

# Stabilisation of Polymer Matrix Polypropylene in LFT & New Developments



**Deloitte.** 2005  
**Technology Fast 50**  
Nederland

**Deloitte.** 2005  
**Technology Fast 500**  
EMEA



[www.addcomp.nl](http://www.addcomp.nl)

# The degradation of Polymers | 1-3

**Inert polymer = technically impossible**

**Impurities, catalytical residues, structural defects.... Cannot be excluded**

**Oxidation is favoured by:**

**Energy (e.g. mechanical stress, heat, light)**

**Metals / metal ions (catalytical residue, impurities, co-additives)**

# The degradation of Polymers | 2-3

**Several oxidation products:**

**Peroxides, peracids, alcohols, ketones, aldehydes, acids, ..**

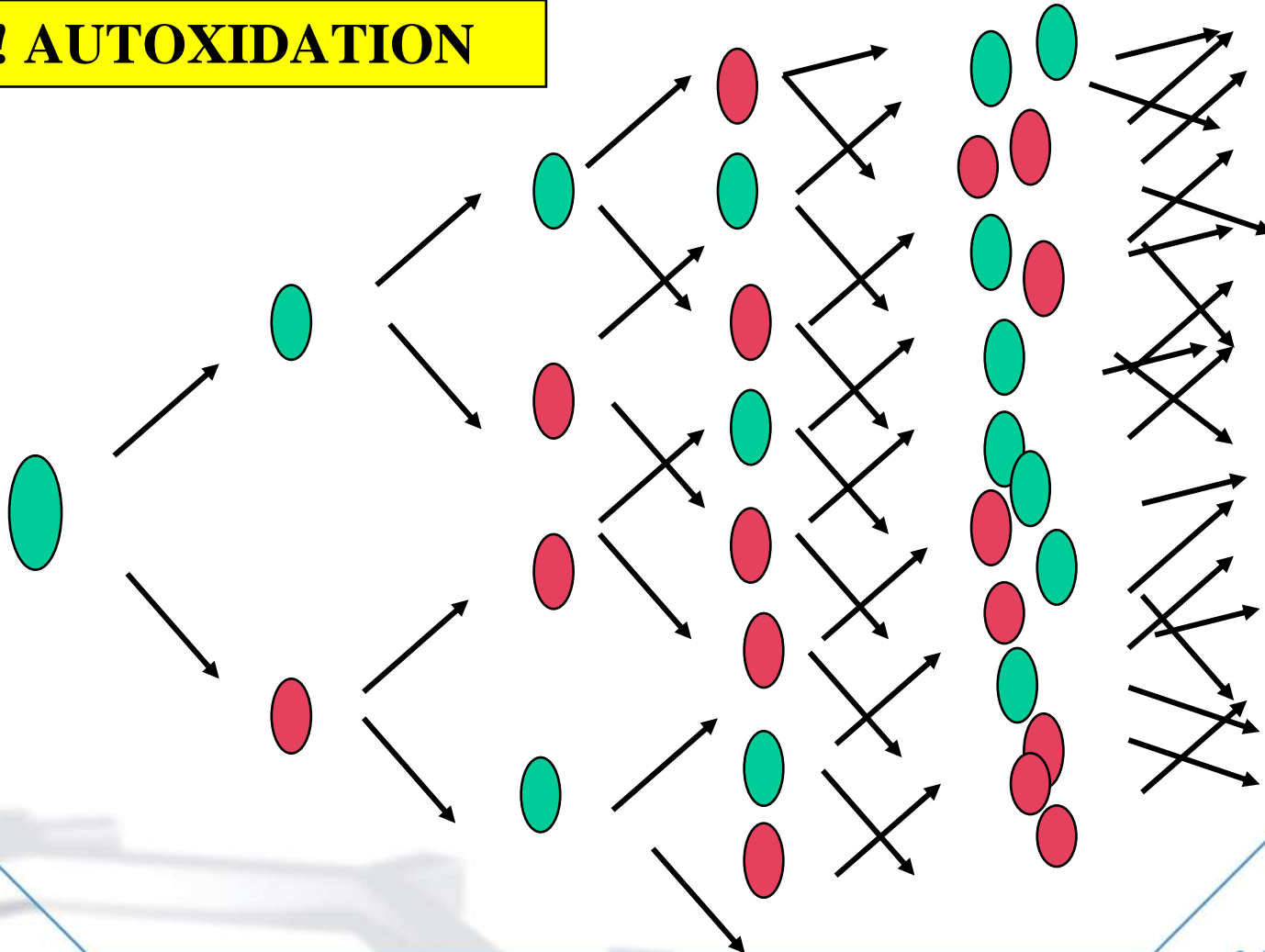
**Oxidation is an autocatalytical process.**



**!! AUTOXIDATION**

# The degradation of Polymers | 3-3

## !! AUTOXIDATION



# Autoxidation can not be avoided

## !! AUTOXIDATION

### When?

During polymerisation process

During compounding, extrusion and storage

During injection moulding, spinning, calendering, thermoforming

During low-end performance (non-durable goods)

During mid-range performance (use-it for a while)

During high end performance (durable goods)

In the dark, under light, in the cold and in the warm...

### "Always"

**... always!**

# Aging

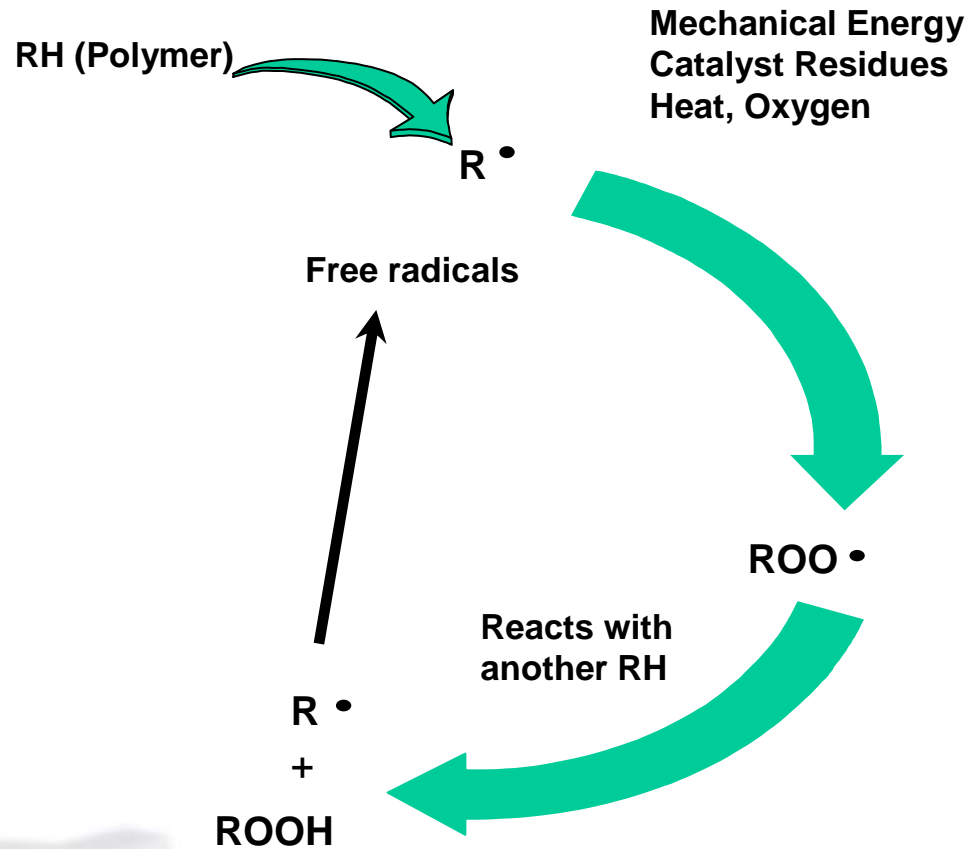
## Aging phenomena caused by processes other than oxidation:

- **Crystallisation (below melting point)**
- **Relaxation processes (around glass transition point)**
- **Degradation by chain scission through hydrolysis (polyesters, PA, PUR)**
- **Sensitivity to oxidation affected by:**
  - **Fillers**
  - **Pigments**
  - **Reinforcing materials**
  - **Other additives**

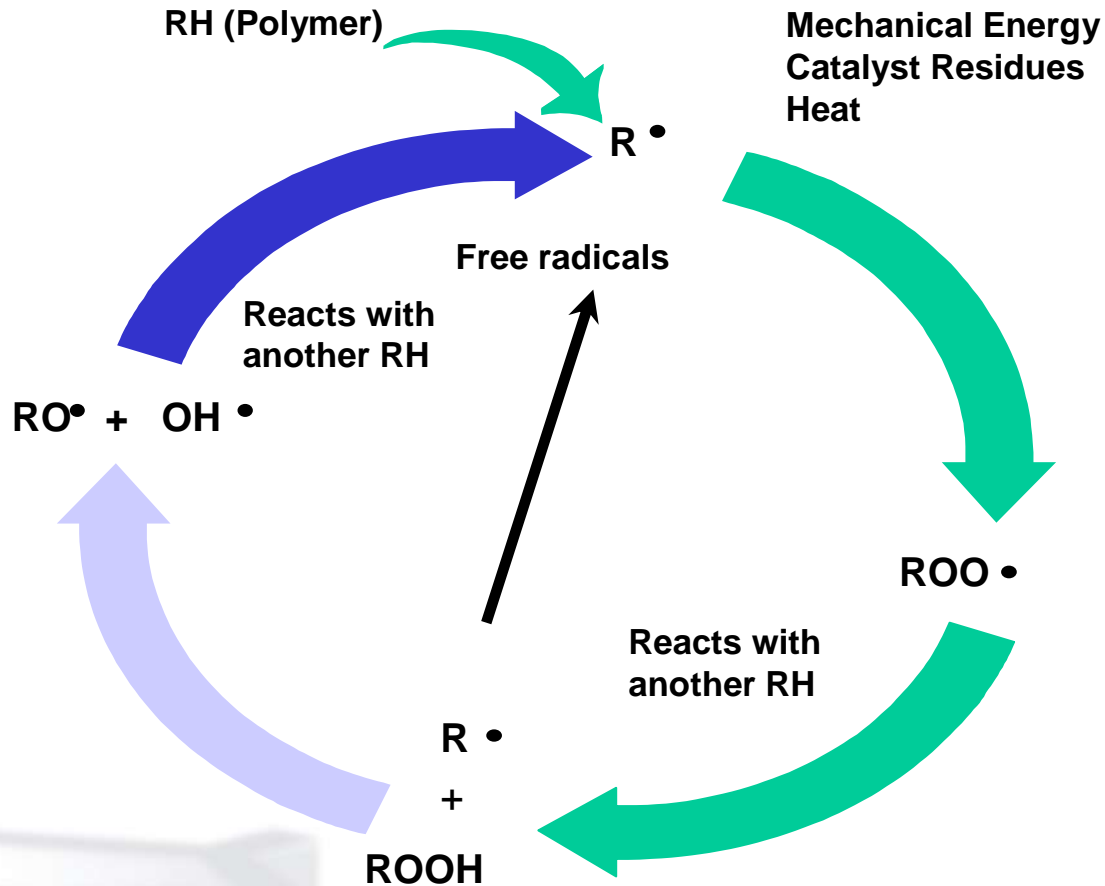
## Aging phenomena caused by oxidation:

- **Free radical initiated reaction**
  - **Chain initiation**
  - **Chain propagation**
  - **Chain termination**

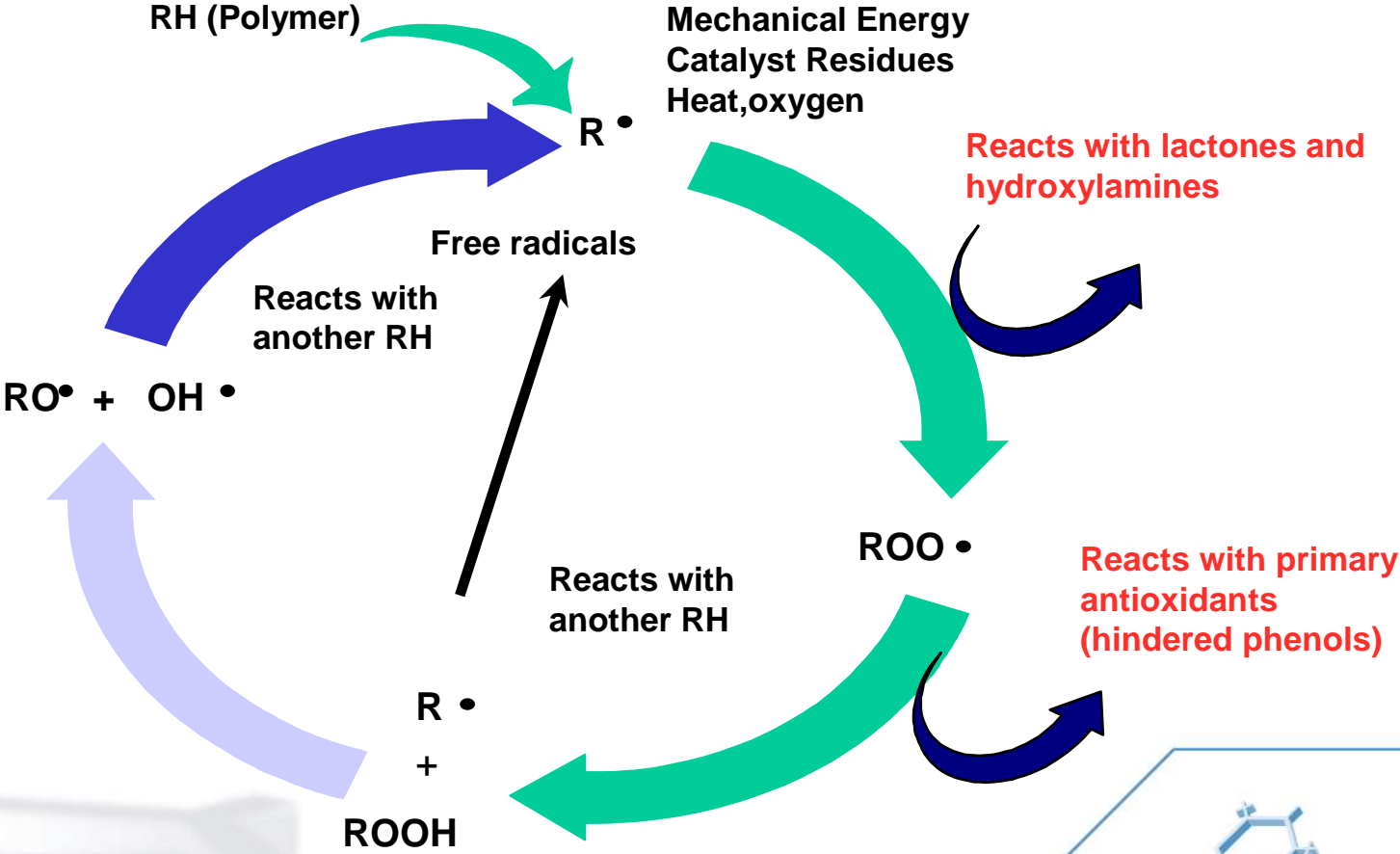
# Polymer Degradation Cycle



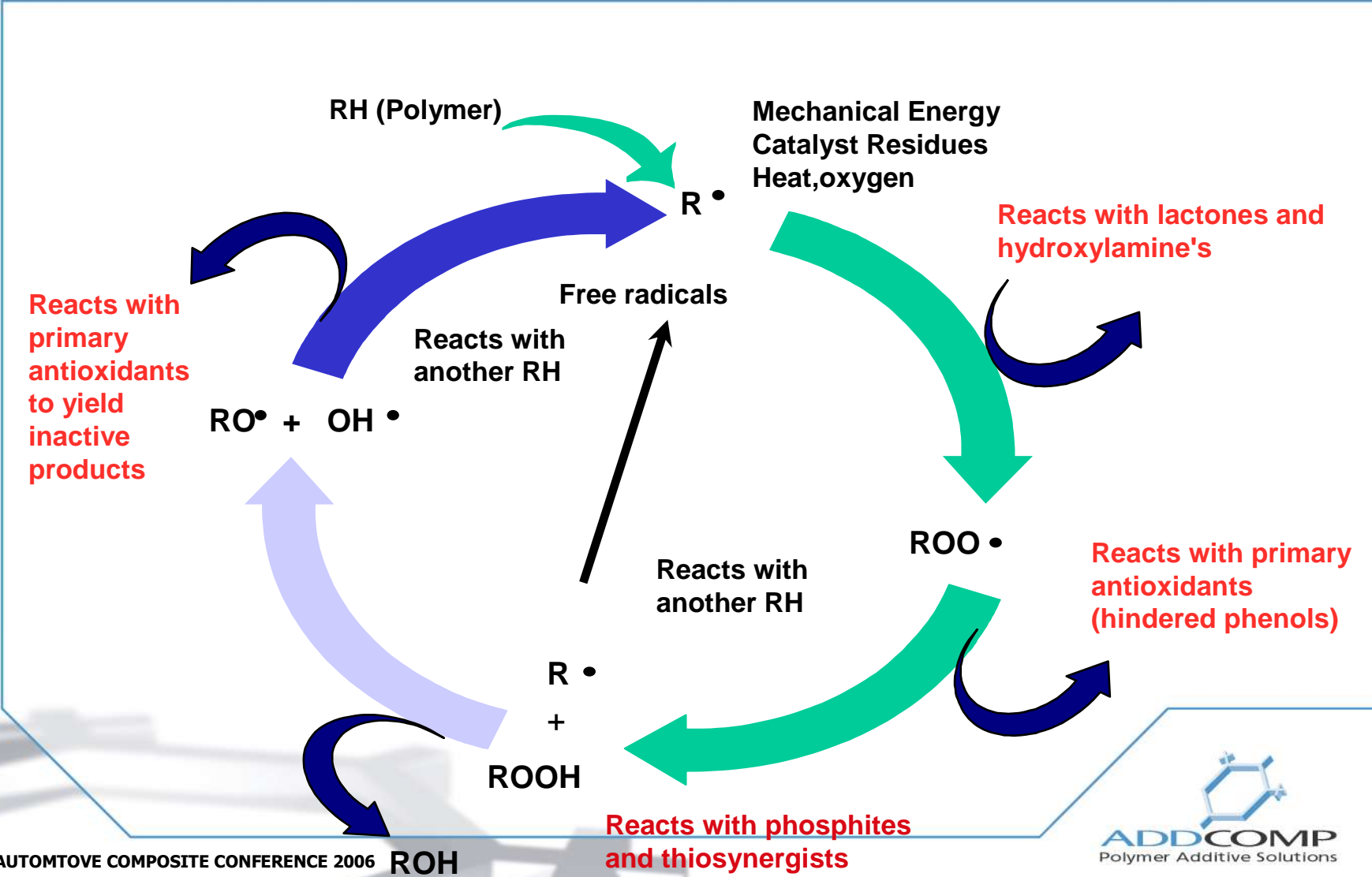
# Polymer Degradation Cycle



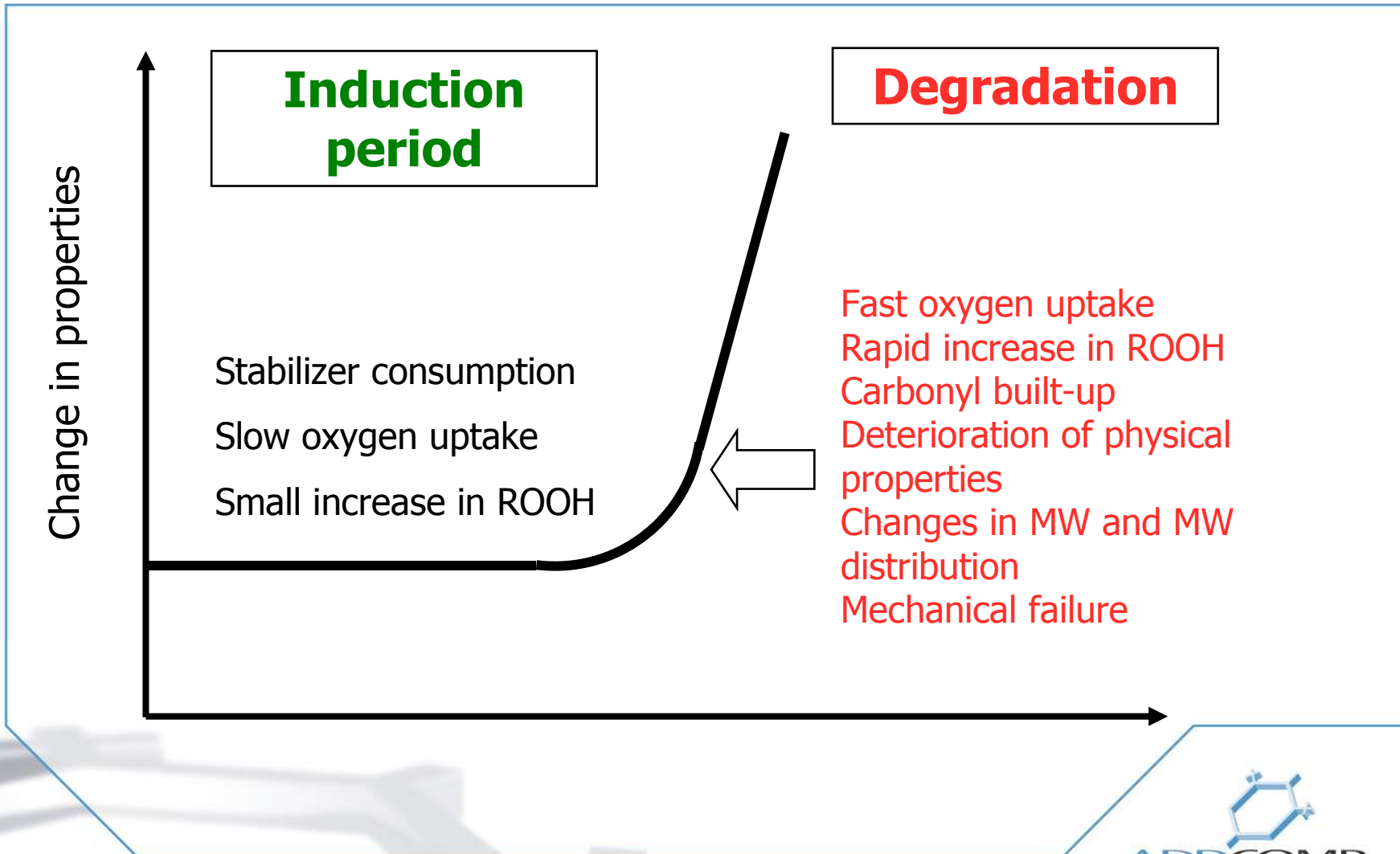
# Polymer Degradation Cycle



# Polymer Degradation Cycle



# Changes in material during aging



# Degradation of polymers

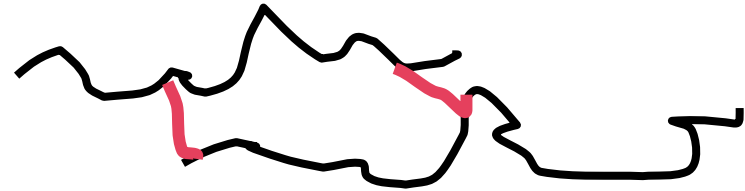
**DEGRADATION**



**MOLECULAR CHANGE**



**CROSS-LINKING**



**CHAIN-SCISSION**



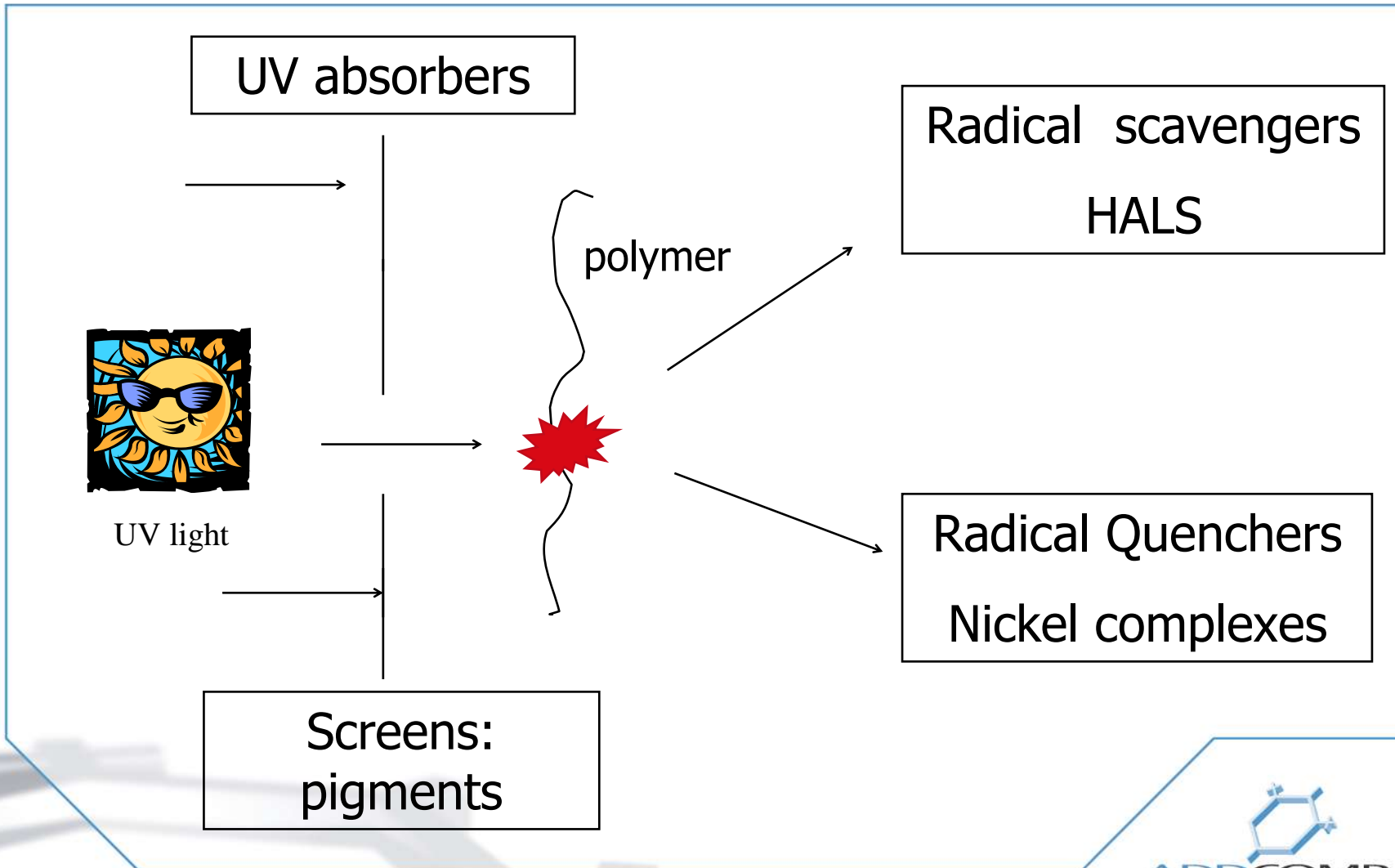
**ADD COMP**  
Polymer Additive Solutions

# Stabilisation Mechanisms

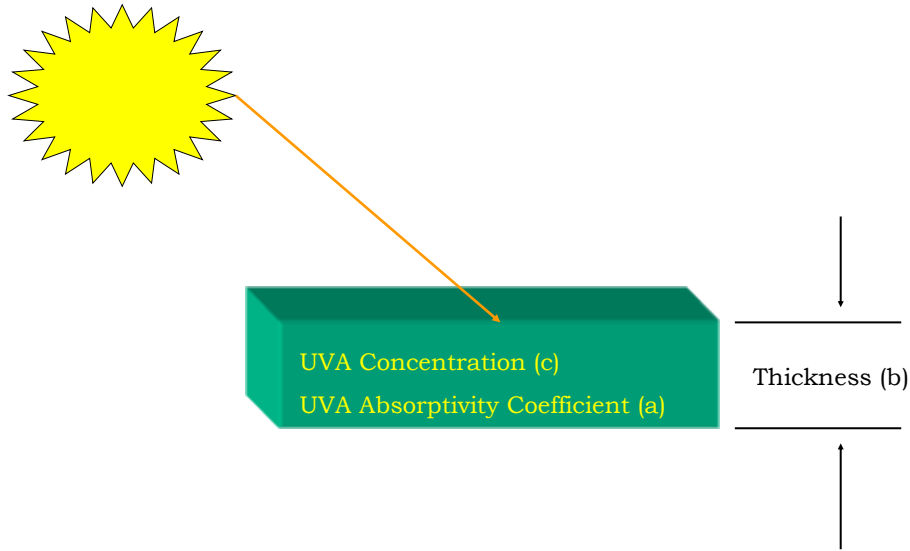
Inhibition of the initiaton step of the degradation

Inhibition of the propagation step of the degradation

# UV-induced degradation



# Absorption of UV light

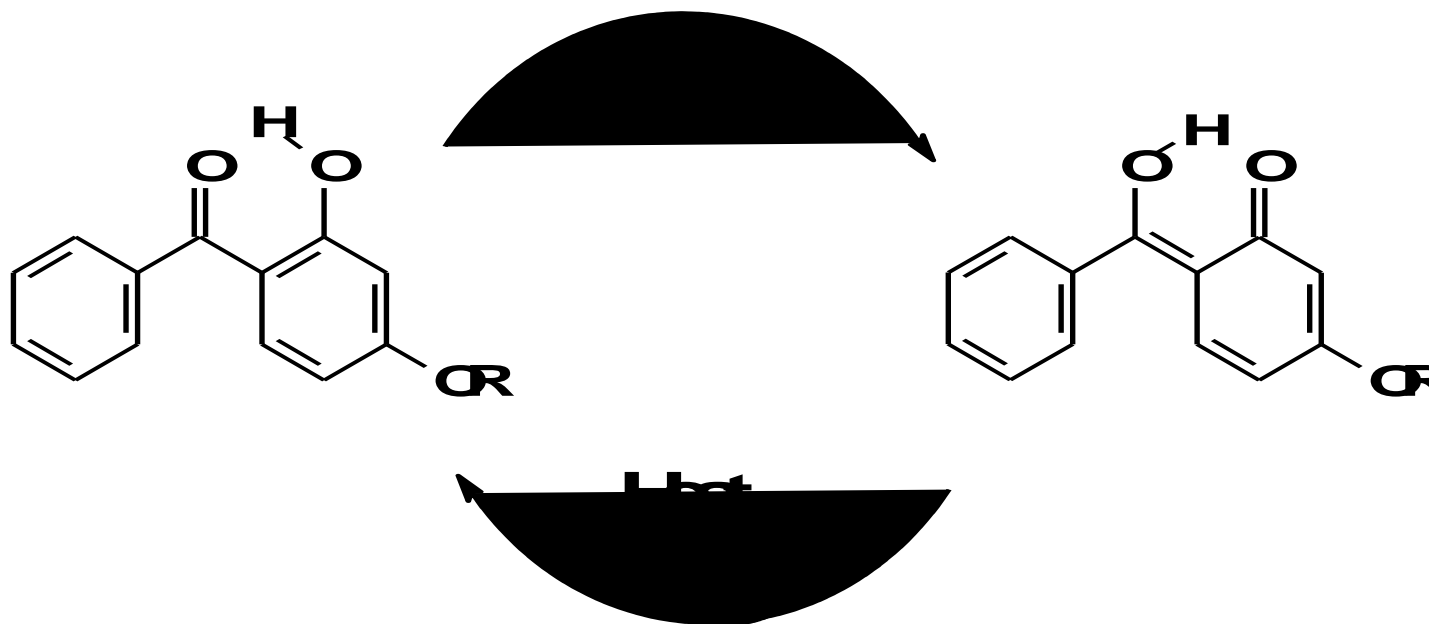


Beer-Lambert Law:

Ultraviolet Light Absorption (A) = **UVA Absorptivity Coefficient (a)** x **Thickness (b)** x **UVA Concentration (c)**

**UV-absorbers are effective in thick articles**

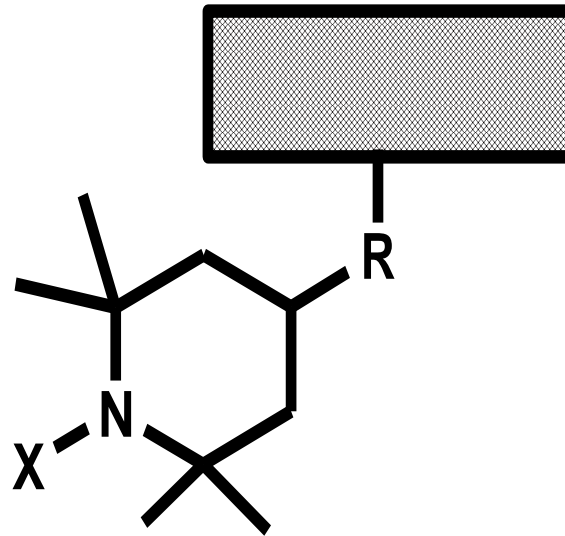
# UV absorbers



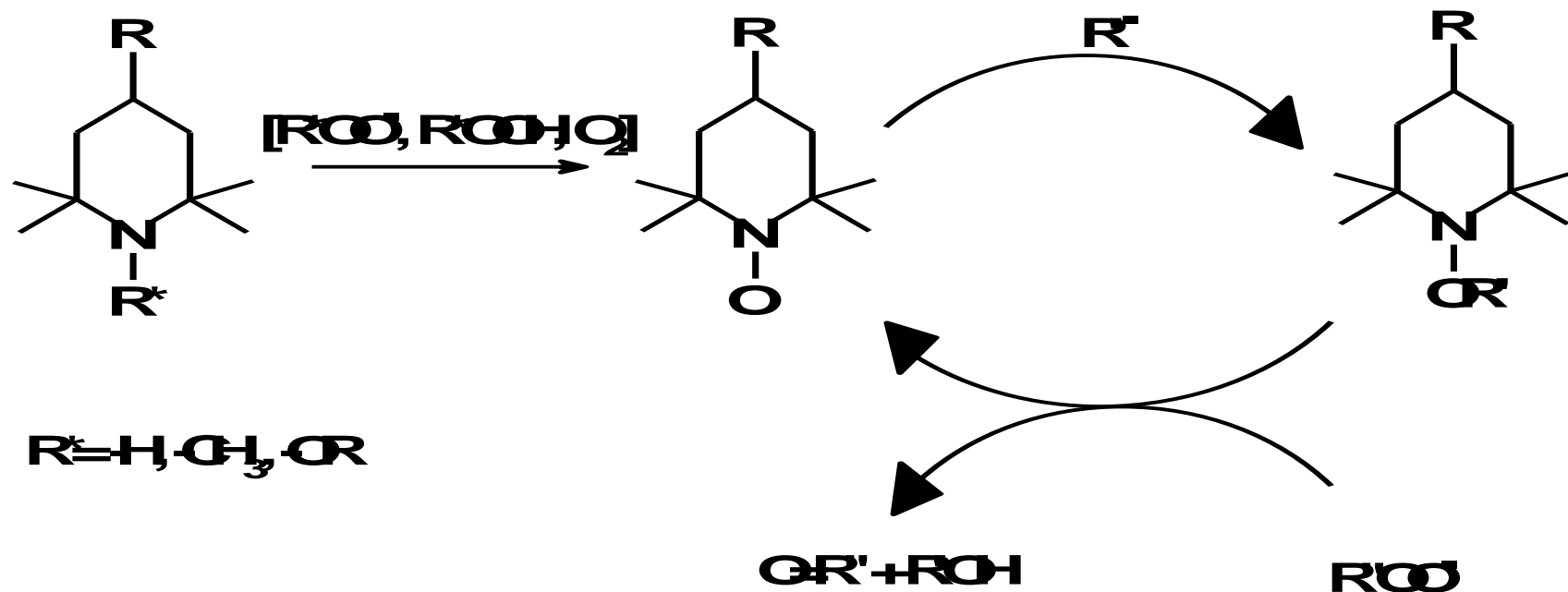
**Absorb UV radiation and dissipate it by (harmless) heat**

# HALS Molecular structure

All Commercial HALS Contain The Same Active Moiety:



# UV stabilisation of HALS



**Thick/thin articles (also in combination with UV absorbers)**

# G-LFT & D-LFT (PP) industry trends

- Ongoing high growth rates: new applications to obtain more function integration as well as replacement of GMT
- EU: Ongoing cost pressures forced upon G-LFT and D-LFT suppliers, industry is restructuring for lower cost. (also use of recycled Polypropylene etc.)
- Many opportunity for innovations as new properties are required: low smell, low VOC and low emissions, and also exterior applications are now being developed.
  - UV performance
  - Special colours
  - FR performance

# LFT stabilization systems: required properties (1)

- Achieve automotive industry standards for Long Term Heat Ageing (LTHA) requirements = guaranteed service life,
- Excellent mechanical properties and retention after LTHA.
- Black, tailor made black or colour
- Reliable processing and consistent product properties
- ISO/TS 16949 : 2002 certified production
- Excellent cost / performance

# LFT stabilization systems: required properties (2)

- Low smell for interior parts such as instrument panel carriers, door modules, etc.
- Low VOC and emissions in general
- Option: increased UV resistance (service life) for exterior parts
- Sufficient chemical stability for recycling LFT after its service life.

# Lower VOC & Emissions: results

- D-LFT underbody panel application (Carb test):
  - Emission reduced from 4  $\mu\text{g} / \text{m}^2$  to  $<1 \mu\text{g} / \text{m}^2$
- Coupling agent measurements:

	Coupling agent <b>A</b>	Coupling agent <b>B</b>	Coupling agent <b>C</b>	Coupling agent <b>D</b> (Ref)
	% emissions	% emissions	% emissions	% emissions
VOC (VDA 278 PBWL 709 – DC)	9%	10%	70%	100%
FOG 120°C	40%	10%	45%	100%

# LFT combi-masterbatches, product examples

- Black or colour and stabilization
- Black, stabilization, and coupling agent
- Black, stabilization, coupling agent, and nucleation
- Black, stabilization, coupling agent and enhance UV protection.
- Black, stabilization, coupling agent and flame retardant (halogen free, UL 94 V0)
- Any tailor made solution

# LFT waste and recycling

- Zero LFT waste streams are possible,
- Current additive systems allow to re-process LFT waste for without loss of quality in the final product.
- Having fulfilled their service life in the car, LFT parts will provide a valuable source of raw material for re-use in new automotive LFT applications
- Recycle PP can be used in automotive LFT application when the right stabilization system is being used.