to have their solvent emissions aggressively policed by government inspectors.

The Solvent Emissions Directive, which is being increasingly enforced in the largest of the European countries, means that many companies will have to look hard

Figure 1 - The European Council Solvent Emissions directive will have most impact on large and medium-sized electronics manufacturers in Europe, such as those in the automotive sector

at ways to reduce their solvent emissions. This, in most cases, will require investment in new methods and technology.

The EC VOC Emissions Directive

Council Directive 1999/13/EC of 11th March 1999 describes that an "emission shall mean any discharge of volatile organic compounds from an installation into the environment…into air, soil and water as well as solvents contained in any products." These include uncaptured emissions released to the outside environment via windows, doors, vents and similar openings. Basically, all of the solvents that enter the facility must be considered as "emitted".

A volatile organic compound (VOC) is defined as any organic compound having at 293.15 K a vapour pressure of 0.01kPa or more, or having a corresponding volatility under the particular conditions of use. In effect, this means any solvent with a boiling point of less than 250°C (i.e. any industrially useful solvent).

In addition, an organic compound refers to any compound containing Carbon and at least one or more of Hydrogen, halogens, Oxygen, Sulphur, Phosphorous silicone or Nitrogen. Surprisingly, many silicone materials will be considered as VOC materials under this legislation.

Finally, the directive currently limits a factory's VOC emissions, as a result of its conformal coating activity, to 5 tonnes before mandatory measurement and reporting is enforced. If a factory is emitting more than 5 tonnes of VOC material (i.e. consuming more than 8000 litres of a typical solvent-based coating) then it must measure its emissions and report this to the local authority.

Emissions must fall below a certain level (currently dependent upon the region) or else measures must be made to meet the emissions criteria. Government agencies are conducting spot checks and imposing significant fines on non-compliant companies.

Figure 2 - One method for long-term VOC reduction is the implementation of conformal coating materials containing little or no VOCs

So if a factory is consuming 8000 litres of solvent-based conformal coating, it is likely to be visited by the government's local authority and subjected to an inspection of its emissions. Should the factory not be in compliance with the directive's requirement, it is likely to be fined and given an imposed plan of action in order to meet its obligations.

For smaller manufacturers, to whom the current legislation does not apply, it is worth considering that the 5 tonnes emission threshold will only be reduced over time and will thus impact more and more producers. In addition, the health and safety implications of using solvent-based materials are becoming more and more stringent. The risk phrases associated with common solvents are making their use ever more difficult, and of course, the insurance premiums for storing flammable materials on-site and using dangerous materials in production make these materials less attractive to both large and small customers.

What can pro-active companies do to ensure they are in compliance with the legislation when the Environment Agency comes calling, as well as reduce the insurance and safety risks associated with their process?

Reducing solvent emissions

There are two main methods available to manufacturers that enable them to reduce their solvent-emissions and comply with national legislation.

Firstly, and perhaps most simply in terms of implementation, emissions can be reduced by installing solvent-incinerators. This enables a factory to keep its existing solvent-based line in place and simply route the extraction flue via an incinerator where the solvents are incinerated to produce primarily carbon dioxide (CO_2). The generated heat can be used to heat the factory in winter, for example.

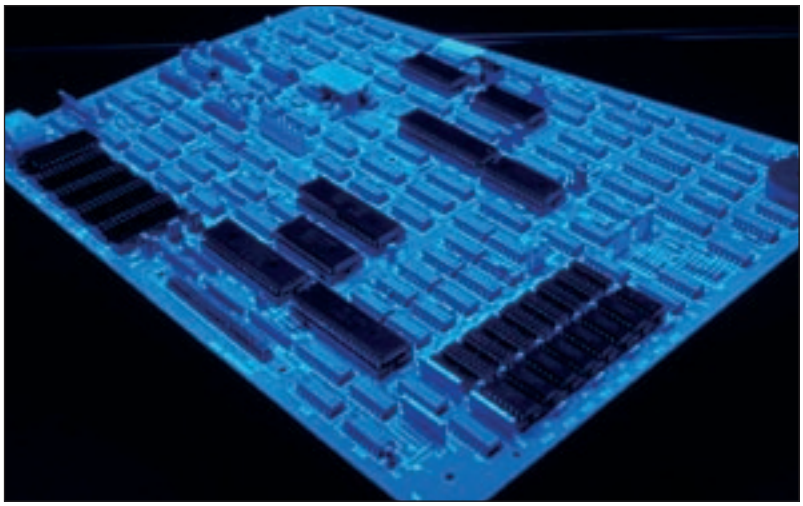
However, the incinerator units are expensive, costing anywhere in the range of €100k-300k, and will dramatically increase the factory's CO_2 emissions. In many European countries, personal and industrial CO_2 emissions are the basis for certain taxes and are likely to be the basis for future industrial taxation as countries strive to reduce their CO_2 emissions.

Perhaps the most effective and viable method for long-term VOC

reduction is the implementation of conformal coating materials containing low or zero VOC. Companies that have moved away from the traditional solvent-based coatings to more environmentally friendly water-based and UV coatings have all seen huge improvements in their levels of emissions.

Coating alternatives: 100% solids materials

100% solids materials are liquids where 100% of the liquid applied becomes solid polymer after curing. These materials come in two distinct types of chemistries: organic materials and inorganic silicone materials. By their very nature, 100% solids materials contain practically no volatile components or solvents, and so VOC emissions can be very low.



100% solids materials can be cured by exposure to UV light, heat, moisture or sometimes a combination of these methods. There are also two component materials that cure by chemical reaction when mixed, but these have huge processing issues in the electronics industry and will not be considered in this article.

UV curing

Materials which cure by exposure to UV light of a suitable wavelength and power are at the cutting edge of technology. They contain no solvents, cure in seconds and have excellent chemical and water resistance. However, they can be extremely brittle, tending to crack during thermal cycling, have poor adhesion, and tend to shrink during curing. The secondary cure mechanism is also often unreliable, resulting in the material remaining liquid in unexposed areas and leading to corrosion. HumiSeal UV40 was developed to be easy to process and resistant to cracking under thermal cycling, offering manufacturers a genuine alternative to solvent-based coatings, with none of the problems normally associated with these materials.

For the first time, high volume users in market sectors such as automotive and consumer electronics, can now gain access to the popular UV curable coating class with the combination of rapid cure speed, high level of processing ease and thermal cycling resistance, never before achieved with UV materials.

The process has taken many years to develop and perfect, but with perseverance and careful polymer engineering, the net result can be summarised chemically as a polyurethane-polyacrylate hybrid UV curable polymer structure.

UV40 yields a macroscopic materials performance that is not dissimilar to the ease-of-processing and thermal cycling resistance offered by other established chemical coating material types. One of the key benefits is its low viscosity, which dramatically eases processing challenges in terms of being able to uniformly and quickly coat a board and ensure the coating spreads over all required areas. In addition, the UV material is also extremely flexible, physically, particularly in response to thermal cycling/shock stress. This means that the coating is far less prone to the conventional cracking that can occur with traditional UV curable materials and which has afflicted them since their first introduction back in the 1980s.

Finally, a reliable and fast acting secondary cure mechanism was engineered to ensure that the coating does not remain liquid in areas not exposed to the UV radiation during curing.

Solventless silicones

These materials are of an inorganic chemistry and generally cure by either a heat catalysed mechanism or a moisture initiated mechanism. Silicone materials have good high temperature stability, due to their inorganic nature and are usually very soft.

The heat cure cycle is typically 5-10 minutes at about 110-120°C, although the catalyst is easily poisoned by processing contamination resulting in the material remaining liquid. In addition, the material viscosity drops as it is heated up, resulting in poor coverage of component leads and other critical areas.

The moisture-cure products often produce VOC emissions during curing, which can also result in bad odours (like vinegar). However, when cured, both types of silicone materials usually offer good protection against liquid water, but are often more porous than other materials to moisture vapour. Silicones tend to become soft when exposed to solvent and generally have low cohesive strength and poor adhesion to unprimed surfaces. Silicones generally have very little abrasion resistance

Coating alternatives – water-based

The primary advantage of water-based coatings is that they can protect electronics assemblies at temperature extremes far beyond the capabilities of conventional solvent-based coatings. Leading formulations also often have similar performance characteristics to older solvent-based products in terms of electrical and physical properties. In addition, when applied at suitable thicknesses, water-based materials can cure rapidly.

As well as being extremely environmentally friendly, they are also non-flammable because they do not use solvents. They are, therefore, safer than most conventional coating ingredients, by reducing Health and Safety demands for fume extraction and handling of hazardous chemicals.

Furthermore, unlike most traditional solvent-based coatings, water-based types can be delivered 'ready-to-use' and, as such, do not require any on-site handling and mixing, or packaging disposal. Finally, water-based materials have a similar order of cost to solvent-based materials and are closer to a drop-in alternative than the other materials discussed.

Getting it right

The protection of the environment concerns us all and there continues to be an increasing level of public awareness regarding environmental protection and responsibility. Of course the cost implications for businesses can be enormous, especially within the electronics industry, with many still feeling the financial impact of the Lead-free directives.

As modern electronics assemblies continue to use ever greater packaging densities and reduced conductor widths and spacing, and are subjected to increasingly hostile operating conditions, the use of high performance conformal coating materials will become increasingly common place for virtually all manufacturers.

Choosing the right conformal coating and application process isn't easy. It therefore pays to work with a vendor that has experience of solving hundreds of specific coating problems and that can give advice on relevant reliability standards and specifications.

Investing time and effort into getting it right will be amply rewarded by the near elimination of end-product failures in the field. These can be the most expensive problems a company will ever have to rectify. In short, if you have to conformally-coat your boards, you must get it right. When you do this, you protect your customers, your profits and our environment.

Head Maintenance Kit For Reliable SMT Placement

With the new Siplace Head Maintenance Efficiency Kit for Siplace placement machines, electronics manufacturers can perform their own preventive head maintenance quickly, professionally and automatically.

The package from Siemens Automation and Drives (A&D) consists of four easy-to-use cleaning and maintenance tools for sleeves, plungers, glass scales and ceramic nozzles which, according to Siemens, provide electronics manufacturers with more availability, reliability and placement quality.

With the new kit, heads can be cleaned faster and more thoroughly than would be possible by hand. The automatic cleaning process improves the functionality of the placement heads and the performance of the entire machine in the long term. The sleeve cleaning station is a compact system that automatically cleans the lateral and longitudinal vacuum drill holes of sleeves. Installation and operation are easy and user-friendly. The plunger maintenance tool makes sure that all plungers are properly cleaned and lubricated, the glass scale cleaning tool cleans glass scales without direct sleeve contact, whilst the ultrasonic cleaner for ceramic nozzles washes nozzles, which are stored in special cleaning cartridges, in an ultrasonic water bath automatically and in just 15 minutes.

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