28. Januar 2020

MEZ

RoHS Pack 15 – 4th Stakeholder Consultation "Substance assessment of Diantimony trioxide" – ZVEI contribution

Preliminary remarks

ZVEI thanks for the possibility to provide comments on the "Substance assessment of Diantimony trioxide".

In future, for consultations with extensive documents we would appreciate to get more answering time. This will provide an opportunity to identify all relevant concerns and to substantiate the argumentation with meaningful examples. In order to involve as many stakeholders as possible, we generally recommend that consultations preferably start at the beginning of the week and end at times when high availability is expected.

We welcome the decision not to propose Diantimony trioxide for a restriction in RoHS Annex II. Concerning the proposal to take a closer look at Diantimony trioxide in connection with halogenated flame retardants, you will find further references and our concerns in this contribution.

In principle, we do not consider a grouping of the inorganic single substance Diantimony trioxide (ATO) and the large group of organic halogenated substances to be appropriate. In our opinion, a robust definition of this group is not possible, which contradicts the grouping rules of the newly published substance methodology (see table on page 9).

Furthermore, substituting the entire flame-retardant system (ATO + halogenated flame retardant) would be a major change in the polymer. The chemical components of a polymer are carefully matched to achieve the mechanical, thermal and electrical properties. Thus, substituting the entire flame-retardant system (ATO + halogenated flame retardant) would mean a complete redesign including validating the properties versus the demands. Whether this works successfully for all applications can only be assessed after extensive and time-consuming testing.

In the case of such far-reaching effects of regulation, the socio-economic aspects in particular must be given greater consideration, since in addition to market movements, cost, time and availability issues, a massive demand for skilled workers is also to be expected for such a changeover.

For your deeper understanding of our concerns, we now provide answers to your questions and details on possible substitution in specific applications and its impact on technical performance and associated socio-economic impacts across the electrical and electronics industry.

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Overview about the main applications (halogenated flame retardant in combination with Diantimony trioxide)*

No.	Application	Materials	Flame retardant system	ATO Concentration
1.	Connectors			
1.1	Connectors with thin wall thickness or compact size (e.g. home appliances, automotive, etc.)	PBT PA	Brominated flame retardant + ATO	4 -7 %
2	Corrugated pipe			
2.1	Lightweight corrugated plastic conduit; Medium-weight corrugated plastic conduit	HDPE	Brominated flame retardant + ATO	Up to 17% in homogeneous material 0,7-0,8 % in 100g conduit (because of multilayer system)
3	Cable			
3.1	Cable Thermoplastics	PA PE PP TPE-U TPE-S	Brominated and chlorinated flame retardant + ATO	5-8%
3.2	Cable PVC	PVC	Chlorine from PVC	5-8%

*Identified applications in the available time period. It should be noted that further applications are conceivable and the list contains components that go into a variety of end applications

Evaluation of substitutes in relation to individual applications

When assessing the substitution potential of technical polymers, special attention must be paid to the respective application, depending on which of the many requirements are demanded of the respective product. These extend from approval requirements, mechanical and electrical properties to issues such as colour, availability and processing properties. Often these properties are interdependent, so that an improvement in flammability, for example, can have a direct influence on mechanical properties and processing. In comparison, polymer commodities, which often require only a few properties, can be easier to substitute. It is not possible to make general statements in these cases and the individual applications must be considered and evaluated in a decisive manner. In the following, you will find some concerns about proposed substitutes in connection with the applications mentioned above.

1. Application Connectors

Polymers used for connectors (e.g. home appliances, automotive etc.) are regulated by international standards. These standards demand certain technical properties of those polymers. Among others the demands are: UL Yellow Card listings, glow wire test requirements (GWFI, GWIT according to IEC 60335-1), various listings for thin wall thickness, CTI, RTI, flammability, temperature resistance, mechanical properties (tensile strength, elongation at break).

1.1 Connectors with thin wall thickness or compact size

Substitute: Inherently flame-retardant materials

All inherently flame-retardant plastics (e.g. LCP, PSU, PES, PEI, PAI) are based on an aromatic basic structure, which is responsible for a higher continuous service temperature, but also for very low CTI values. However, these CTI values are required to design the necessary creepage distances of the component for a certain operating voltage. For this reason, plug connectors produced from these plastics ought to be constructed much larger based on the very low CTI value. By no means does this correspond with the process of miniaturization and thus with the principle of material and energy efficient development. If the size and therefore the creepage distance remain unchanged, the permissible rated insulation voltage has to be reduced considerably. As a result, these articles can no longer be applied in many areas of the electrical industry.

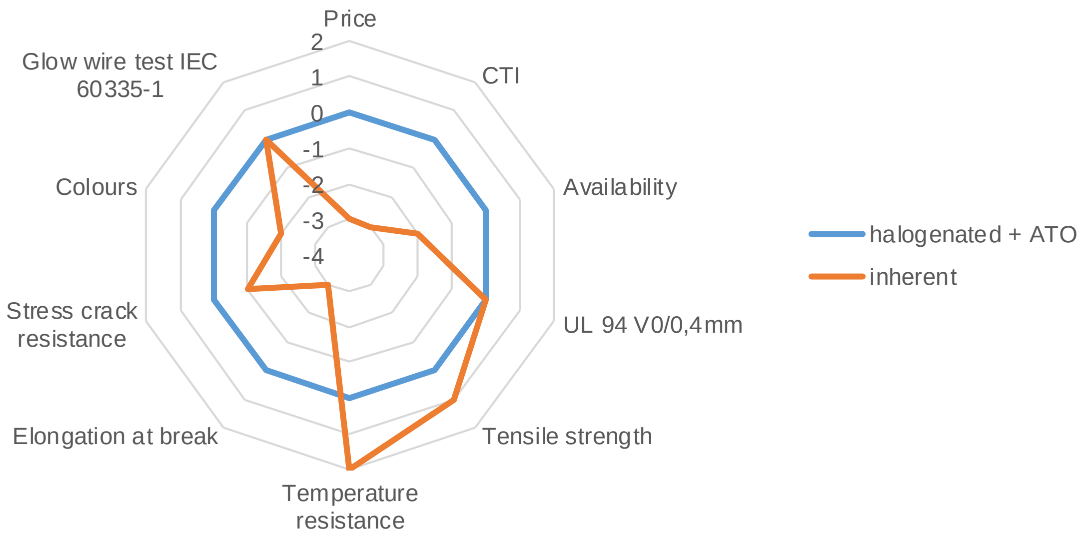
In addition to the extremely high price of the inherently flame-retardant plastics (at least three times as high), they would have to serve a very large market as a current niche product if ATO were to be banned from now on. This would result in supply bottlenecks, which would also justify a significant extension of the possible changeover period.

Furthermore, colouring inherently flame-retardant plastics is very difficult because of their often dark intrinsic colour. It has to be considered here that certain colours/colour combinations are either specified or have been established over the years in many areas of the electrical industry. For example, protective conductor terminal blocks and/or pluggable elements have to be designed in the colour combination "green/yellow" according to DIN EN 60947-7-2 "Low voltage switchgear – Part 7-2: Ancillary equipment – Protective conductor terminal blocks for copper conductors". So colours are a safety criteria for the handling in production and maintenance. Colour stability and colour brilliance is also a challenge with inherently flame-retardant plastics. Due to the high processing temperatures, colour changes can occur with many pigments, especially with organic pigments used for bright colours.

For plug connectors with a very thin wall thickness (≤ 0.4 mm) the only alternative with respect to the flowability of the melt is LCP. However, besides the disadvantages already stated before, LCP also possesses very poor weld line strength, an extremely low strain at break and distinctive anisotropic mechanical properties.

Another important aspect that must be severely taken into account is that the materials listed above can by no means be used in existing tools, which is due to their processing parameters and the shrinkage in plastic processing tools. Therefore, a vast number of new plastic processing tools would have to be constructed (also see socio-economic consequences).

Fig. 1: Comparison of properties - Halogenated + ATO polymers vs inherently flame retardant polymers (connectors)*



* The original material used represents the zero line in the diagram and the properties have been qualitatively evaluated according to this. Worse properties of the substitute are therefore evaluated with negative values and better properties with positive values.

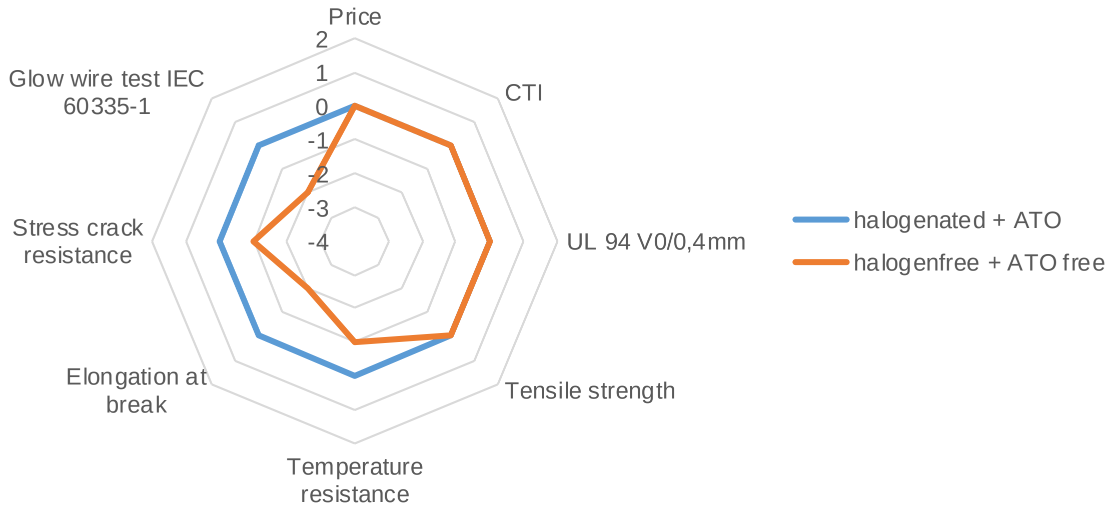
Substitute: Other Materials without halogenated flame retardant and ATO

When using not inherently flame-retardant materials as substitutes, it should be noted that up to twice as much flame-retardant additive is required to achieve the UL 94 V0 classification regarding thin wall thicknesses ≤ 0.4 mm for halogen-free flame-retardants compared to halogenated flame-retardants. This has considerable negative influences on the mechanical characteristics of the material, especially on the strain at yield, the strain at break and the impact strength. Declines in the strain at yield of up to half the characteristic values of halogenated flame-retardants are not uncommon with halogen-free systems. Non-reinforced PBT is especially affected in this respect.

Apart from the fact that, as already explained above for the inherently flame-retardant substitutes, existing plastics processing tools cannot be used any longer, certain mechanically stressed part geometries would have to be revised and/or adjusted, which often leads to a redesign/new construction of the respective plastic processing tools.

It should also be noted that amorphous substitutes in the field of engineering thermoplastics (e.g. polycarbonate, polyphenylenether) are much more susceptible to stress corrosion cracking than semi-crystalline engineering thermoplastics. This concerns in particular organic solvents, plasticizers (e.g. direct contact with plastic seals and/or O-rings) and oils. As a result, many branches of industry (e.g. processing industry, food industry) would no longer be able to use these articles, as their chemical resistance is no longer guaranteed and the articles therefore represent a safety risk regarding to the contact safety of live parts. In addition, polycarbonates, for example, are unsuitable for thin-wall applications as they do not meet UL 94 V0 listings below 0.75mm.

Fig.2: Comparison of properties - Halogenated + ATO polymers vs. other materials with halogen-free flame retardants (without inherent)*



* The original material used represents the zero line in the diagram and the properties have been qualitatively evaluated according to this. Worse properties of the substitute are therefore evaluated with negative values and better properties with positive values.

2. Application corrugated plastic conduit

2.1 Light and medium-weight corrugated plastic conduit

Halogenated flame retardants are used in corrugated plastic conduits with light and medium compressive and impact strength. The conduits are mainly based on polyethylene.

The prohibition of ATO in conjunction with halogenated flame retardants results in substitution with halogen-free flame retardants. Halogen-free flame retardant is based on organic phosphorus compounds and the basic polymer is polypropylene. Inorganic phosphorus compounds are out of question because they are only use for technical polymers.

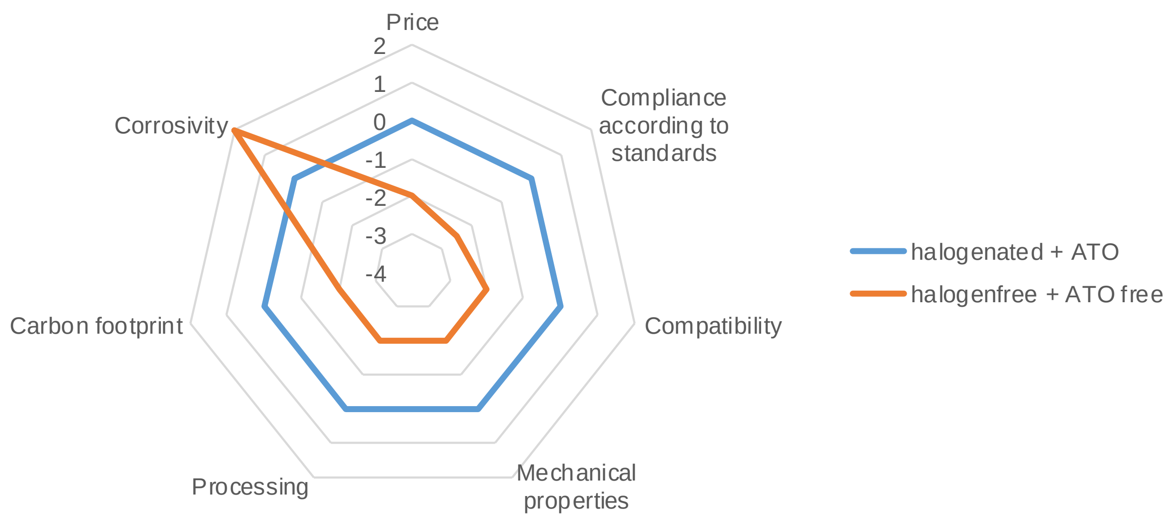
For compatibility with the halogen-free flame retardants the basic polymers of the corrugated plastic conduits should be replaced with polypropylene. The costs are still very high.

Furthermore, in the case of using halogen-free flame retardants the production process is only stable for small types and thin wall thicknesses. For large types the quantity of the flame retardants has to be increased. However, the amount of flame retardants is limited according to the standard. Therefore, the standard is not complied.

Another possibility is using metal hydroxide instead of organic phosphorus compounds. The disadvantages are the high costs and the higher amount of the basic component required. Therefore, the mechanical properties are drastically reduced, and the standard is not complied.

A very important fact is the life cycle assessment. For extrusion recycled polyethylene is used which is compatible with the basic polymers of the corrugated plastic conduits. As mentioned above, in the case of changing the flame retardants you need polypropylene as basic polymer. Polypropylene as recycled materials is only used for injection molding. Therefore, the carbon footprint increases by 47% because using recycled materials would be no longer possible.

Fig.3: Comparison of properties - Halogenated + ATO polymers vs. other materials with halogen-free flame retardants (corrugated plastic pipes)*



* The original material used represents the zero line in the diagram and the properties have been qualitatively evaluated according to this. Worse properties of the substitute are therefore evaluated with negative values and better properties with positive values.

3. Application Cable

3.1 Cable Thermoplastics/PVC

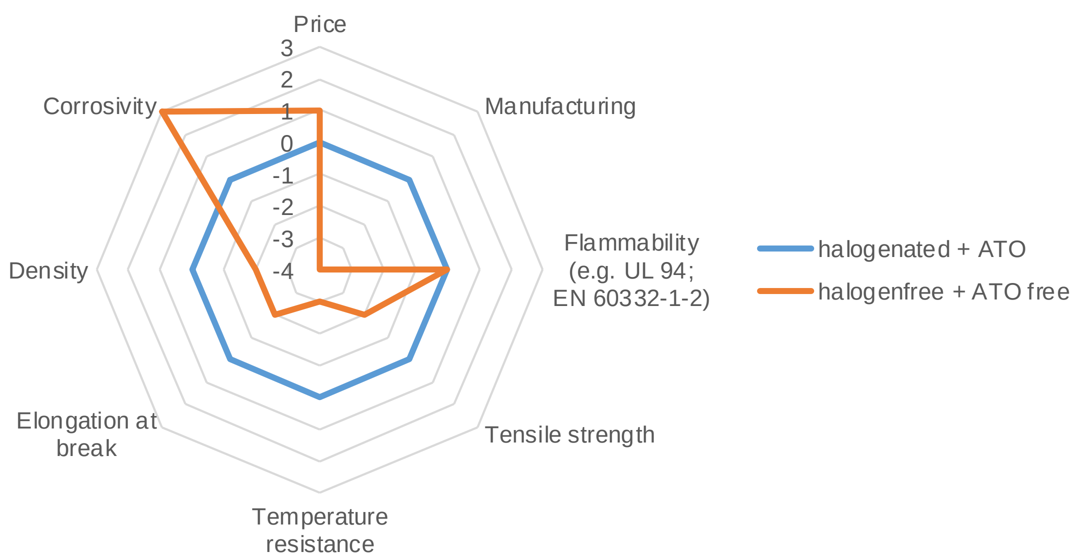
Polymers used for cables (e.g. electrical appliances, medical, household, etc.) are regulated by national European and international standards. These standards demand certain technical properties of those polymers. Among other the demands are: UL Yellow Card listings, listing for thin wall thickness, CTI, flammability, temperature resistance, mechanical properties (tensile strength, elongation at break).

Polymers without halogenation nor the addition of ATO cannot fulfill these requirements at all time.

The processability of polymers used for cable production without halogenated flame-retardant as well as not halogen-based polymers in combination without ATO will significantly decrease. Parameters such as the slower production speed, higher pressures during extrusion and less process stability will occur by using halogen free polymers in cable production. Nowadays the production sites in Europe cannot be used in all cases for such halogen free systems due to different construction of the extrusion lines (e.g. e-beam, silicone polymers).

The availability of the halogen free material cannot be granted in all cases due to the lack of sources and production capacities of these polymers.

Fig. 4: Comparison of properties - halogenated +ATO polymers vs. halogen-free polymers (cable insulation)*



* The original material used represents the zero line in the diagram and the properties have been qualitatively evaluated according to this. Worse properties of the substitute are therefore evaluated with negative values and better properties with positive values

Qualitative impact on EEE producers (including administrative efforts)

a. Development (new construction) / Time [h] / Costs [Euro] / Staff [headcount]*

b. Quality/Laboratory (type tests, tests during development, tests during production) / Time [h] / Costs [Euro] / Staff [headcount]*

c. Approvals (Home appliances standard, UL approvals, approvals for specific markets) / Time [h] / Costs [Euro] / Staff [headcount]*

d. Production (tool costs, conversion of production processes) / Time [h] / Costs [Euro] / Staff [headcount]*

e. Administration (technical documentation, data maintenance in systems, suppliers and customer communication) / Time [h] / Costs [Euro] / Staff [headcount]*

f. Increase in material prices / Costs [Euro/pa]*

g. Long transition period required (see Fig. 5 below)

h. Availability of substitutes critical, which will be further worsened by regulation

i. Availability of the products will decrease, as new designs for some applications and especially for SMEs are not profitable, so that discontinuations may occur

j. Spare parts supply for existing products is deteriorating because new approvals for spare parts are not profitable

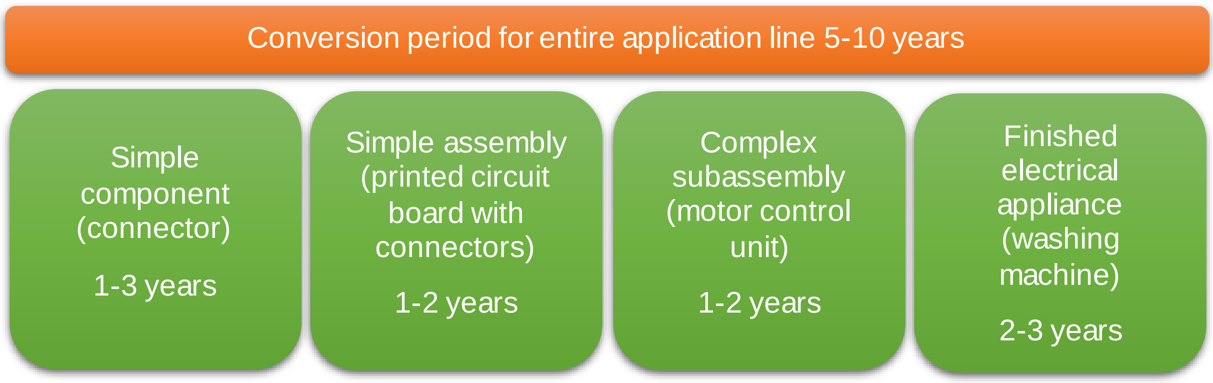
k. Small companies may not be able to cope with the effort or may take much longer to convert, which could lead to market shifts to the larger companies.

l. Quantity of qualified personnel not available on the labor market for the conversion

m. Long service life will increase, especially in the capital goods sector

* Quantitative assessments on these topics are submitted separately and confidentially from single member companies

Fig. 5: Diagram showing the required changeover time for one application line (example)*



* The example is based on idealized conditions; depending on the application and with regards to common development loops, the exact time may vary. The primary aim is to show that the changing times within the supply chain do not occur in parallel but rather one after the other

Further comments on „RoHS Annex II Dossier for Diantimony trioxide" from Oeko-Institut

1. Group approach of Diantimony trioxide and halogenated flame retardants

The Oeko-Institut proposes a review to assess whether a regulation of diantimony trioxide in combination with halogenated flame retardants as a group is appropriate. With reference to the newly published "Methodology for Identification and Assessment of substances for inclusion in Annex II under RoHS" and the Annex 6 "Guidance on groups of similar substances" contained therein, we do not consider this permissible on the basis of the criteria mentioned there.

The following criteria are mentioned there (additional also our assessment of the proposed combination of substances):

Criteria from Methodology:	**Assessment of ATO combined with halogenated flame retardant:**
Common structure, functional group(s) constituents or chemical classes	No, different structure; different functional group; different chemical class; ATO – inorganic; HFRs - organic
Common (eco-)toxicological effects, hazard classification or toxicokinetics	No, ATO - Cancer Cat 2; HFRs – various; different hazard potentials already exist even within the group of halogen-containing flame retardants
Common physico-chemical properties	No, ATO – inorganic; HFRs - organic
Common mode or mechanism of action	No, ATO - Heat absorption (without additional FRs no FR function itself); HFRs - Working on radicals in gas phase
Common adverse outcome pathway	No
Common environmental fate/behaviour	No
Likelihood of common precursors and/or breakdown products via physical or biological processes that result in similar substances	No, ATO – inorganic; HFRs - organic
Constant pattern or trend across the group in the potency of the properties	No, ATO – inorganic; HFRs - organic
Comparable type and duration of exposure due to either the use of the EEE or the management operations of the related WEEE	Comparable type and duration of exposure is possible, no robust definition on this criterion
Similar or same purpose/use/function in specific applications	Yes, no robust definition on this criterion
Presence in EEE, or reasonable expectation of presence in EEE according to the substance's characteristics, for the same purpose/use/function	Yes, no robust definition on this criterion

While it is mentioned that the above list is not complete and other criteria can be used, the main focus is on a robust definition of the group. In our opinion, this is not achievable for the substance-group combination of diantimony trioxide and halogenated flame retardant. The individual substance ATO and the very large group of undefined halogenated substances do definitely not meet the criteria for grouping as defined in the substance methodology.

2. Comment on percentage volume data of ATO (Oeko-Institut Dossier paragraph 2.2)

The high amounts of 25% ATO mentioned in the dossier could not be detected in the applications known to us. Usually, the amount of ATO used is directly related to the amount of flame retardant added, since a higher content of ATO above a certain level does not result in higher effectiveness. This means that usually less than 8% ATO is used. Sporadically higher amounts of ATO, as in the application of corrugated plastic conduits, could only be found in multilayer systems where the absolute content over the whole system is below 1%.

3. General comment on the flame retardancy substitutes mentioned in the dossier

Technical literature frequently mentions alternatives to ATO. These have not been established to date, even though ATO has been under discussion for quite some time. In addition, these alternatives are by far no equivalent and need to be added in higher concentration, or the concentration of the halogenated flame retardant needs to be increased. This considerably changes the mechanical properties compared to conventional halogenated flame-retardant systems with ATO, which comes along with much inferior values for strain at yield, strain at break and impact strength.

Halogen-free flame retardants also have to be added in higher concentrations because they are considerably less effective than the halogenated systems. Again, this has a strong negative influence especially on the mechanical properties, as already explained before with the ATO alternatives.

Both aspects stated above (ATO alternatives and halogen-free systems) result in the need to adjust mechanically stressed part geometries and consequently in many new plastic processing tools to be constructed.

It should be mentioned that halogen-free flame retardants are also increasingly under discussion. The REACH registration of zinc borate, zinc stannate and zinc hydroxostannate have to be noted here, but also RDP (resorcinol bis(diphenylphosphate)), which features on the REACH CoRAP list.

Red phosphorus has also been heavily criticized in electrical applications for quite some time, as it tends to outgas under the influence of damp heat and deposits on the surface of the current-carrying metals. This especially affects tin and silver surfaces and leads to a considerable increase in contact resistance values and thus poses a potential safety hazard.

In addition, it has to be remembered that not every halogen-free flame retardant can be used with every plastic, based on the required homogenization process.

4. General comments on plastics in the electrical industry[1]

The freedom of companies to develop innovative products must be guaranteed in a technology-open framework. Manufacturers must continue to be able to determine the design of their products independently and find a balance between the use of primary and secondary raw materials (e.g. recycled plastics), efficiency in the use phase, product life, reparability and recyclability.

The electrical industry mainly uses technological plastics in its products. Possible safety requirements as well as demands on quality and function of a product must always be guaranteed. As a rule, this means certified plastics, which in view of their long service life (sometimes 50 years) and the required product safety must meet the highest technical standards in order to guarantee the safety of products. In addition, the great diversity of the product portfolio of the electrical industry should be taken into account. There are no overarching requirements and potential regulations should always be considered product-specific / functional. Some product specific standards are for example IEC 60335, IEC 60947, UL 1059, IEC 61984, IEC 60512, etc.

In principle, product safety from the user's perspective must always be the main focus. For example, the wide variety of technical plastics used in many applications in the electrical industry serves to protect the user from electrical current (plugs, device housings, power distribution boxes, functional components, etc.) and to provide insulation protection for the plant safety of industrial infrastructures.

All requirements must be evaluated in detail and implemented accordingly:

- **Product safety:** Electrical insulation, UV exposure, tracking resistance, temperature resistance, fire behaviour, arc fault protection, colouring (indicates certain functions of electrical components, e.g. emergency stop switches or intrinsically safe circuits in explosion protection areas) and, in conjunction with this, colour stability;
- **Mechanics:** High degree of design freedom and thus fulfilment of even complex functional requirements (e.g. manufacture of the smallest electronic components) with low material input;
- **Materials/technical:** Low density, suitable for use with foodstuffs, long-term reliability, reinforced with glass fibre, increased breakage resistance and elasticity (enables high energy absorption), lower corrosion and more resistant to chemicals than metals, flame resistance, poor heat conductors and electrical non-conductors (use as insulation material);
- **Optics/aesthetics:** Wide range of colouring options, colour stability (white should remain white over the entire service life), acoustics, odour neutrality.
- **SMERC-Principle:** All proposals for product-related requirements to be examined according to the SMERC principle (specific, measurable, enforceable, relevant and compatible with competition).

In addition, of course, **market economy arguments** also play a role:

- High quantities (injection moulding) with low material input/component price
- High dimensional accuracy/reproducibility of components, low reject rate
- Fully automatic production

[1] based on the ZVEI discussion paper "Plastics in the Electrical Industry", publication planned for January 2020

Glossary of abbreviations

Abbreviation	Description
ATO	Diantimony trioxide
LCP	Liquid crystal polymer
PSU	Polysulfone
PES	Polyether sulfone
PEI	Polyetherimide
PAI	Polyamide-imide
PBT	Polybutylene terephthalate
PA	Polyamide
HDPE	High-density polyethylene
PP	Polypropylene
PE	Polyethylene
TPE-U	Thermoplastic polyurethane (urethane-based)
TPE-S	Thermoplastic polyurethane (styrene-based)
PVC	Polyvinyl chloride
CTI	Comparative Tracking Index
GWFI	Glow wire flammability index
GWIT	Glow wire ignition temperature
RTI	Relative temperature index
SME	Small and medium sized enterprises
HFR	Halogenated flame retardant
UL Yellow Card	Approval requirement for the North American market with global importance
SMERC	Specific, Measurable, Enforceable, Relevant and compatible with Competition