



Circular economy and plastics strategy : PVC recycling and new formulations 31/05/2018

Quality and safety of recycled PVC containing legacy additives

Geoffroy Tillieux

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LEGACY ADDITIVES MANAGEMENT

an ongoing approach to ensure quality and safety

Legacy additives management : an ongoing approach to ensure quality and safety (1)

- With the introduction of the REACH regulation 1907/2006/EC more attention was put on proving the safety of the use of chemicals substances included in recycle application
- European Plastics Converters (EuPC) and Plastics Recyclers Europe (PRE) with the support of VinylPlus early on devised a system to ensure the safety of recycled materials

Legacy additives management : an ongoing approach to ensure quality and safety (2)

- **Step 1 : Contribute to the elaboration of the guidance on waste and recovered substance by animating the platform of recovery industries : initial version September 2008, latest version May 2010 :**
https://echa.europa.eu/documents/10162/23036412/waste_recovered_en.pdf/657a2803-710c-472b-8922-f5c94642f836
- **Main elements**
 - Handling of waste is outside the scope of product regulations (out of REACH)
 - A recycler placing a pellet on the market and having reached the end of waste is a manufacturer under REACH
 - Exemption to register (REACH 2.7.d)
 - Obligation to keep Safety Data Sheet (SDS) of virgin substances (for PVC monomers SDS and dangerous additives)
 - Obligation to provide Safety Data Sheet of recyclate to customers
 - A recycler manufacturing an article directly from waste is not a manufacturer but well converter and should therefore inform customer on the presence of substances of very high concern in the article he sells

Legacy additives management : developing safety data sheets for recyclers



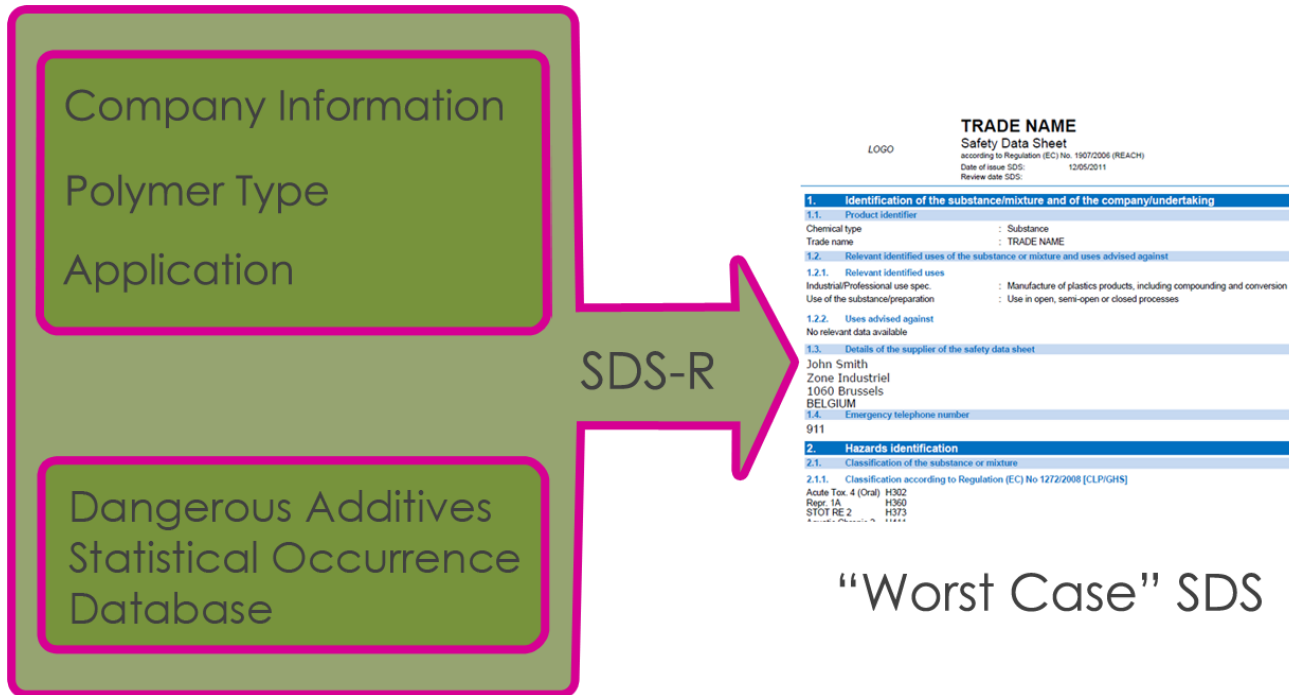
- Recyclers have little to no information on composition source material, yet need to supply an SDS
- To solve the problem experts from PRE, EuPC, PlasticsEurope, and VinylPlus worked together to develop a solution.

What SDS-R Tool does for recyclers





- **Safety Data Sheet for Recyclers Tool: SDS-R Tool**

1. SDS based on “worst case scenario” based on historical additivation rate
2. Refinement possible if more information on the source is known
3. Tailor made SDS

SDS-R: “worst case scenario”



SDS-R: Refinements

Rigid PVC	Window Profiles only	Start from worse case A, B, and C present				
			A absent B present C present			
				A absent B absent C present		
				A absent B present C absent		
					A absent B absent C absent	

SDS-R: Tailor-Made SDS

- **A tailor made SDS for more complex situations**
 - Less hazardous than highest refinement
 - When a atypical hazardous additive is discovered not covered by “worst case”
 - Optional customization
 - Specific application

Safety through knowledge on legacy additives

Item	Cd compounds	Pb stabilizers	Sn	DEHP	Sb2O3	TiO2
Classification	Carc 1b; Repr 1b Very toxic to aquatic life	Repr. 1a Very toxic to aquatic life Non threshold effect on children IQ?	DBT : very toxic to aquatic life DOTE : under discussion to reclassify from repr 1b to 2	Repr 1b « New » Endocrine disrupter for human and env	Carc 2. under CORAP eval	Not classified, under discussion (Carc 2 by inhalation? Via lung overload)
Concentration of legacy additives today	Worst case formulation , then measurements (2017) , in waste could be slightly above 1000ppm, but usually below (depends on recycler monitoring)	Up to 2%	Only traces of DBT	Cable waste : typical 3 to 5%, up to 7% Flooring : up to 10%	2 to 8% in some cable grades. Actual level in waste to be ascertained	Typically up to 5% in white products. Up to 20% as filler

Safety through knowledge on legacy additives



Item	Cd compounds	Pb stabilizers	Sn	DEHP	Sb2O3	TiO2
Volumes of recyclate on the market	<p>Waste projections : EuPC model forecast model (since 2000), regularly updated + controlled loop committee</p> <p>Recycled waste : 640 kT registered in Recovinyl and VinylPlus system, complemented by market surveys (Conversio)</p> <p>Application : Recovinyl (2015); a new study shall be launched Q2 2018</p>					
Workers safety	Airborne Dust measurements (2008)	Airborne dust (VRAR 2008) measurements Biomonitoring (Cats 2016)	Total dust measurement	Air measurement Biomonitoring (PCE 2016-2017)	Under development , participation in I2A airmonitoring/biomonitoring programme	Characterization of dustiness of mixture/recyclates containing TiO2 (EuPC and PRE) Survey on dustiness levels and RMM at plastics converters

Safety through knowledge on legacy additives

Item	Cd compounds	Pb stabilizers	Sn	DEHP	Sb2O3	TiO2
Emission potential	Fabes 2016	Fabes 2016	Fabes 2016	Fabes 2016		
Modelling release to skin and risk assessment		FABES+Arche 2017				
Modelling leaching outdoor and risk assessment		FABES+ Arche 2016; update for single layer pipe in 2017		Arche 2017		
Modelling leaching during waste storage and risk assessment		FABES+ Arche 2016		FABES+ Arche 2018		

Safety through knowledge on legacy additives

Item	Cd compounds	Pb stabilizers	Sn	DEHP	Sb2O3	TiO2
Man via the environment, effect on IQ		Arche 2017				
Cost benefit analysis restriction		RDC 2017 (including effect on IQ)		VinylPlus, EuPC, PRE (2015, 2016, 2017)		
Cost benefit analysis, impact of SEAC draft opinion+ technology screening soft PVC multilayers?		RDC 2018				

LEGACY ADDITIVES REGULATORY FRAME

Regulatory frame : current

Obligation	Cd	Pb	Sn	DEHP	ATO	TIO2
Provide a safety data sheet	Yes	Yes	Yes	Yes	Yes	No
Respect EU and National OEL	Yes (National)	Yes Binding OEL+ National limits	Yes for DBT (National)	Yes (National)	Yes (National)	Yes National , incl. Limits related to dust control
Restriction	100ppm, derogation in certain rigid PVC application at 1000ppm (under review)	Restricted in articles that may be put in the mouth, ROHS, ELV, toys Upcoming. Derogation for recycle. 2% for specified rigid application; 1% for specified soft PVC applications See infra	DBT restricted DOT restricted specific applications such as flooring, wallpaper, childcare article, female hygiene product	Restricted in toys and food contact. Upcoming restriction :- indoor article except industry, agriculture, horticulture... - (prolonged) skin contact	No	No
Authorization	No	No	No	Yes	No	No

LEGACY ADDITIVES : CASE STUDY PB RESTRICTION

- **2000, PVC industry commits to phase out virgin Pb stabilizers by end 2015**
- **Completed end 2015**
- **2015 : EC asks Echa to work on a restriction :**
 - Confirm industry voluntary initiative
 - Concern that increase in PVC articles imports could contain Pb
 - Pb lately considered by EFSA and Echa as a non threshold substance for which exposure should be minimized (increase of blood pressure could lead to loss of IQ points in children)

- **Call for evidence by Echa in December 2015**
- **VinylPlus provided info on :**
 - Confirmation of virgin stabilizer use phase out at EU converters
 - Applications for recyclates are provided
 - Information in socio-economic impact of restriction (preliminary screening by Tauw 2013)
 - Information on workers biomonitoring
 - Information on information on leaching potential

Remarks on the public consultation in the restriction process

- Whilst Vinyl had generated a lot of data, the questions by Echa required further studies to answer
- This takes time
- Echa comities tend to ignore information provided towards the end of the consultation periods, which is unfortunate, because at the same time they require substantiated and thorough answers, which cannot be done overnight.

Echa restriction

- **Annex XV dossier published in December 2016**
- **Proposal to restrict Pb in PVC with exemption for selected rigid application (copy paste of cadmium derogation) up to 1% for 15 years**
- **ECHA confirms that recycling is an appropriate risk management measure for rigid PVC**
 - When taking all end-of-life management options into account, ECHA report⁽¹⁾ confirms that the large majority of lead is released through the incineration of PVC (as bottom ash and APC residues/sludge ⁽²⁾ : 90% of emissions) and NOT through recycling of PVC articles containing lead stabilizers
 - Due to the very low migration of lead from PVC matrixes, recycling can be considered as a risk management measure in itself, protecting the environment
 - Furthermore, the Waste Framework Directive clearly prioritizes recycling over incineration and landfilling in the waste hierarchy
 - ➔ **Therefore, restricting PVC recycling would lead to an increase of lead release by using other end-of-life options**
- **Remark VinylPlus : the Pb emission avoided from import is very low 7 T/year compared with the 27000 T Pb released in the environment annually**

- Annex XV dossier published in December 2016
- Proposal to restrict Pb in PVC with exemption for selected rigid application (copy paste of cadmium derogation) up to 1% for 15 years
- VinylPlus provided the following information in June 2017 :

Market data : restriction would result in ban of 172,5 kT of products mainly soft PVC

1% limit impractical, would severely limit the use of rigid PVC where typical concentration is 2%

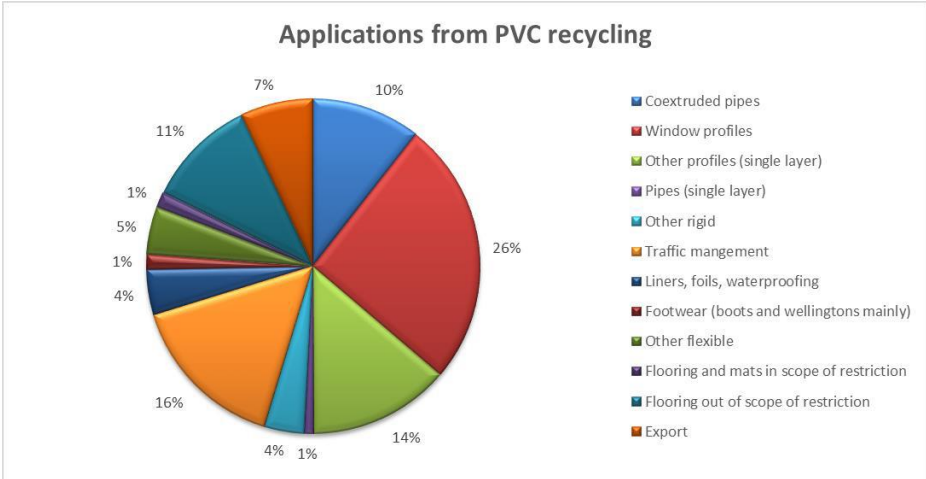


Table 1: % of Pb metal weight/weight in post-consumer PVC waste

Application	Extrapolated average concentration	Typical maximum reported (1)	Calculated worst case (based on past formulations)
Window	<2%	2%	<2.8%
Other profiles	<2% (2)	1-2% (2)	<2.8%
Pipes	0.75%	1%	<1,6%
Cable	<1%(3)	<1%(3)	<2.9%
Flooring	<0,1%?(4)	<0.1%?(4)	<0.8%
Roofing	<1%	1.2%	<2.5%
Other flexible	<1%	<1%	<1.2%

VinylPlus risk assessment on recycle uses (Arche 2016)

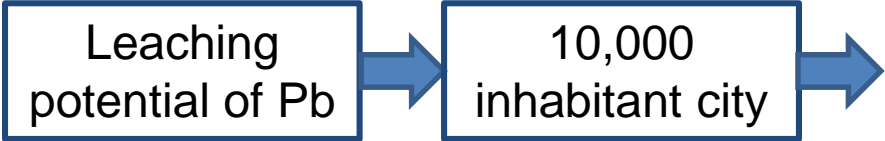


Table 3: Exposure concentrations for Pb through dermal or oral contact of PVC articles containing 2% lead.

Use	Total surface exposed to water in a standard town (m ²)	Leaching rate (mg Pb/m ² /y)	Pb leached (g Pb/y)
Pipes and fittings	9,500	0	0
Window frames	12,195	0	0
Roller shutters	14,400	1.812	26.09
Roof tiles	4,000	55	220
Road furniture	550	55	30.27
Total			276.36



Table 5: Overview PEC, PNEC and RCR values for lead in the different environmental compartments (STP, water, sediment and soil). Data from <http://echa.europa.eu/registration-dossier/-/registered-dossier/16063>.

Environmental compartment	Unit	PEC	PNEC	RCR
Water	µg Pb/L	0.61	3.1 (1.2) ^a	0.20 (0.51) ^a
Sewage Treatment Plant (STP)	µg Pb/L	0.061	100	0.0006
Sediment	mg Pb/kg dw	83.63	174	0.48
Soil (direct toxicity)	mg Pb/kg dw	28.32	212 (170) ^b	0.13 (0.17) ^b
Soil (secondary poisoning)	mg Pb/kg dw	28.32	109 (54) ^b	0.26 (0.52) ^b

Dermal assessment



New information provided in September 2018

After clarification of scope, current restriction would mean the ban of 150 kT of applications



Assessment of population exposure and potential IQ impact through exposure to Pb (Man via the environment) (Arche 2017)



Assessment of population exposure and potential IQ impact through exposure to Pb (Arche 2017)



Cost efficiency of restriction (RDC 2017)



Cost benefit analysis of restriction (RDC 2017)

RDC 2017: cost (in)efficiency of restriction (per kg Pb emission avoided)

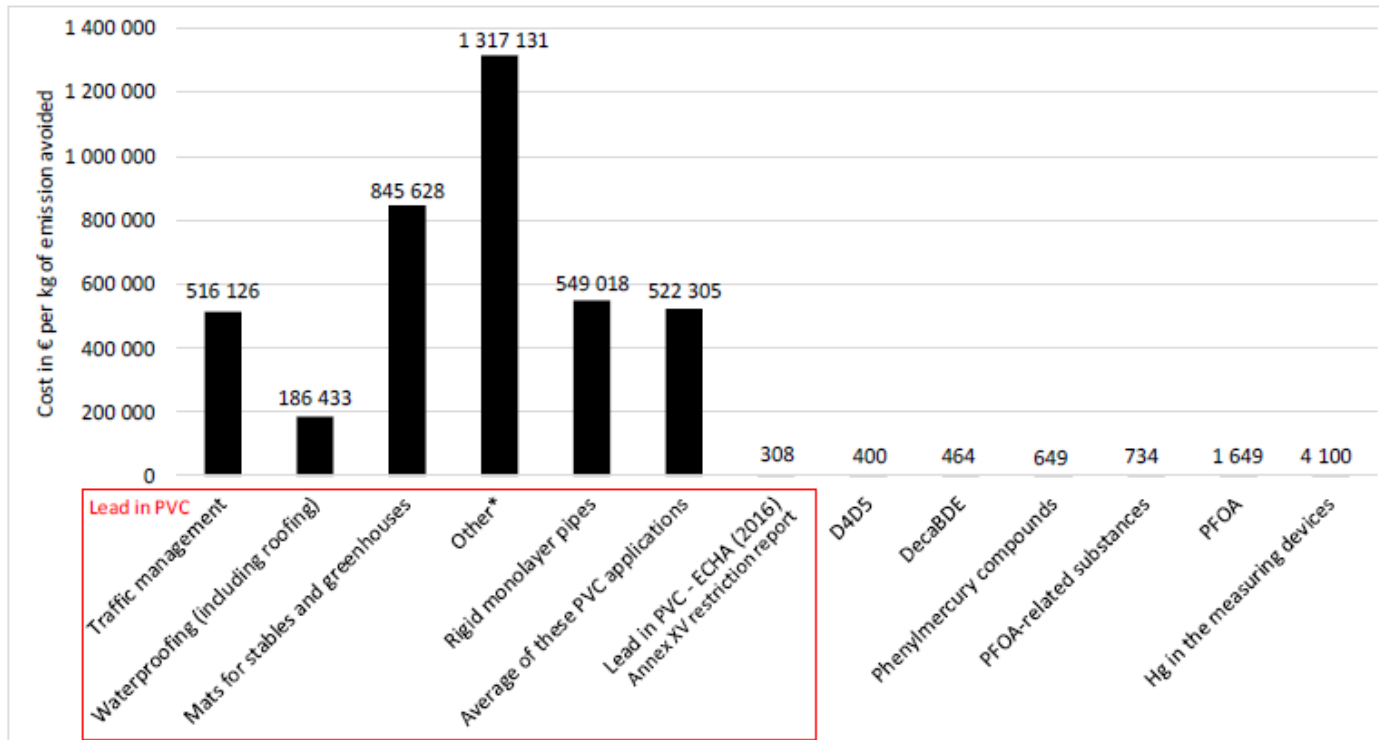


Figure 2: Cost-effectiveness of lead restriction in PVC applications compared to previous restrictions (linear scale)

N.B.: "Other" includes 3-layer hoses, noise insulations sheets, footwear and boots for professionals (without skin contact)

RDC 2017: cost benefit analysis

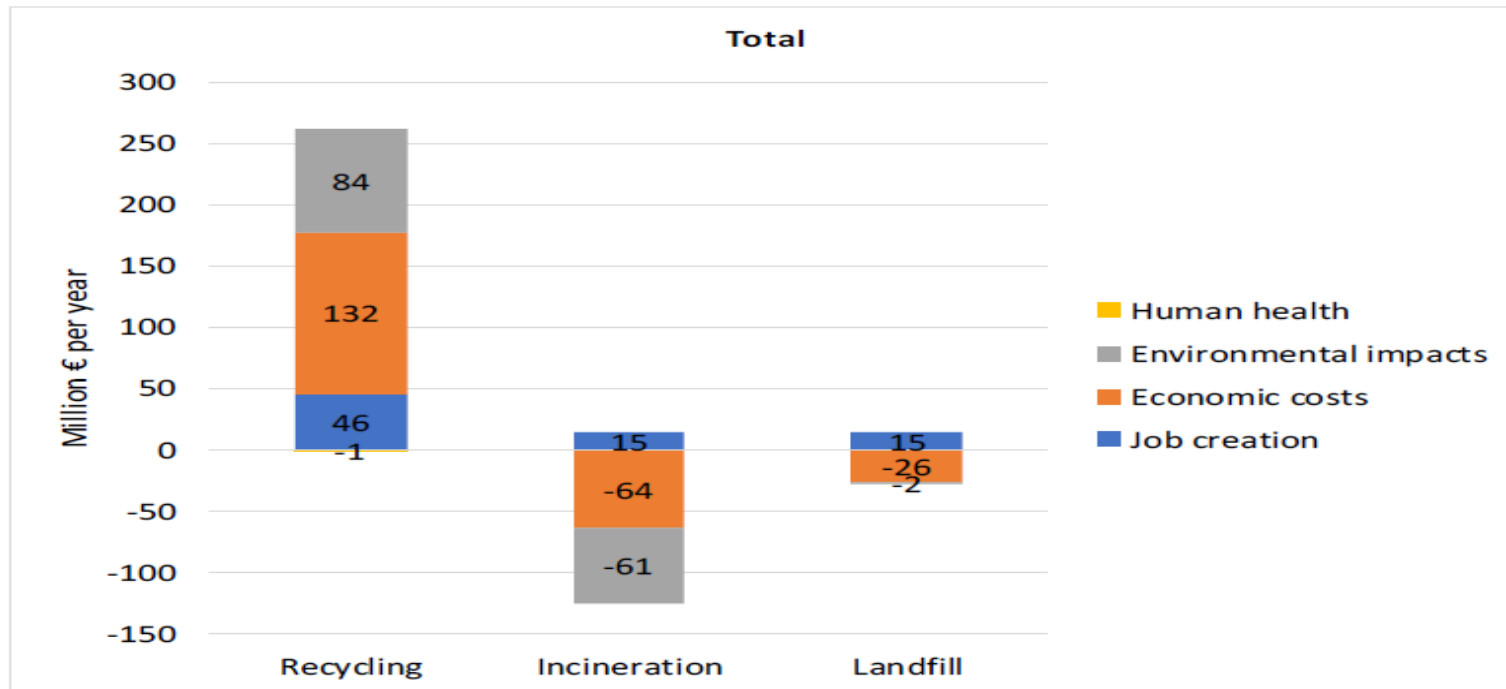


Figure 4: Detailed Cost/benefit results of the treatment routes for the aggregate of the considered PVC applications

Using PVC recyclates is better for society than incinerating or landfilling PVC waste. The societal benefit of recycling is:

- 371 million € per year compared to incineration
- 274 million € per year compared to landfilling

Lead Restriction : RAC opinion in December-Draft SEAC opinion

In Rigid PVC 2% is allowed in:

- profiles and sheets for exterior applications in buildings and non-buildings. (or example, gutters, fascias, shutters, blinds and wall cladding);
- decks and terraces provided the the recycled PVC is used in the middle layer and is entirely covered with a layer of virgin PVC;
- profiles and sheets for use in concealed spaces or voids in buildings and non-buildings (where they are inaccessible during normal use, excluding maintenance, for example, cable ducts);
- profiles and sheets for interior building applications provided the entire surface of the profile or sheet facing the occupied areas of a building after installation are produced using virgin PVC (for example, doors and windows fabricated from coextruded PVC profiles or sheets);
- multi-layer pipes if the recycled PVC is used in the middle layer and is entirely covered with a layer of virgin PVC (excluding pipes for drinking water); and
- fittings, excluding fittings for pipes for drinking water (for example joints, elbows, flanges for pipes, furniture, coachwork, etc).

Lead Restriction

In Soft PVC 1% is allowed in:

- mats for stables and greenhouses;
- multi-layer hoses;
- noise insulation sheets;
- the following applications provided the recycled PVC is entirely enclosed with a layer of virgin PVC: roofing and waterproofing, road furniture, traffic management systems and professional footwear.

Input into the SEAC public consultation

- **60 days including Christmas break to comment**
- **Updated socio-economic assessment to encompass emission during whole lifetime of product**
 - **SEAC proposal equates to banning 127 KT PVC recycling (soft PVC mainly)**
 - The societal benefit of recycling ranges between 241 million € per year (1 788 €/t) and 328 million € per year (2 437 €/t) depending on which disposal route is considered for this particular analysis.
 - 1000 jobs at stake
- **Technology and economic feasibility of soft PVC encapsulation**
 - Whilst technically feasible for sheets (multilayers) the cost would be prohibitive except for the higher value products
 - Most of the remaining products (traffic management, roofing tiles, boots for professionals) are made by compression or injection moulding; the technical feasibility to encapsulate the recyclate within layers of virgin PVC is unknown, and most probably prohibitively expensive. **The technology is not readily available and hence would entail development costs.**
 - To enlarge technical feasibility encapsulation with virgin PVC **should instead allow the use of adequate cover layer.**

SEAC opinion

- Confirms RAC opinion.
- Notes in p. 38 that whilst potentially technically feasible, the encapsulation technology is yet to be developed and more time is needed
- SEAC could however not conclude on the needed time period (hence to be fixed by Commission)

■ Timeline

- Echa opinion published on 8 May and transmitted to EC
- **Conditions for use of recyclate in soft PVC applications to be clarified (transition period, cover layers, assessing the need for derogation)**
- Q 3 2018 Vote in the REACH Committee
- Q3 2020 Entry into application (2 year transition period)

CASE STUDY TIO2

The issue

- **TIO₂ proposed for classification as carcinogen 1b by FR**
- **Mechanism lung overload**
- **Not specific to TIO₂ but actually to most dusty materials (poor soluble low toxicity substances)**
- **In September, RAC proposed classification as carcinogen 2 (suspected carcinogen)**
 - Mode of action : lung overload
 - Based on one single study and read-across to workers in coal mines
- **Industry question the proportionality and adequation of this risk management option**
 - TIO₂ in dust form is only an issue of workers safety, not consumer
 - If concern for TIO₂ at workers, the most proportionate route is the adoption of an occupational exposure limit
 - Classification is unspecific, does not lead to increased workers protection, creates fears of consumer and pressure for substitution and has undesirable consequences such as the classification as hazardous of several waste stream containing TIO₂ (e.g. in construction)
 - A recent study by EuPC, EuMBC, Plastics Europe and PRE shows that TIO₂ is firmly bound in the polymer matrix of pellets, which mostly have very low dustiness (or in one case of medium dustiness (a micronized PVC) , the particles are not respirable)