1st Questionnaire Exemption No. 39a (renewal request)

Exemption for „Cadmium selenide in downshifting cadmium-based semiconductor nanocrystal quantum dots for use in display lighting applications (< 0,2 µg Cd per mm² of display screen area) “

Abbreviations and Definitions

Cd	Cadmium
QD	Quantum dots
Najing	Najing Technology Co. Ltd

Background

The Oeko-Institut and Fraunhofer IZM have been appointed within a framework contract[1] for the evaluation of applications for the renewal of exemptions currently listed in Annexes III of the new RoHS Directive 2011/65/EU (RoHS 2) by the European Commission.[1]

Najing Technology Co. Ltd (Najing) has submitted a request for the renewal of the above mentioned exemption, which has been subject to a first evaluation. The following formulation has been requested for renewal (amending the specified Cd threshold) for a period of two years:

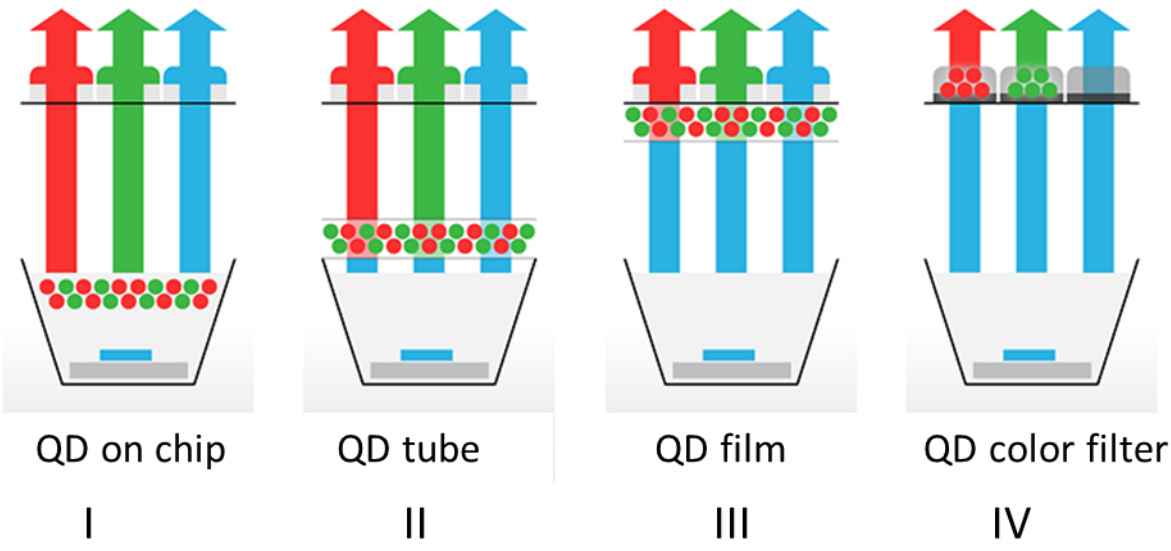
“Cadmium selenide in downshifting cadmium-based semiconductor nanocrystal quantum dots for use in display lighting applications (<0.1 µg per mm² of display screen area)”

The information you have referred has been reviewed and as a result we have identified that there is some information missing and have formulated a few questions to clarify some aspects concerning your request.

Questions

1. Your request is made to allow the use of cadmium in “Quantum dot light converting film used in display device”. Please confirm if the scope of the exemption can be limited to on surface applications of QD (QD light converting film), or explain why this is not possible.
   Answer: *The scope of the exemption cannot limited to on surface applications, because quantum dot light converting components include on chip type (I), on edge type (II)，on surface type (III&IV). These are widely accepted product formats or promising product formats in the industry.*

[1] The contract is implemented through Framework Contract No. FWC ENV.A.2/FRA/2015/0008 of 27/03/2015, led by Oeko-Institut e.V.



2. You request a renewal of two years in May 2018. Further on (see 7(b)) it is estimated that InP substitutes shall reach parity in 2020 and full commercialisation by 2022. Please clarify if the renewal is requested until May 2020 or until when the renewal is requested.
   Answer: *The renewal requested by us is until October 31, 2021, two years after October 31, 2019.*

3. You state “The high quantum efficiency of the Cd QDs is typically higher than 88%, which is necessary for QD film based backlights to deliver higher power efficiency (12% - 45% more energy efficient than traditional LED LCDs for colour gamut sizes from 70% NTSC to 100% NTSC). However, the quantum efficiency of the Cd-free QDs is lower than 70%”. Please provide examples of applications and their efficiency to clarify the actual efficiency of applications and how they compare (i.e. refer to numerical efficiency in relation to products with identical function and display size and not the ranges reflected by “above 88 %/ lower than 70 %).
   Answer:

   Quantum efficiency (QE) is the ratio of the amount of emitted photons to the amount of absorbed photons. We use the source spectrum and emission spectrum to integrate the amount of photons to get QE.

   QE=（P2-P4）/（P3-P1）

   P1=the number of blue wavelength photons of emission spectrum;
   P2= the number of excepting blue wavelength photons of emission spectrum;
   P3= the number of blue wavelength photons of source spectrum;
   P4= the number of non-blue wavelength photons of source spectrum.

Three different QD films from three TV maker's products on sale were adopted for comparison experiments as below: Najing's QD film of TCL TV (XESS 55" X2)、3M's QD film of Hisense XT910 and Samsung's QD film of Samsung 55KS7300.
The comparative test data with the three QD films using the same test fixture (TCL 55X2) as shown in Table 1, and the comparative test figure is as shown in Fig.1.

Table 1. The comparative test spectrum with the three QD films using the same test fixture (TCL 55X2)

TV product NO.	Hisense XT910	TCL55 X2			Samsung 55KS7300		
QD film's information	3M (CdSe)	Najing (CdSe)			Samsung(Cd-free)		
Test fixture	TCL 55 X2	TCL 55 X2			TCL 55 X2		
Quantum efficiency (QE)	92.81%	89.56%			67.69%		
Relative QE ratio	100%	96.50%			72.93%		
NTSC(1931)		105.48%			89.01%		
DCI-P3		95.59%			91.43%		
		Luminance(nit)	x	y	L(nit)	x	y
White		432	0.2839	0.2966	324	0.2840	0.2964
R		92	0.6871	0.3004	64.97	0.6825	0.3093
G		293.33	0.2156	0.7146	227.55	0.2779	0.6547
B		45.16	0.1535	0.0613	32.7	0.1492	0.0685

The highest quantum efficiency of the CdSe QD is 92.81%, and the quantum efficiency of the Cd-Free QD is 67.69% in the same test fixture. We can conclude that the quantum efficiency of the Cd-free QD are 27.07% lower than the Cd QD in the same test fixture.

It is also apparent that the free-Cd QD's brightness is 25% lower than the CdSe's. The NTSC-1931 color gamut of the fixture *of CdSe QD is 16.47% higher than the Cd-free QD-LCF. The DCI-P3 color gamut of the* fixture *of CdSe QD is 4.16% higher than Cd-free QD-LCF. Based on the above results, CdSe is superior to the Cd-free in brightness and color gamut.*

4. In your answer related to REACH aspects you mention the use of cadmium oxide, classified as a SVHC, as a cadmium precursor. Please explain what is meant by cadmium precursor, how this substance is used and whether it remains in the final application.

Answer: *In chemistry, a precursor is a compound that participates in a chemical reaction that produces another compound. CdO changes to CdSe in quantum dot synthesis reaction, so it will not remain in the final application.*

Please note that answers to these questions are to be published as part of the available information relevant for the stakeholder consultation to be carried out as part of the evaluation of this request. If your answers contain confidential information, please provide a version that can be made public along with a confidential version, in which proprietary information is clearly marked.