

JUNE 13, 2012

# CARE OF PLASTICS

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Media

bek & frohnert<sup>LLC</sup>

# Webinar Plan

- PLASTICS DEFINED



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# Webinar Plan

- PLASTICS DEFINED
- HOW WE IDENTIFY AND CHARACTERIZE THEM



# Webinar Plan

- PLASTICS DEFINED
- HOW WE IDENTIFY AND CHARACTERIZE THEM
- SIGNS OF DETERIORATION



# Webinar Plan

- PLASTICS DEFINED
- HOW WE IDENTIFY AND CHARACTERIZE THEM
- SIGNS OF DETERIORATION
- CAUSES OF DETERIORATION



# Webinar Plan

- PLASTICS DEFINED
- HOW WE IDENTIFY AND CHARACTERIZE THEM
- SIGNS OF DETERIORATION
- CAUSES OF DETERIORATION
- RECOMMENDATIONS

...for Monitoring, Storage, Exhibit, Cleaning,  
Repair, Etc.



# Plastics Defined

## Polymer composites

Polymer(s) + Plasticizers  
Colorants  
Opacifiers  
Fillers or bulking agents  
Fire retardants  
UV stabilizers  
Working property modifiers  
Performance modifiers



# Plastics Defined

- Common name for polymer composite materials
- Fundamental component is a polymer - long chain molecule, usually with carbon backbone.
- Material properties of polymer depend on the atoms present and their arrangement.
- Polymers often not useful on their own.
- Smaller molecules added to change properties of final “plastic” material.





# Plastics Defined

## Polyethylene

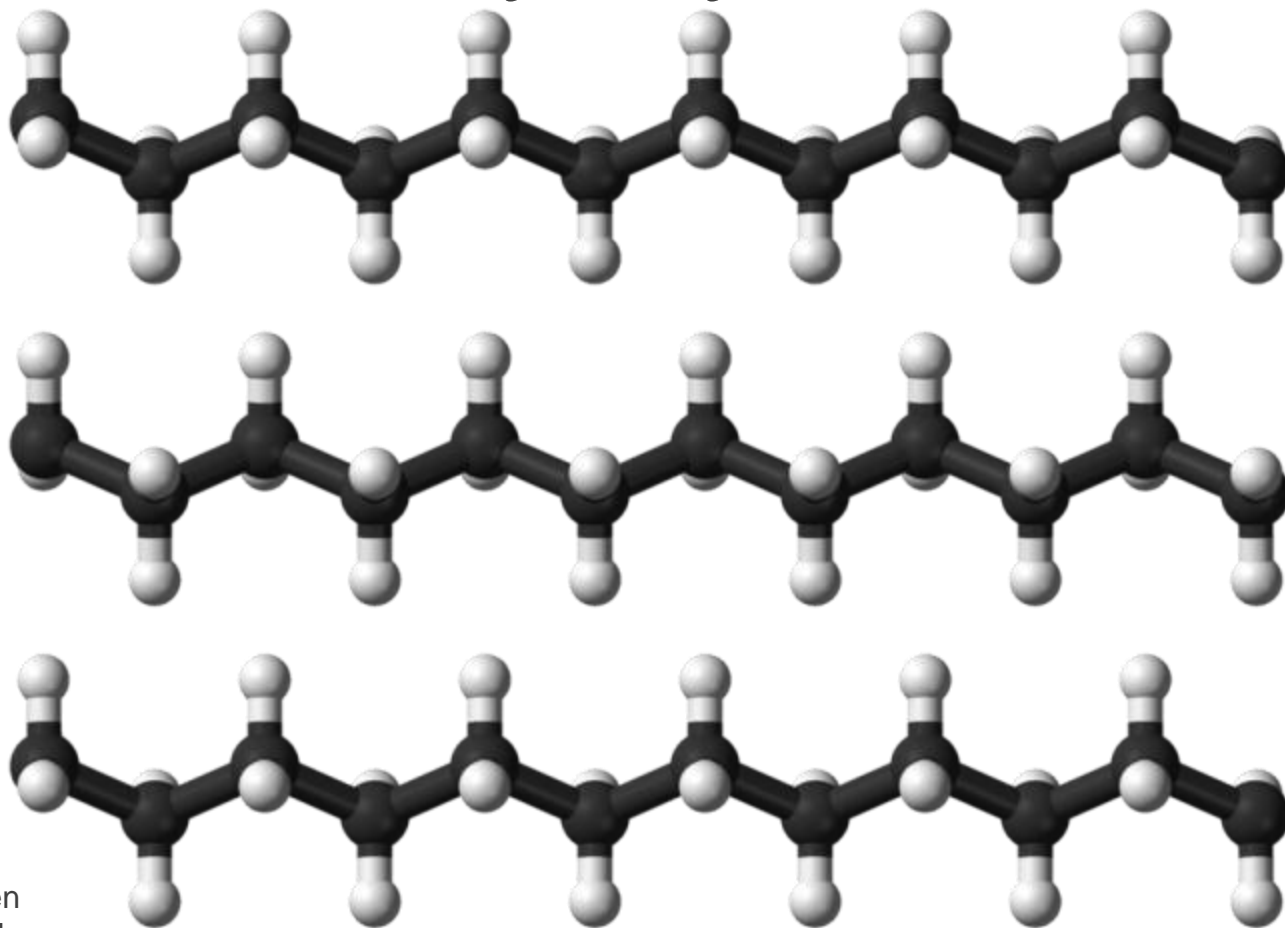


Image Credit: Ben  
Mills



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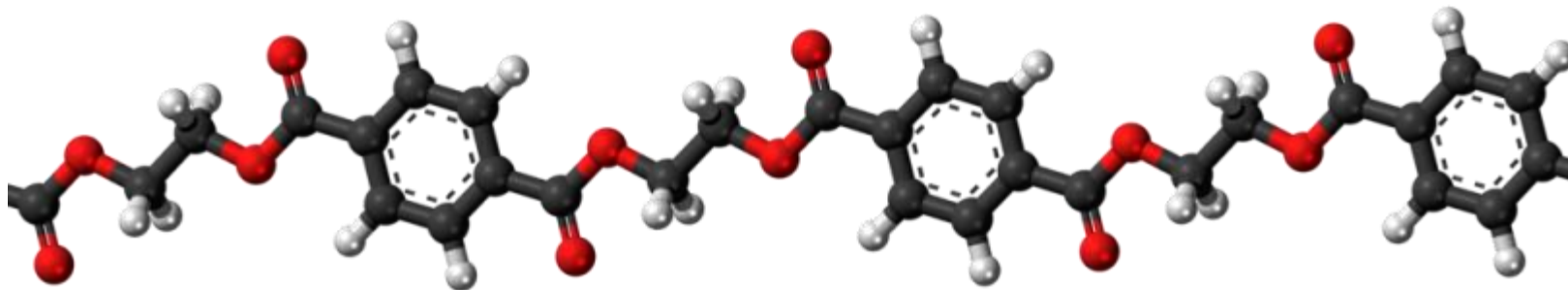
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# Plastics Defined

## Polyethylene terephthalate (PET)



## Cellulose

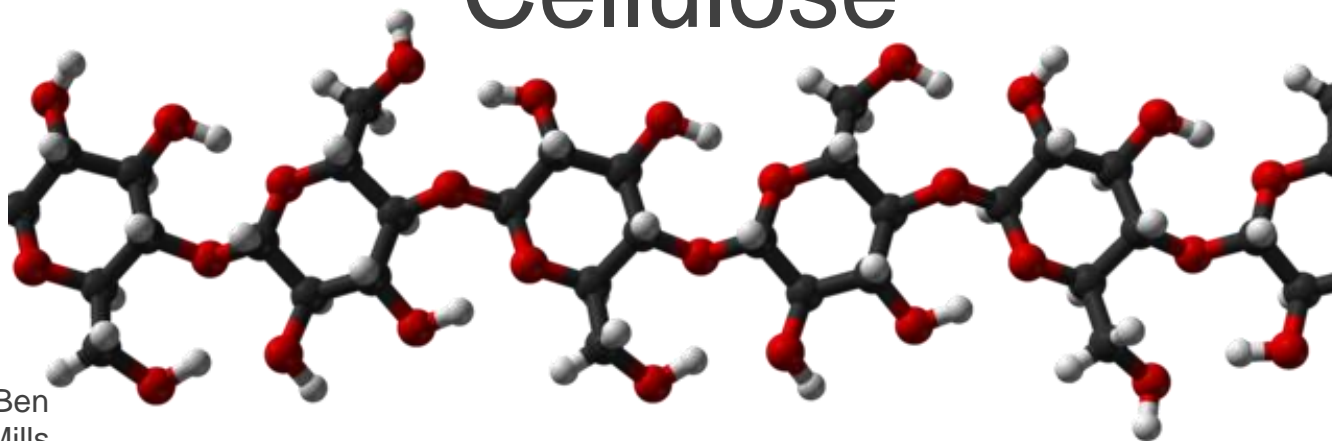


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# Identification and Characterization

- Scientific analytical instrumentation
  - Non-destructive/non-sampling: Raman, FTIR, XRF spectroscopies
  - Requires sample be removed: GC-MS



# Identification and Characterization

- Scientific analytical instrumentation
  - Non-destructive/non-sampling: Raman, FTIR, XRF spectroscopies
  - Requires sample be removed: GC-MS
- Visual cues
  - Resin codes on underside
  - Look
- Smell (of artifact or by melt/burn tests)
- Density
- Solubility



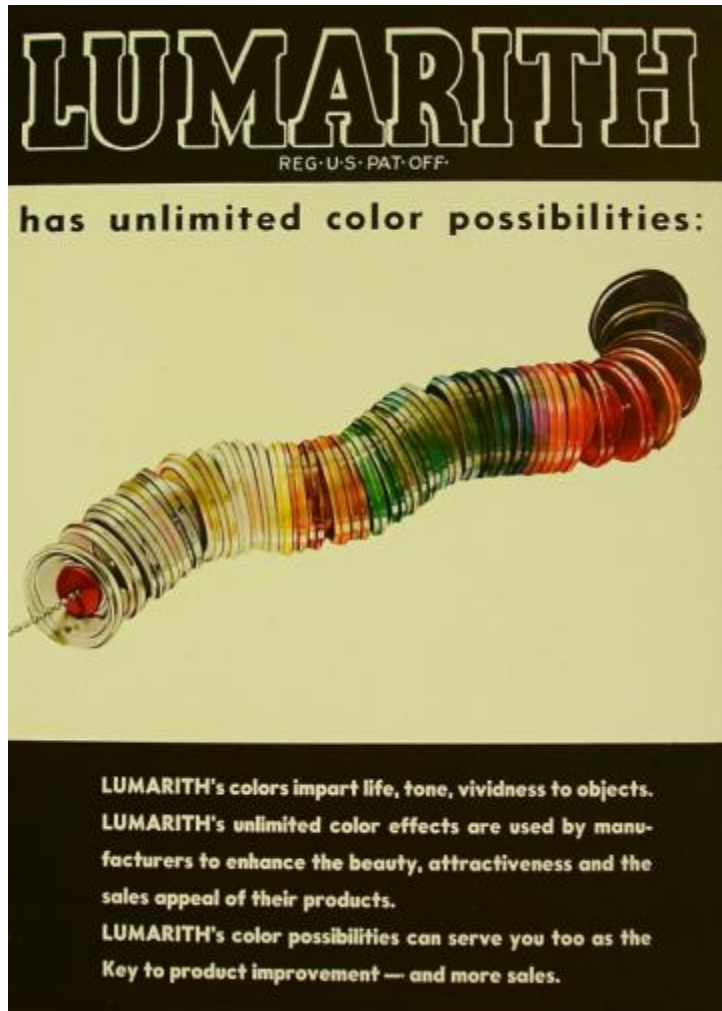
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# Plastics Defined



Salesman's kit of "Lumarith" brand cellulose acetate coupons (National Museum of American History)

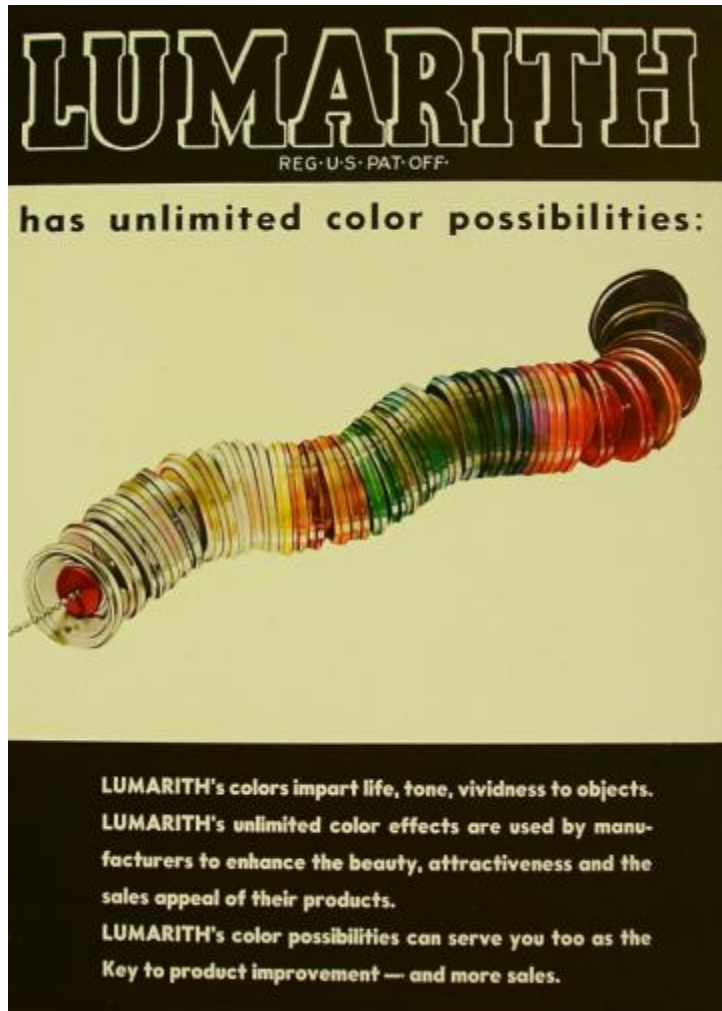


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# Plastics Defined



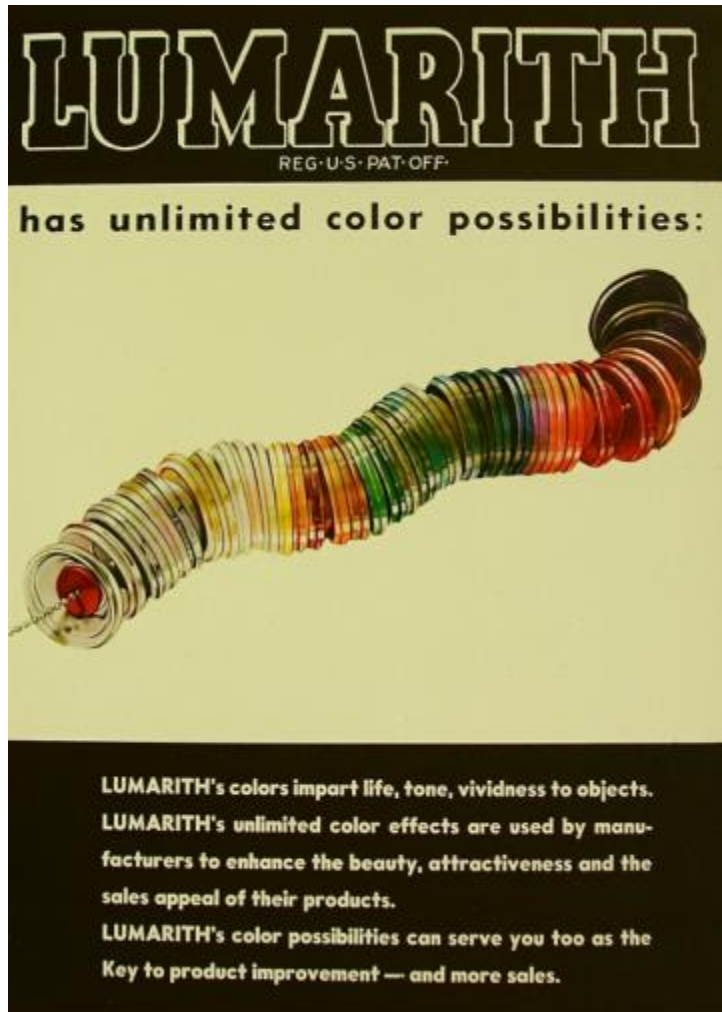
Salesman's kit of "Lumarith" brand cellulose acetate coupons (National Museum of American History)



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# Plastics Defined



← Colorants

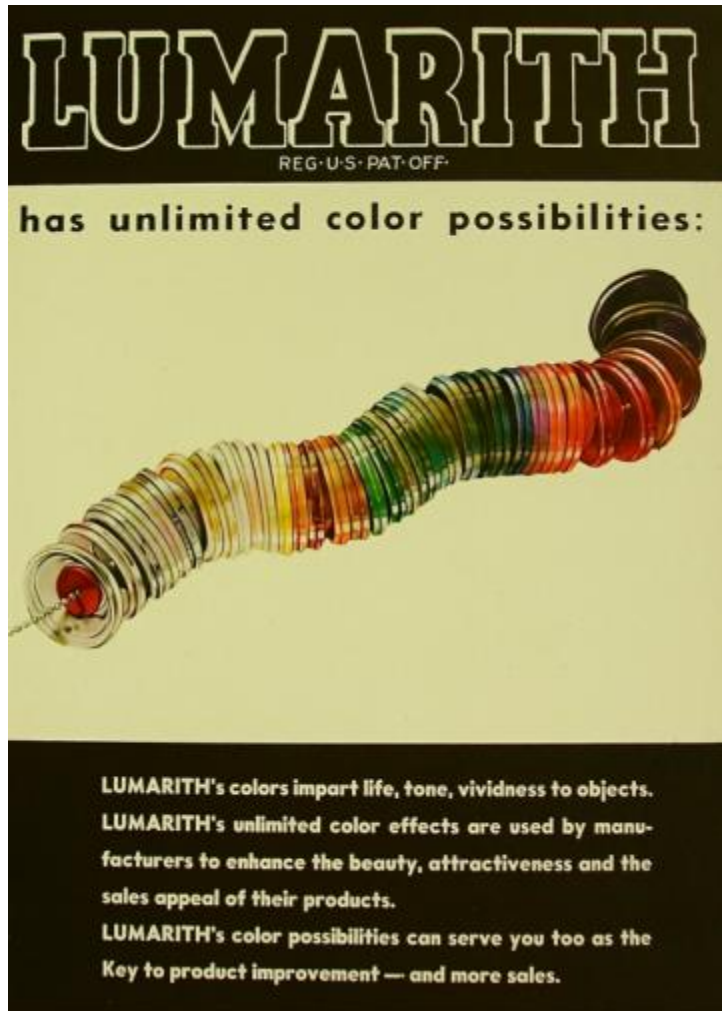
Salesman's kit of "Lumarith" brand  
cellulose acetate coupons  
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# Plastics Defined



← Colorants

← Opacifiers

Salesman's kit of "Lumarith" brand cellulose acetate coupons (National Museum of American History)

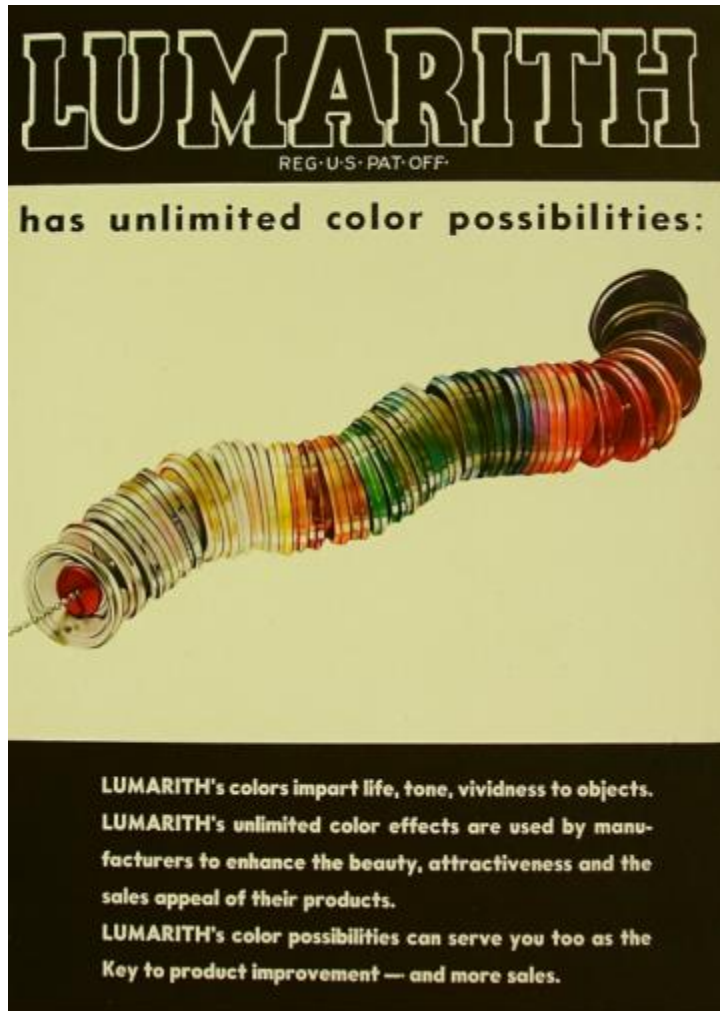


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# Plastics Defined



- ← Colorants
- ← Opacifiers
- ← Glitter !!!

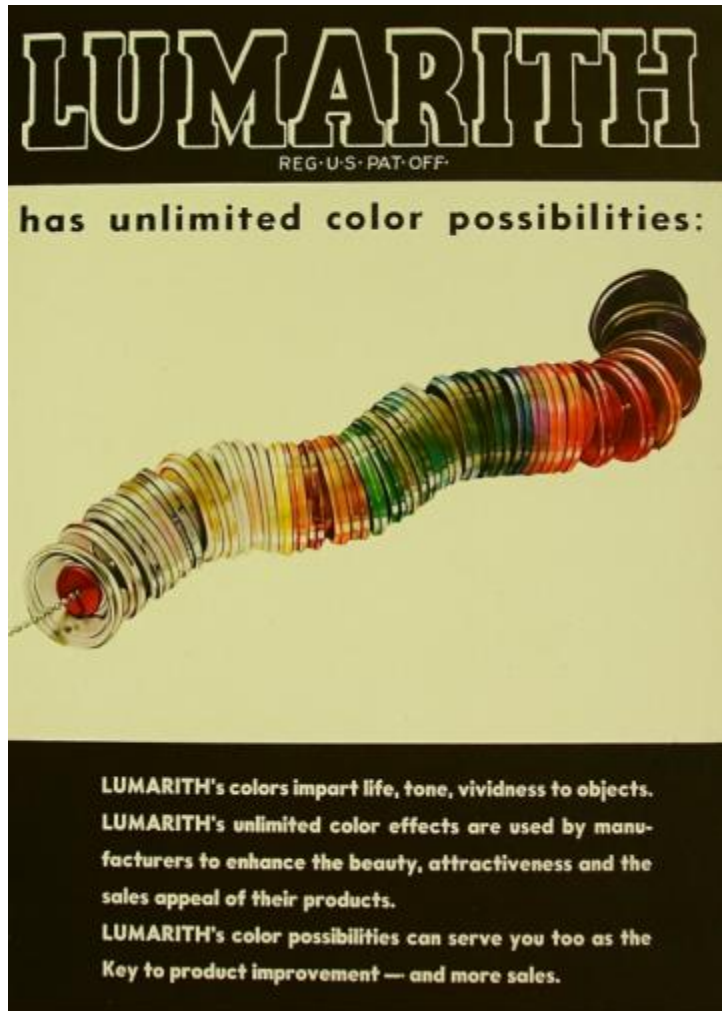
Salesman's kit of "Lumarith" brand  
cellulose acetate coupons  
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History)



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# Plastics Defined



- ← Colorants
- ← Opacifiers
- ← Glitter !!!
- ← Plasticizer

Salesman's kit of "Lumarith" brand  
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# Causes of Deterioration

## EXTERNAL TO ARTIFACT

- Mechanical damage
- Temperature
- Humidity
- Light
- Pollutants
- Biological organisms



# Causes of Deterioration

## EXTERNAL TO ARTIFACT

- Mechanical damage
- Temperature
- Humidity
- Light
- Pollutants
- Biological organisms

## INTERNAL TO ARTIFACT

- Chemical instability
- Incompatibility of components
- Contaminants (from manufacturing process)
- Defects and Internal stresses





# Signs of Deterioration

- Visible
- Smell
- Weight
- Mechanical changes
- Unseen chemical changes





# Visible Sign: Discoloration



## Plastic “Duck” spray bottles

- Originally each was single yellow color.
- Today differential discoloration visible
- Light exposure suspected culprit



*About 10 years old*

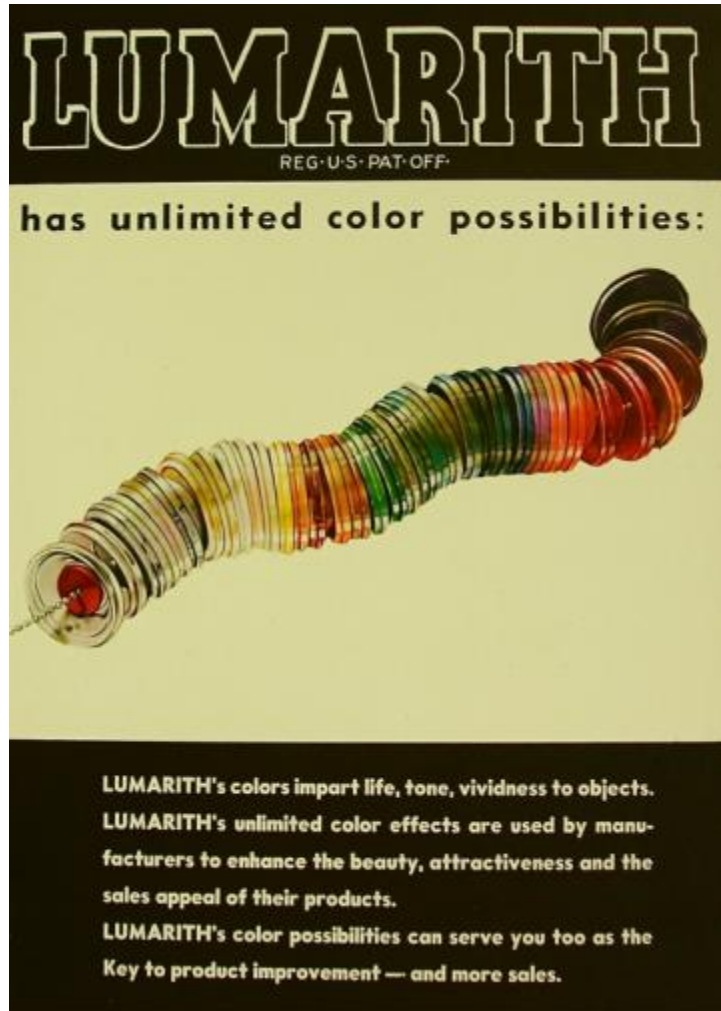
Spray bottles courtesy of Joan Brochard



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# Visible Signs of Deterioration



Salesman's kit of "Lumarith" brand cellulose acetate coupons (National Museum of American History)



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# Visible Signs of Deterioration



**46 Good Condition**



**3 Severely Deteriorated**



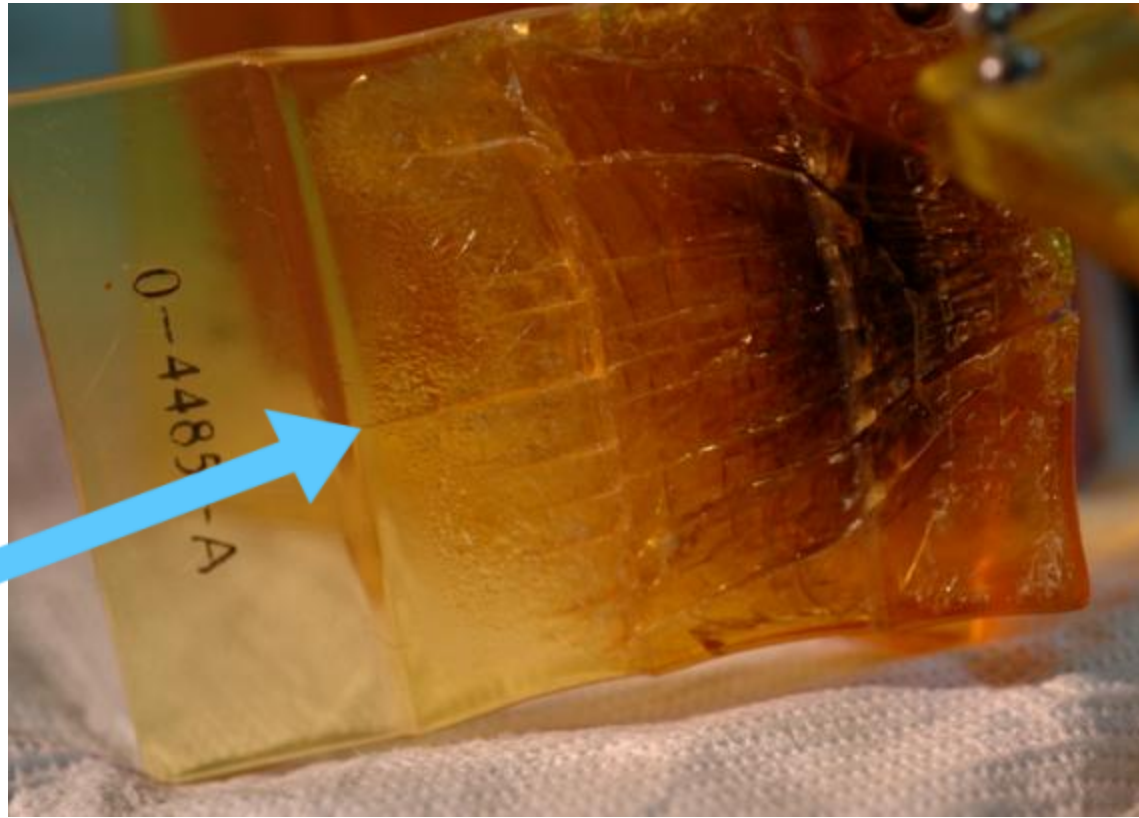
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# Visible Signs: Exudation



Liquid plasticizer  
(diethyl phthalate)  
exudes from  
cellulose acetate



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# Visible Signs: Shrinkage

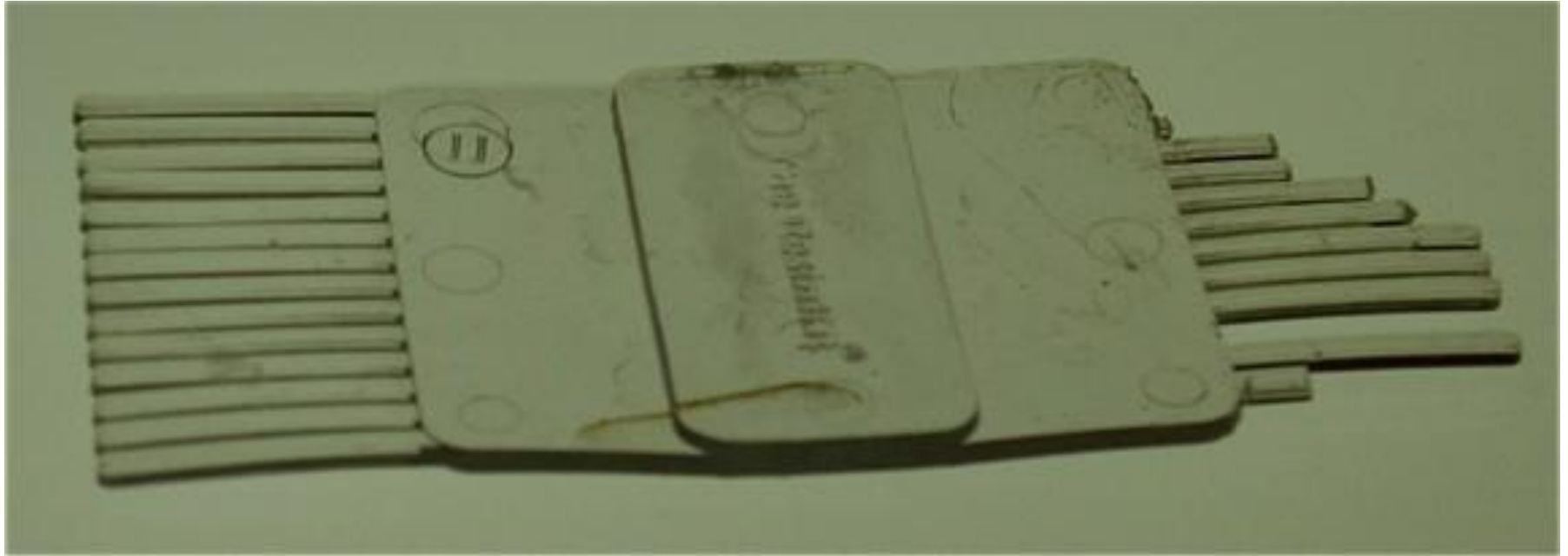


Loss of diethyl phthalate, TPP, and acetic acid causes shrinkage

- Distortion
- Formation of waist
- Cracking



# Visible Signs: Distortion



Distorted sample from The Resin Kit™



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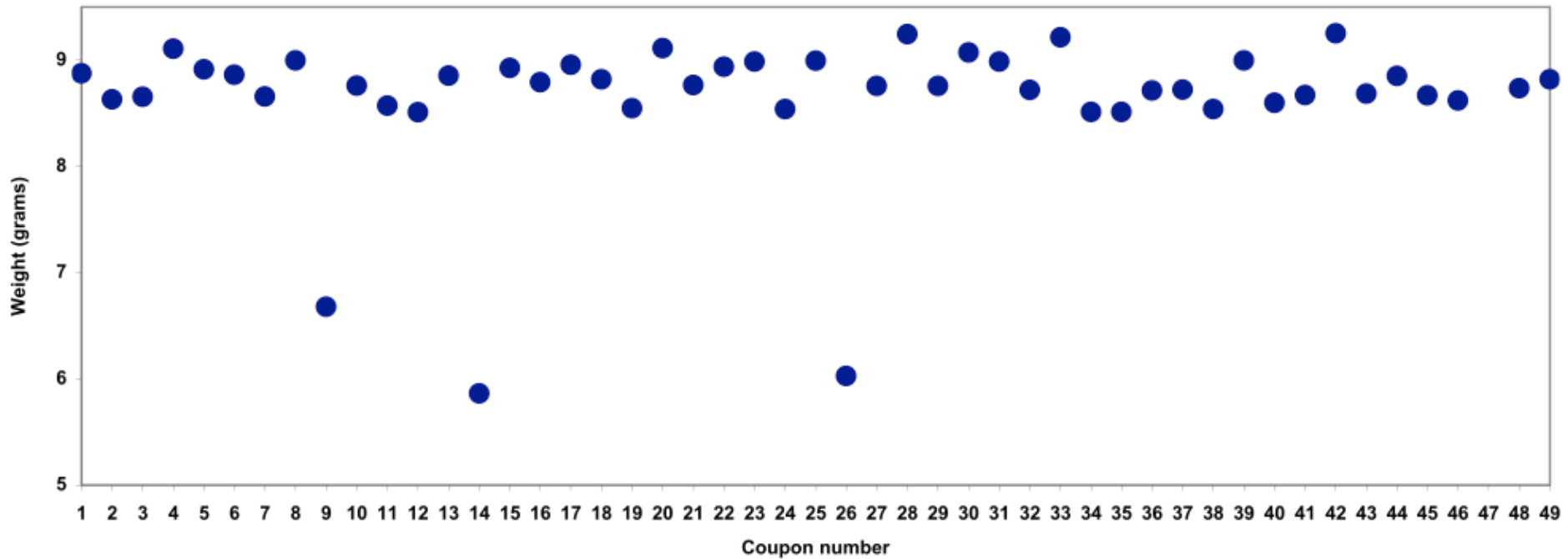
# Smell as Indicator of Deterioration



- Emitted by artifacts
- Smelly plastic and rubber may indicate loss of volatile acids, plasticizers, or other substances.
- Examples:
  - Acids may smell like vinegar or vomit
  - Camphor may indicate cellulose nitrate



# Weight Loss: Lumarith Coupons



3 deteriorated coupons have lost 20-30% of their weight!!!

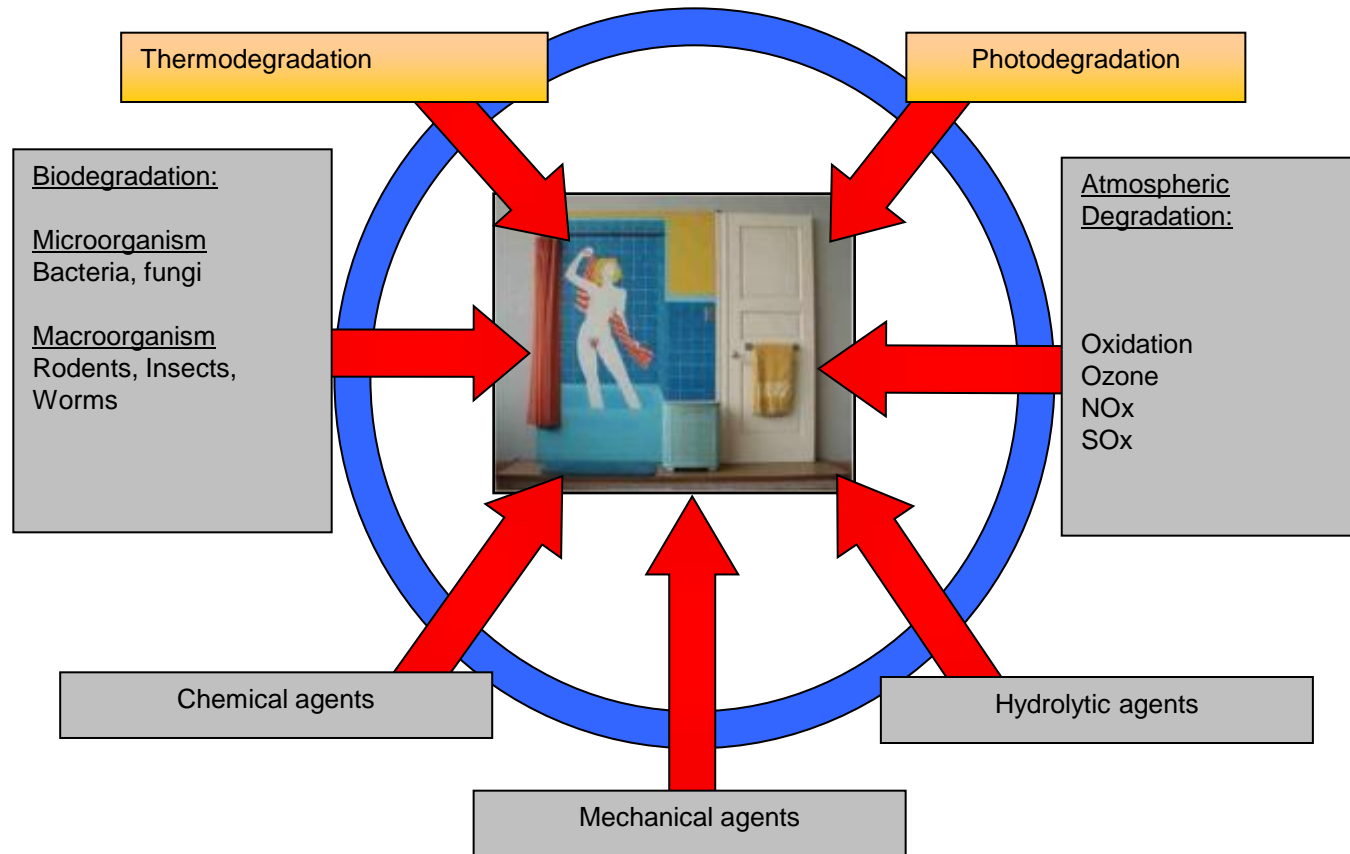


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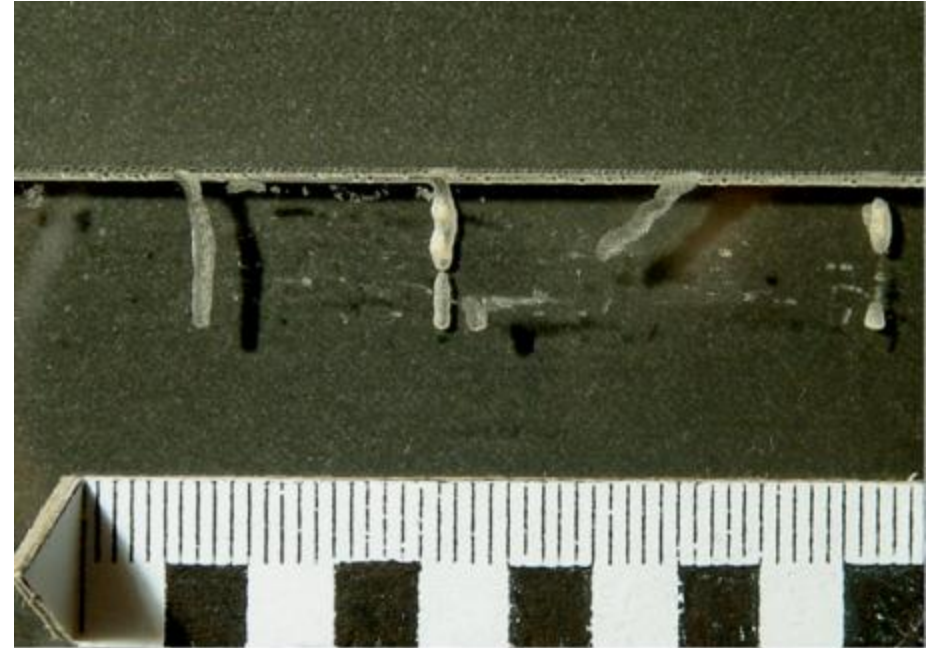
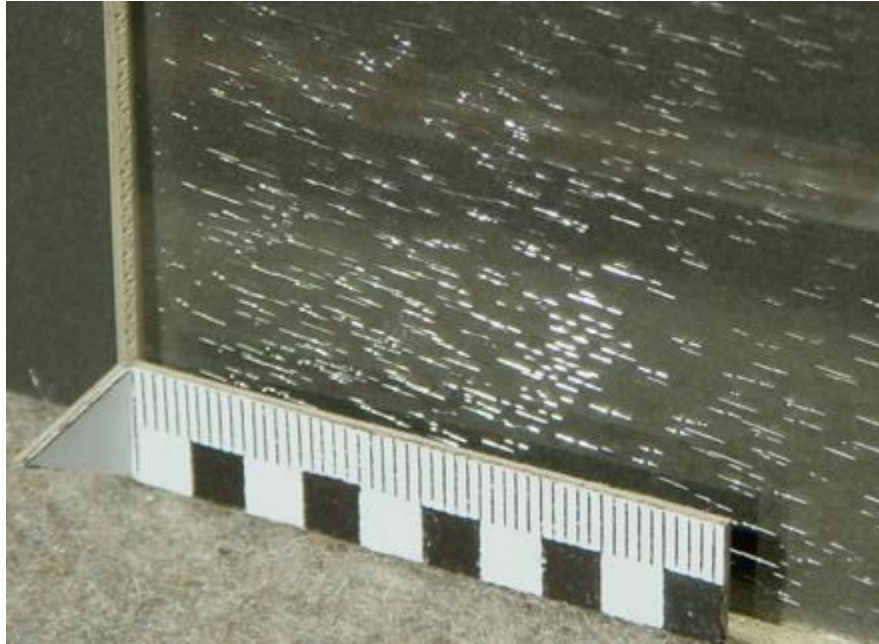
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# Influencing Factors of Degradation



# Crazing and Insects



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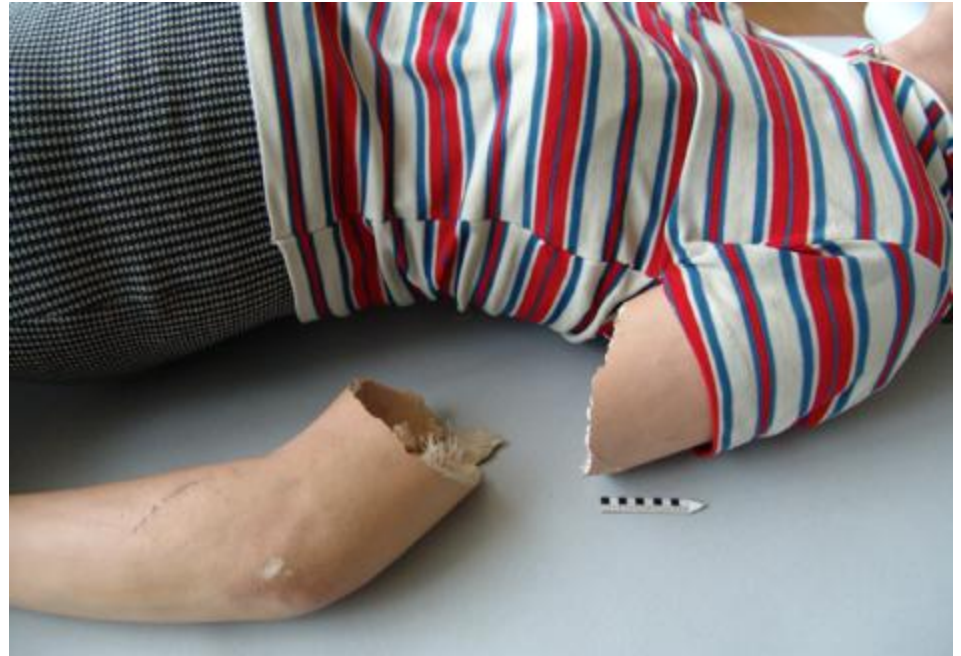
# Liquid Deposits / Loss of Plasticizer



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# Mechanical Damage



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# Degradation of PUR



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# Monitoring

- Objects specification and determination of the scope of examination
- Pilot survey/ monitoring to identify the variety of the objects and to quantify the project
- Analysis of the results of the pilot survey and modification of the data sheet
- Survey/ monitoring: collecting data
- Analyzing data
- Presentation of the results



# Questions

- In which condition are the artworks made of synthetic-organic polymers in your collection?
- What is the kind and extent of the damages?
- Is there any danger caused by storage criteria and immediate environs?
- Are there any particular works that need to be separated from others and stored in isolation (e.g. degraded CN, CA, PVC or PUR)?
- Are there any further preventive steps necessary, e.g. storage in closed containers, involving indicators and/ or oxygen absorbers?
- Are there any objects which can not exhibited anymore, due to material degradation and contraposition to artistic intent?
- How can changes in condition be examined and monitored in a long term view?



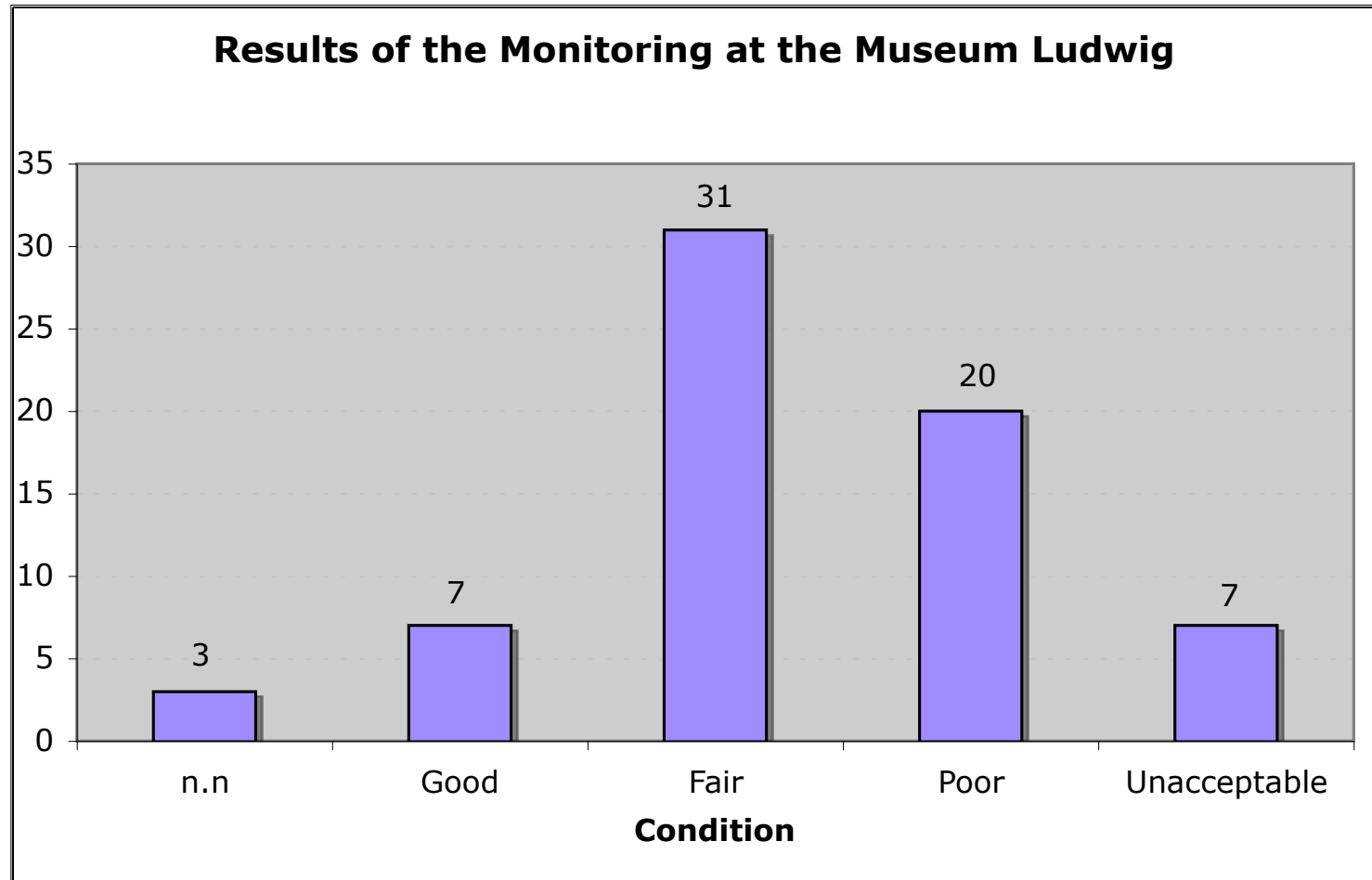
# Museum Ludw



<b>Identifikation Kunstwerk:</b>		Künstler:		Titel:	
Datierung:		Maß in cm(HxBxT):		Inv. Nr.:	
Technik/Anzahl SOPs:					
Ähnliche Objekte:		Rest. Dok: <input type="checkbox"/> nein <input type="checkbox"/> ja ⇒		Erster Eindruck: <input type="checkbox"/> e <input type="checkbox"/> u <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	
<b>Aufteilung des Objekts in:</b>		Kunststoff 1:	Kunststoff 2:	Kunststoff 3:	Kunststoff 4:
Objektelement/teil:					
Materialbeschreibung:					
Herstellungsland/Hersteller:		<input type="checkbox"/> n.n	<input type="checkbox"/> n.n	<input type="checkbox"/> n.n	<input type="checkbox"/> n.n
Handelsname:		<input type="checkbox"/> n.n	<input type="checkbox"/> n.n	<input type="checkbox"/> n.n	<input type="checkbox"/> n.n
Stempel/Markierung:		<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒
Analyse:		<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒
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Lagerung:					
<b>Schadenskriterium:</b>					
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Volumenveränderung:		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
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Loser Oberflächenbelag:		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
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Korrosion* (in %):		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Vergilbung/Verfärbung:		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Flecken (in %):		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
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Crazing/Haarrisse* (in %):		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Kratzer (in %):		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Riss/Einriss (in %):		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Ausbruch/Abriss (in %):		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Bruch/Zerriss (⇒ Definitionen):		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Einschlüsse (⇒ Definitionen):		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Alte Restaurierungen*:		<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒
Vandalismus:		<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒	<input type="checkbox"/> nein <input type="checkbox"/> ja ⇒
Zustand Kunststoff* (⇒ Def.):		<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4	<input type="checkbox"/> n.n <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
<b>Gesamtzustand Kunstwerk Σ:</b>		<input type="checkbox"/> 2 STABIL/Zufriedenstellend		<input type="checkbox"/> 3 INSTABIL/Schlecht	
<input type="checkbox"/> 1 GUT		<input type="checkbox"/> 2 STABIL/Zufriedenstellend		<input type="checkbox"/> 3 INSTABIL/Schlecht	
Konservatorisch guter Zustand		leichte Schäden, aber stabil, kein aktiver Schädlingsbefall. Keine kurzfristigen Maßnahmen erforderlich. Regelmäßige Kontrolle!		Instabiler Zustand, kaum transport- und/oder ausstellungsfähig. Maßnahmen empfehlenswert bis notwendig oder regelmäßige Kontrolle in kurzen Abständen!	
				aktive Degradation, starker Geruch, Zerfall, aktiver Schädlingsbefall, Gefahr der Kontamination anderer Objekte. Maßnahmen dringend erforderlich	
<b>Datum des Monitorings:</b>				<b>Name des Untersuchenden:</b>	

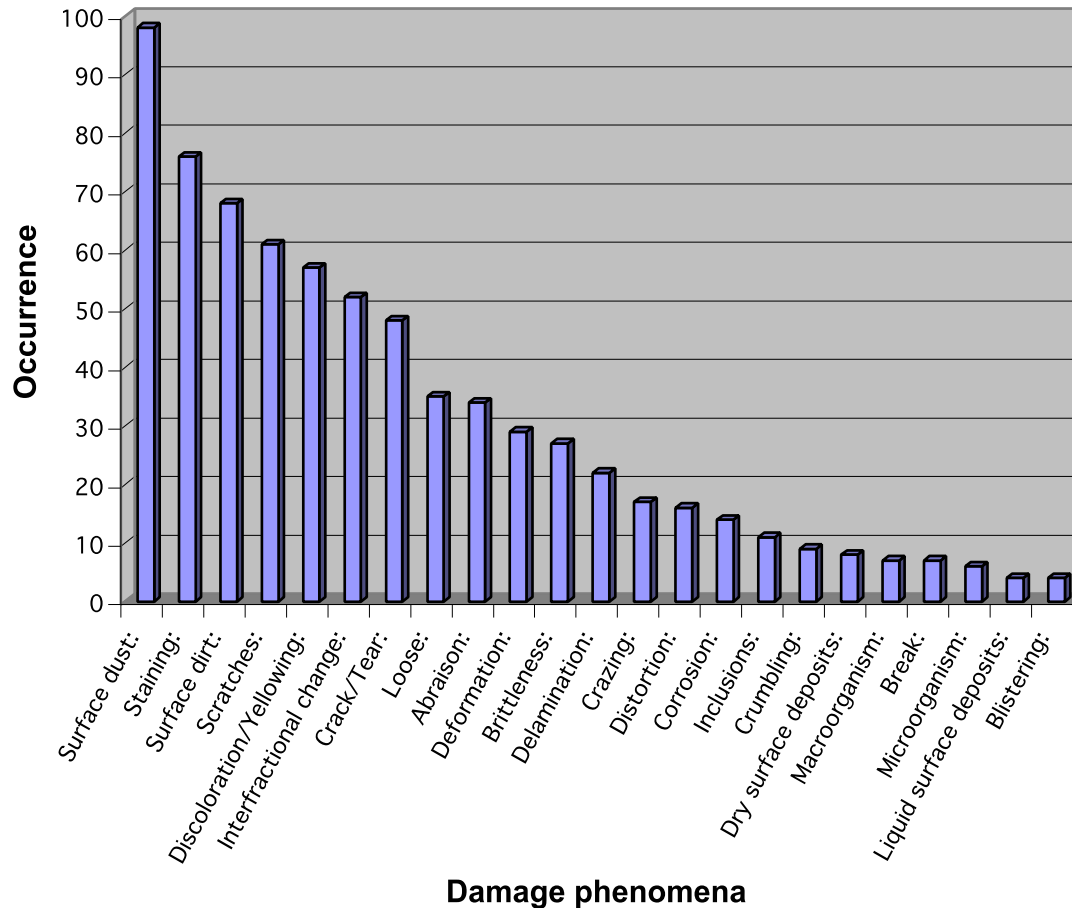


# Museum Ludwig: Results



# Museum Ludwig: Results

**Results of the Monitoring:**  
**Diagram showing the occurrence of damage phenomena found in the examined plastic-artworks at the Museum Ludwig**



# Advantages of Monitoring

- Not time consuming
- Thorough knowledge of the collection condition that can be translated in preventive conservation and treatments
- Education of the eye: observation of the phenomena of degradation of various plastics components in works of art
- Tool of collection management
- Budget planning



# Outlook



Smithsonian  
*Museum Conservation Institute*

bek & frohnert<sub>LLC</sub>

JUNE 13, 2012

# The End

