ROHM AND HAAS ELECTRONIC MATERIALS

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CIRCUIT BOARD TECHNOLOGIES

Technical Communications

It's not easy being greener

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It's not easy being greener

Ensuring that circuit board plating chemicals and processes comply with current and future global environmental legislation is no trivial matter. Navigating both new and revised regulatory directives is complicated by variations in regional and customer requirements. Additional difficulty is provided by the combination of industry-driven and supplier's own internal sustainability standards and requirements.

As a supplier of PWB processing and plating chemistries, we now routinely include a broad range of sustainable development targets in project development objectives that were once dominated by cost and performance metrics. Attention to these sustainability factors ensures that our new products meet the widest possible range of environmental compliance requirements and reduces the need for reformulations requiring costly and inconvenient customer requalifications.

Unfortunately, developing these sustainable development targets is not a simple matter, as there are no universal lists of restricted materials for product formulators to reference.
Regional regulations that initially apply only to particular industries or uses tend to evolve into broader, more complex global restrictions. Acceptable threshold limits may later be made more strict or even evolve into complete bans.
Formulators must also consider customer ban lists. Customers may demand that our products meet targets that exceed regulatory requirements. As an example, when a regulation restricts materials in the finished products that our customers ship into commerce, usage of those materials during the manufacturing process that does not lead to incorporation may also be banned.
The possibility that changes in public opinion or the political party in control of government might affect future legislation must also be considered.

Formulators must also be aware of reclassification of substances, driven by new test data or re-assessment of existing information. Such changes may move a substance into a new, more restricted category, such as suspected carcinogen, mutagen, reprotoxin, persistent organic pollutant, persistent bio-accumulative toxin or endocrine disrupter.

Juggling all these concerns, while trying to still meet cost and performance targets, is the job of the "greener" formulator today. The outline below represents just a small sampling of the many regulations that affect the products that are needed by today's PWB industry.

RoHS and REACH

RoHS, the Restriction of Hazardous Substances Directive, or to use its full title "Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment 2002/95/EC" , was adopted in February 2003 by the European Union[i] and took effect on July 1, 2006. This directive bans the placing on the EU market of new electrical and electronic equipment containing more than specified levels of six materials: lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) flame retardants. The EU is already considering changing the RoHS directive and may add new substances, as well as changing the scope and eliminating some of the present exemptions.

RoHS was initially developed in the EU but, as is the case with many such regulations, similar legislation is being adopted worldwide. While the USA and Canada do not have national legislation that restricts hazardous substances in electrical equipment, some US states have adopted limited restrictions, notably California. The Califoria legislation (SB20) came into force in January 2007, imposing EU-RoHS restrictions (same substances, concentration limits), but limited to displays larger than four inches measured diagonally. There have been several attempts to broaden the scope to match that of EU-RoHS and it seems to be only a matter of time before those changes occur. Many US states have adopted restrictions on mercury in electrical equipment and some have restrictions on flame retardants; penta- and octyl-bromodiphenyl ether. China also has legislation widely referred to as "China-RoHS" which came into effect in March 2007 and applies to a wide range of electrical equipment sold in China.

Persistent, Bioaccumulative and Toxic chemicals (PBTs) are increasingly appearing on regulators' watch lists worldwide. Due to their hazardous nature, countries are developing approaches to restrict their widespread use, including outright bans in some cases. In the European Union, the REACH regulation (Registration, Evaluation, Authorization and Restriction of Chemicals) is a single system that replaces a number of European Directives and Regulations. At 849 pages,it is a highly complicated piece of legislation!

The legislation has two main elements: protection of human health and protection of the environment. While the original usage of a chemical may not directly harm humans, it may subsequently contaminate the air or water and then enter the food chain through plants, fish or other animals. REACH requires companies to assess PBT and vPvB (very Persistent, very Bioaccumulative) characteristics of chemicals they manufacture or import into the EU, with the intention of creating incentives to limit usage of such classes of materials. It affects both the production and use of chemical substances, and their potential impacts on both human health and the

environment. It is the strictest law to date regulating chemical substances and impacts companies throughout the world, through their EU business dealings.[ii] REACH entered into force in June 2007, with a phased implementation over the next decade.

The regulation states that chemicals manufactured or imported into Europe at volumes of one ton or more must go through a registration process. To complete this registration process, the suppliers of a chemical must prove that it is safe, by submitting information about toxicology, intended uses, and chemical safety assessments. There are many uncertainties about the regulation at present - such as which raw materials might become commercially unavailable (either due to specific toxicity issues or due to costs associated with required toxicity tests), possible adverse impacts on product development cycle times, and protection of proprietary information during the registration process.

REACH will also require more communication up and down the supply chain. Customers need to know whether a supplier has submitted registration or authorization records for substances that will be used in their processes or incorporated in their products. Suppliers need to better understand how customers handle the materials provided to them in order to conduct risk assessments and recommend safe handling measures. Since some companies function as both a supplier and a customer, communication will need to be initiated both ways. Ultimately, REACH should make our lives easier because it combines 40 separate pieces of legislation into one consistent chemical law across 27 European countries.

Other countries such as Canada and Japan have already started a similar screening process for the chemicals in their national inventory lists. US-EPA conducts risk assessments for PBT characteristics, and actually maintains a PBT list for TRI (Toxic Release Inventory) reporting. While all this regulatory activity is designed to protect human health and the environment from exposure to hazardous chemicals, chemical suppliers face an ever-increasing challenge to screen existing and new components in their products for PBT characteristics.

Alkylphenol and Alkylphenol Ethoxylates

Alkylphenols (AP) are chemical compounds used primarily to manufacture alkylphenol ethoxylates (APE). APEs, the most common of which are the nonylphenol ethoxylates (NPE), are non-ionic surfactants, widely used as emulsifiers, wetting agents, dispersants, foam control agents and surface tension control agents. Industrial applications include paper and textile manufacture, paints, resins, adhesives and industrial cleaners.

While commercial APEs themselves are not considered to pose a risk to the environment, biodegradation of the ethoxylate chain by bacteria results in the formation of more toxic, less soluble metabolites, which tend to bioaccumulate through absorption on suspended solids. These metabolites have been reported to imitate or enhance the effect of estrogen hormones, and they are commonly referred to as “endocrine disruptors” by regulators.
A subset of AP / APE materials, specifically nonylphenols, octylphenols and their ethoxylates or derivatives have been the subject of attention by regulatory agencies.

Europe banned nonylphenols and nonylphenol ethoxylates, based on their endocrine disruption effects. As of January 2005, NP and NPE were classified as a "reproductive hazards" and their use in European cosmetics and other consumer and industrial products was prohibited at levels above 0.1% by weight of NP or NPE through Directive 2003/53/EC.[iii] Environment Canada declared NP/NPE as CEPA Toxic in 2000, which calls for substitution by environmentally acceptable substances. In the US, the EPA has established new water quality criteria that are designed to limit the amounts of NP discharged into the environment. They are encouraging reduced use through the Safer Detergents Stewardship Initiative (SDSI). In Japan, the National Institute of Technology and Evaluation is working with industry to promote replacements for both NP and NPEs (Japan NITE, 2004).

EU Detergent Regulations

The EU Detergent Regulation (EC) 648/2004[iv] became effective on October 8, 2005. The aim of the regulation is to give increased protection to the aquatic environment from the impacts of persistent detergents and surfactants. The new regulation established stringent rules for biodegradability of surfactants used in detergents. The previous legislation on biodegradability of detergents only covered *primary biodegradability* and only applied to anionic and non-ionic surfactants. The new legislation emphasized *ultimate biodegradability* and adressed important concerns regarding the potential toxicity of persistent metabolites.

Primary biodegradabaility determines whether the structure of a substance has altered or whether surface active properties have been degraded. Primary biodegradation is measured by determing the remaining level of parent surfactant in biodegraded liquids.

Ultimate biodegradability, on the other hand, is a broader measure indicating the release of CO_2 or the consumption of oxygen. Complete biodegradation would mean complete conversion to carbon dioxide, water, and mineral salts. Under the new regulation, any surfactant used in detergents has to be tested for its

ultimate biodegradability. If the detergent meets the criteria for ultimate biodegradability, it may be put on the market without further restrictions. If not, the manufacturer may ask for a derogation, provided the detergent is at least primarily biodegradable.

Other Materials

The regulatory restrictions of concern to formulators are not limited to those mentioned above. Concerned by recent exposure studies, the Federal Government and some states are considering new restrictions, including bans, on products that contain formaldehyde. Perfluoroalkylsulfonate (PFAS) compounds (whose perfluorinated carbon chain length is ≥ 5 carbons) are considered by global regulators to be persistent, bioaccumulative toxins and usage is now subject to restrictions or bans. For a number of years, usage of the strong chelate EDTA (a primary chelating agent found in many electroless copper plating formulations) has been regulated in some European countries, due to concerns about solubilization of heavy metal ions.

Leveraging Sustainability

Ensuring that product development groups have a comprehensive understanding of environmental regulations is vital to cost-effective new product creation. Technical objectives have to not only accurately reflect current restrictions and those that can be reasonably anticipated, but also appropriate targets for corporate citizenship.

To achieve these goals, close cooperation between corporate environmental health and safety groups and formulators is imperative. This cooperation is reinforced by internal training programs to clarify procedures for chemical assessment and selection.

This approach provides substantial competitive advantage and enhances the sustainable aspects of a company's product portfolio by ensuring chemical selection does not adversely impact human health or the environment.

Developing products that enable our customers, and their customers, to achieve the highest level of performance with the lowest impact on people and the planet is one of Rohm and Haas's sustainability commitments. While we have much work ahead, we believe our approach is well-suited to respond sucessfully to the many regulatory challenges that lie ahead of us all.

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Rohm and Haas Electronic Materials LLC is a global supplier of a comprehensive range of making printed circuit fabrication products, including through-hole

pretreatment, electroless copper / direct plate and electrolytic copper and tin plating processes.

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[i] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:037:0019:0023:EN:PDF

[ii] "European Parliament OKs world's toughest law on toxic chemicals". San Francisco Chronicle (14 December 2006).

[iii] Official Journal of the European Union: DIRECTIVE 2003/53/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 June 2003 amending for the 26th time Council Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations (nonylphenol, nonylphenol ethoxylate and cement), July 17, 2003

[iv] Regulation (EC) No 907/2006 of 20 June 2006 amending Regulation (EC) No 648/2004 on detergents, in order to adapt Annexes III and VII thereto