

Implications of EU environmental legislation for PV

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Outline

- **Most important EU legislation**
WEEE = Waste electrical and electronic equipment
ROHS = Restriction of the use of certain hazardous substances in electrical and electronic equipment
- **Implications for photovoltaics**
- **Conclusion and recommendations**

WEEE from 13 August 2005

Producers responsible for financing of
take back and recycling of product at end-of-life

Administration

Cost increase

Waste Electrical and Electronic Equipment

1. Large household appliances



2. Small household appliances



3. IT and telecommunication s equipment



4. Consumer equipment



5. Lighting equipment



6. Electrical and electronic tools



7. Toys, leisure and sports equipment



8. Medical devices



9. Monitoring and control instruments



10. Automatic dispensers



ROHS from 1 July 2006

No Cd, Pb, Hg, Cr⁶⁺, polybrominated biphenyls (PBB)
and polybrominated diphenyl ether (PBDE)
in new electronic equipment on EU market

WEEE categories
except medical devices, monitoring/control instruments

ROHS: maximum concentration values

0.1 wt% for Pb, Hg, Cr⁶⁺ and some flame retardants

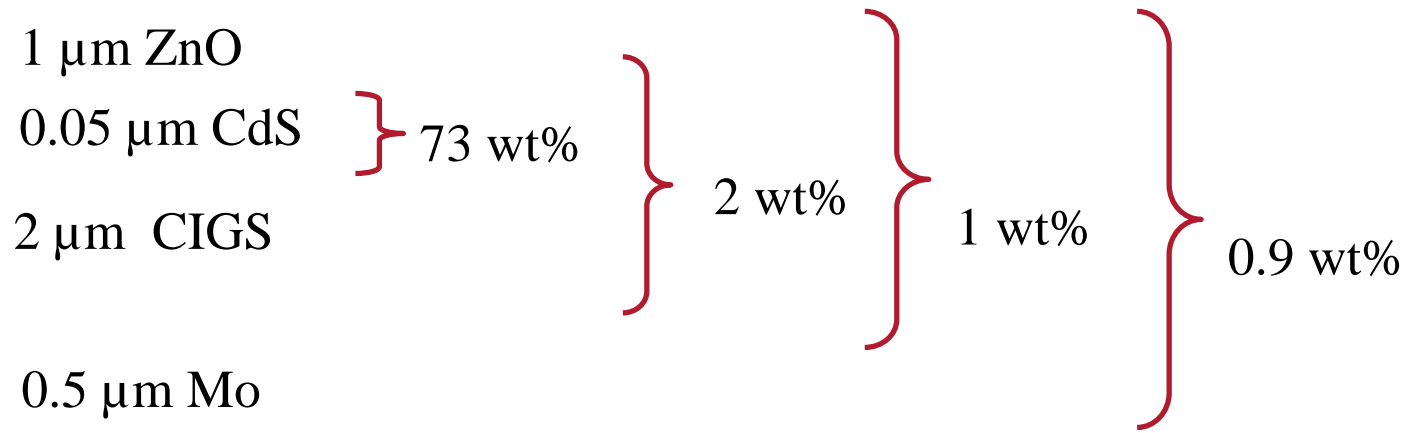
0.01 wt% for Cd

in **homogeneous material** (= material that can not be mechanically disjointed in different materials)

Homogeneous = of uniform composition throughout

Mechanically disjointed: materials can, in principle, be separated by mechanical actions (unscrewing, cutting, crushing, grinding and abrasive processes)

Example of Cd concentration values in CIGS solar cells



> 0.01 wt% cadmium

ROHS exemptions

Possible when alternatives:

- are technically or scientifically impracticable or
- have higher environmental, health and/or consumer safety impacts

Review of each exemption at least every four years

WEEE/ROHS & Photovoltaics

Included: PV consumer products

Excluded: PV modules

Inverters: needs clarification



“ROHS” substances in PV

Lead

- 1-5 wt% Pb in standard glass frit of metallization paste (exemption: lead in glass of electronic components)
- Solder of the tabs: $\text{Sn}_{60}\text{Pb}_{40}$ (alternatives have higher melting temperature)

Cadmium

- CdS and CdTe in CdTe solar cells
- CdS in CIGS solar cells

Flame retardants

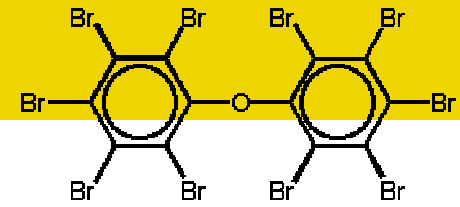
- Plastics of cables, junction box, charge controllers and inverter

Current situation for Cd-containing modules

Cadmium directive

Metallic cadmium not allowed

CdS and CdTe are non-metallic, so allowed



Flame retardants in ROHS

- **PBB** no longer produced since 2000
- **Penta-BDE** and **octa-BDE** banned by August 2004 (another directive).
- **Deca-BDE**: ROHS exemption is not yet decided.

Source: *Bromine Science and Environmental Forum*

PV modules not included in WEEE/ROHS

How to stay out of WEEE/ROHS?

No PV in waste streams!

- Develop take back systems
- Develop recycling technologies
- Develop design-for-recycling technologies

Take back systems (examples)

First Solar

- Take back/recycling of own CdTe modules
- Insurance of take back/recycling

SolarWorld AG

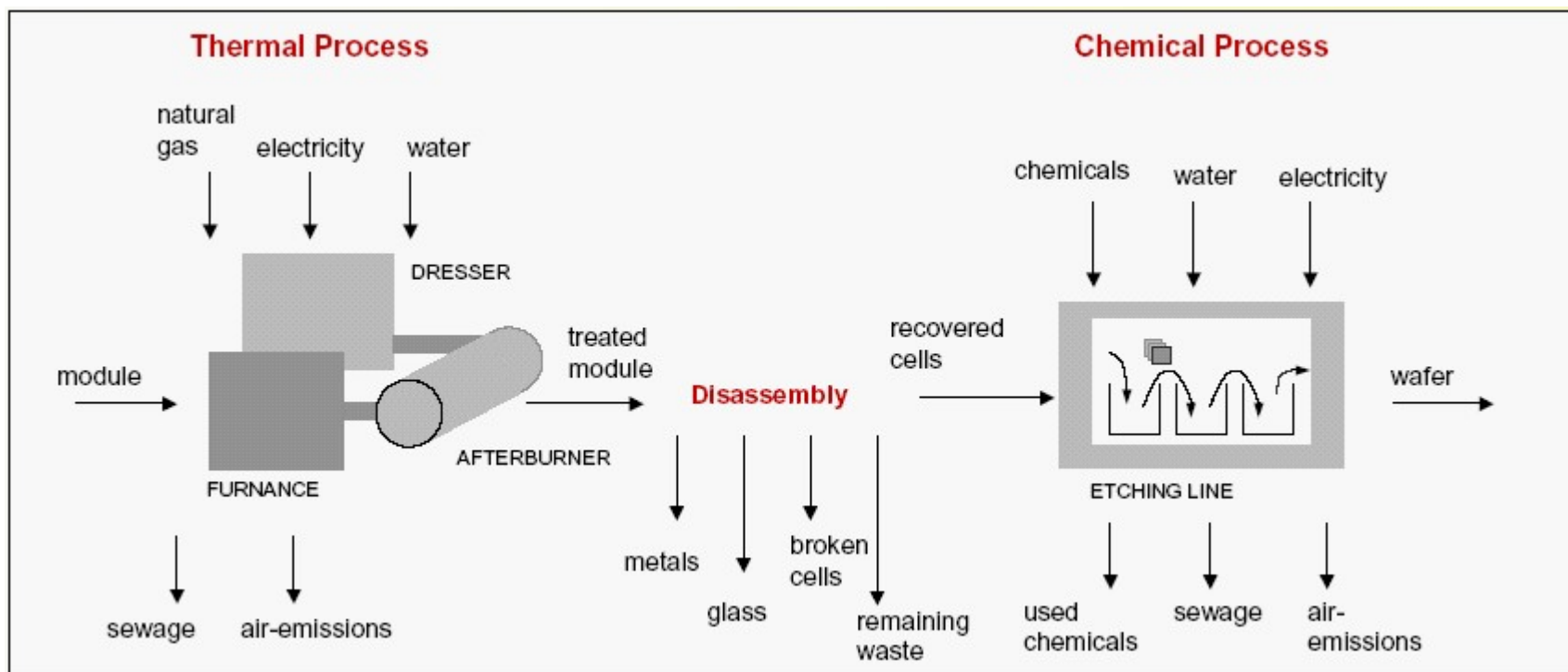
- Take back of own modules for recycling

Deutsche Solar AG

- Voluntary take back system for solar cells and modules

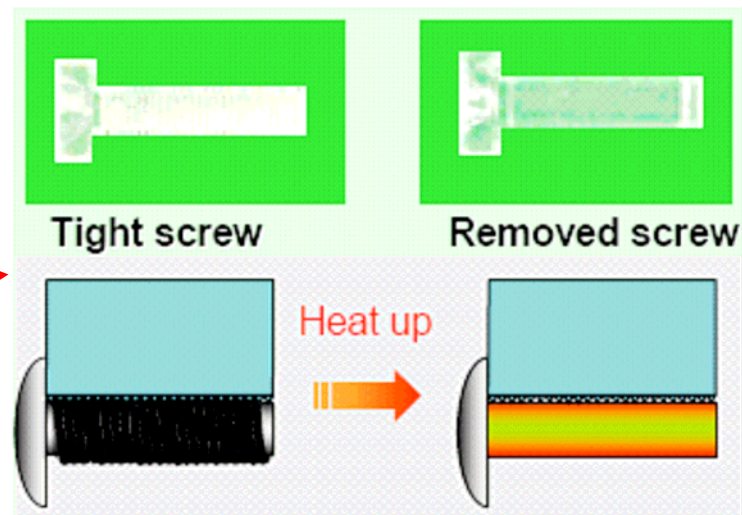
Recycling activities: crystalline silicon cells and modules (example)

- Deutsche Solar AG pilot line



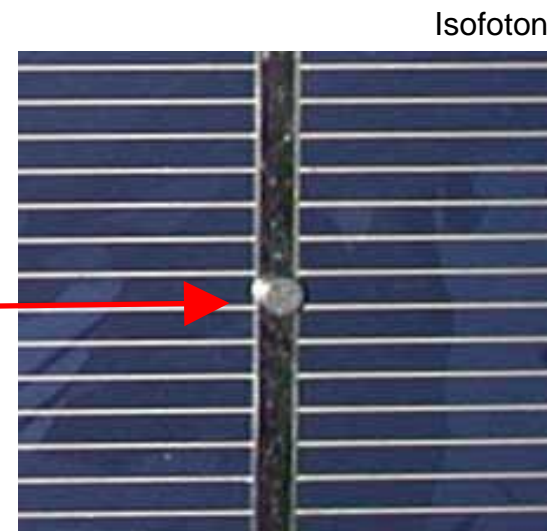
Design-for-recycling (examples)

- **Shape-memory-alloys screws** →
to join frame and laminate



- **Low adherence to cell**
Additional polymer layer /
replacement of EVA

- **Magnets** →
to join tabs with metallization of cell



ECN

Conclusions

	WEEE	ROHS
PV modules	not included	not included
PV in consumer products (watches etc.)	✓	✓
Inverters, charge controllers	?	not included
Lead in glass frit of metallization paste		exempted

✓ Producers financially responsible for collection and treatment.

✓ No Pb, Cd or deca-BDE in PV component.

Recommendations for PV

Close the production cycle

Save valuable materials

- develop voluntary take back systems
- develop design-for-recycling technologies
- develop recycling technologies
- develop alternatives to ROHS substances

Improve the environmental profile of PV.

Don't forget life cycle thinking!

Thank you for your attention

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Paper is available from <http://www.ecn.nl/> or m.dewild@ecn.nl

