

# Collection Condition Assessment : VideoTape Deterioration Study

J TS 2007, Toronto : 27-30 J une 2007



## Introduction



## Tape Deterioration Symptoms



## Tape Deterioration Markers



## Conclusion

1

# Tape Deterioration Symptoms



**Magnetic Tape Structure**

**Deterioration Symptoms**

**Scope of Symptoms Study**

**Testing Tools**

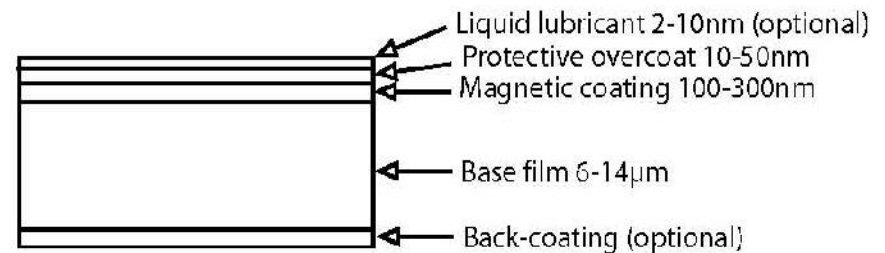
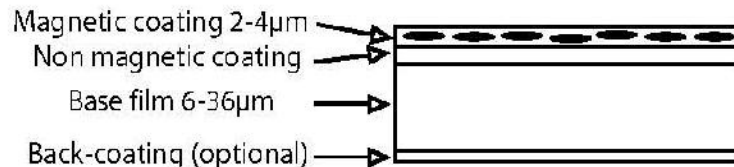
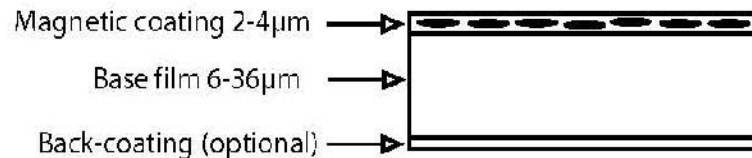
# 1. Tape Structure

## Particulate Tape (oxides, metal) vs Metal Tape (evaporated)

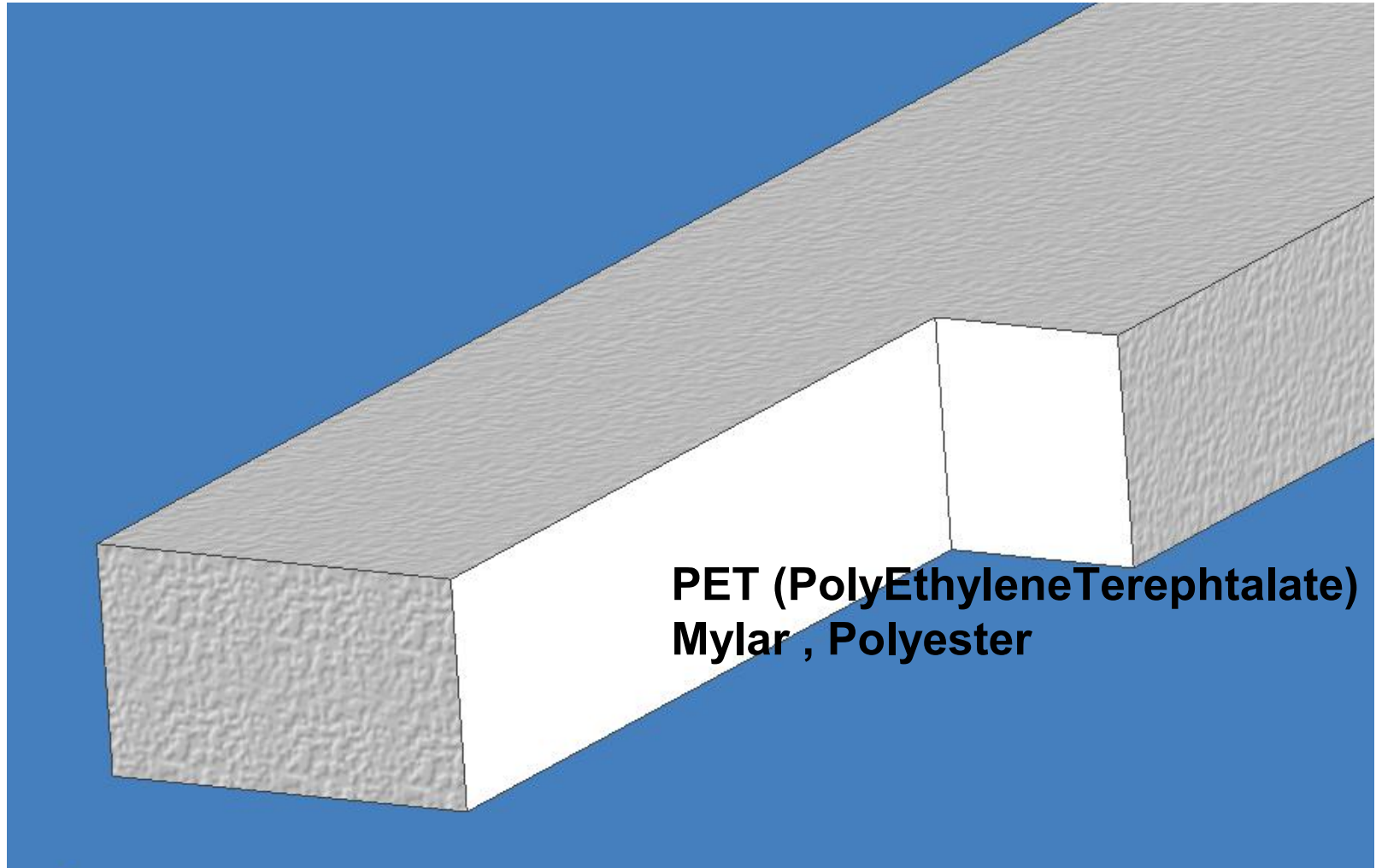
Conventional particulate media (upper left),

Dual Coat particulate media (left bottom),

Thin-film magnetic tape (right).



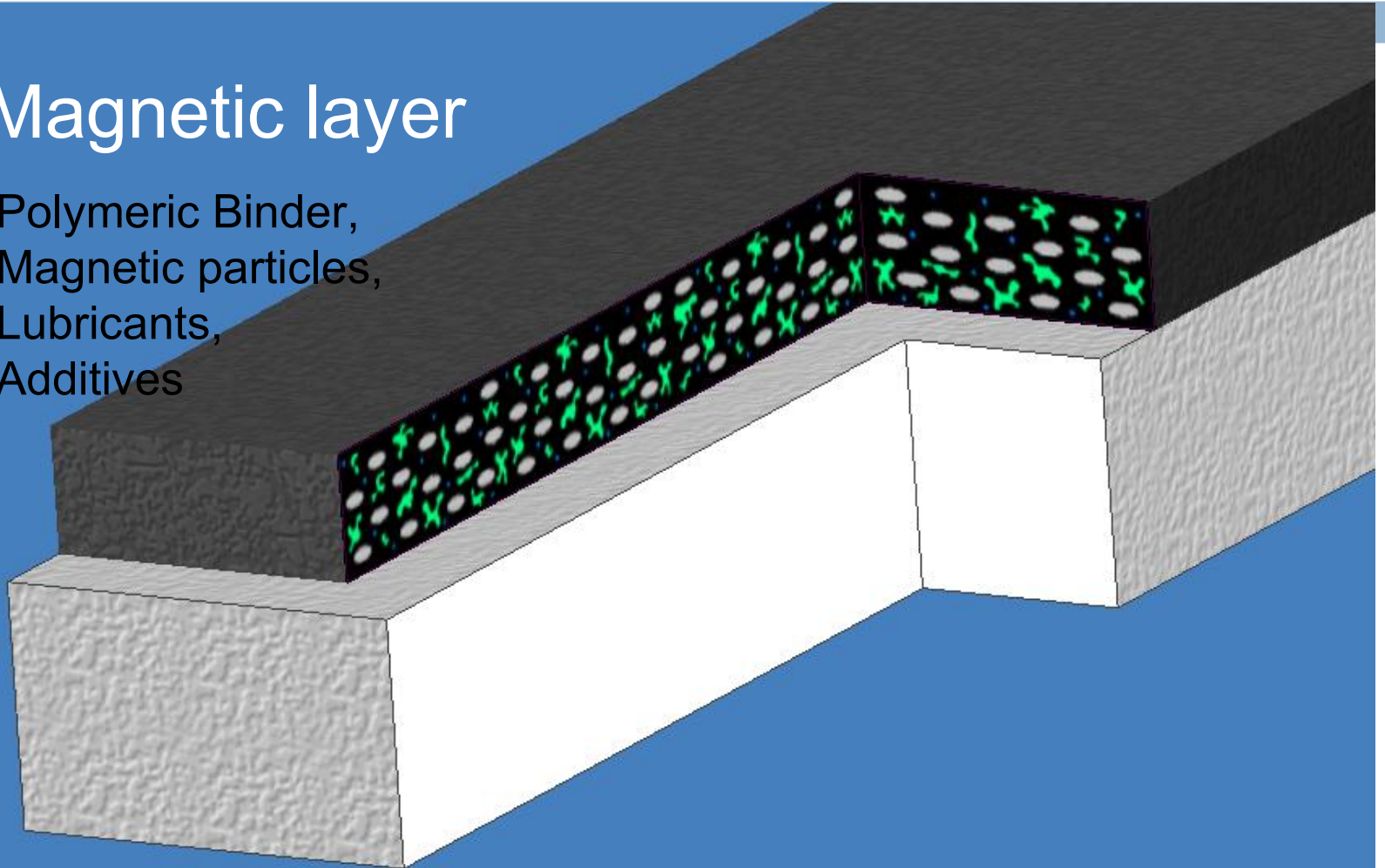
# base film (substrate)



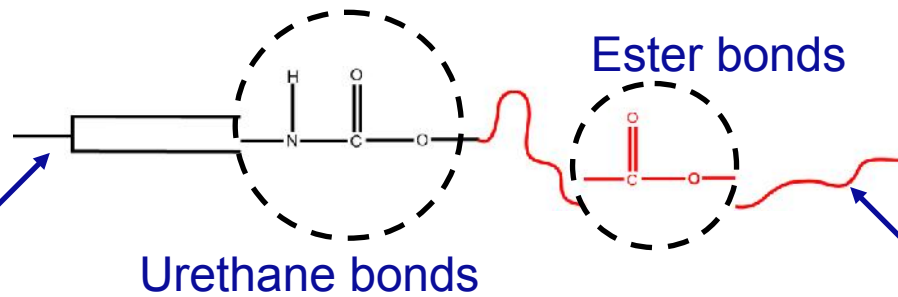
# coated with a magnetic layer

## Magnetic layer

Polymeric Binder,  
Magnetic particles,  
Lubricants,  
Additives

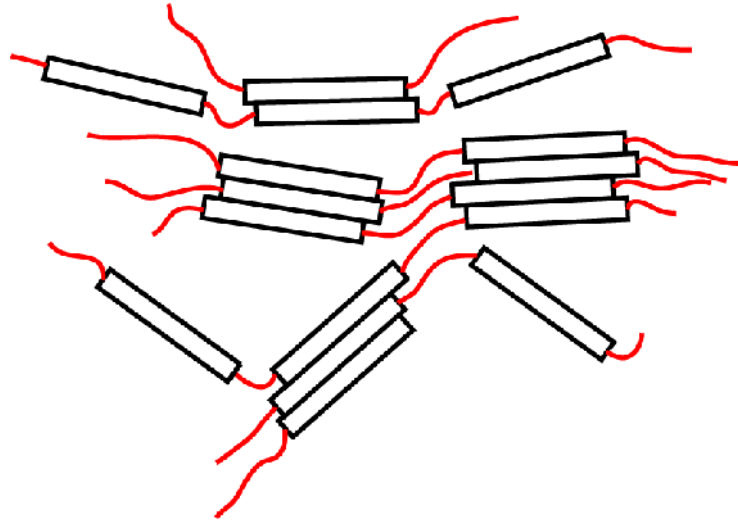


# Polyester-Polyurethane Binder



## Hard blocks :

- Bonding properties
- Hardness

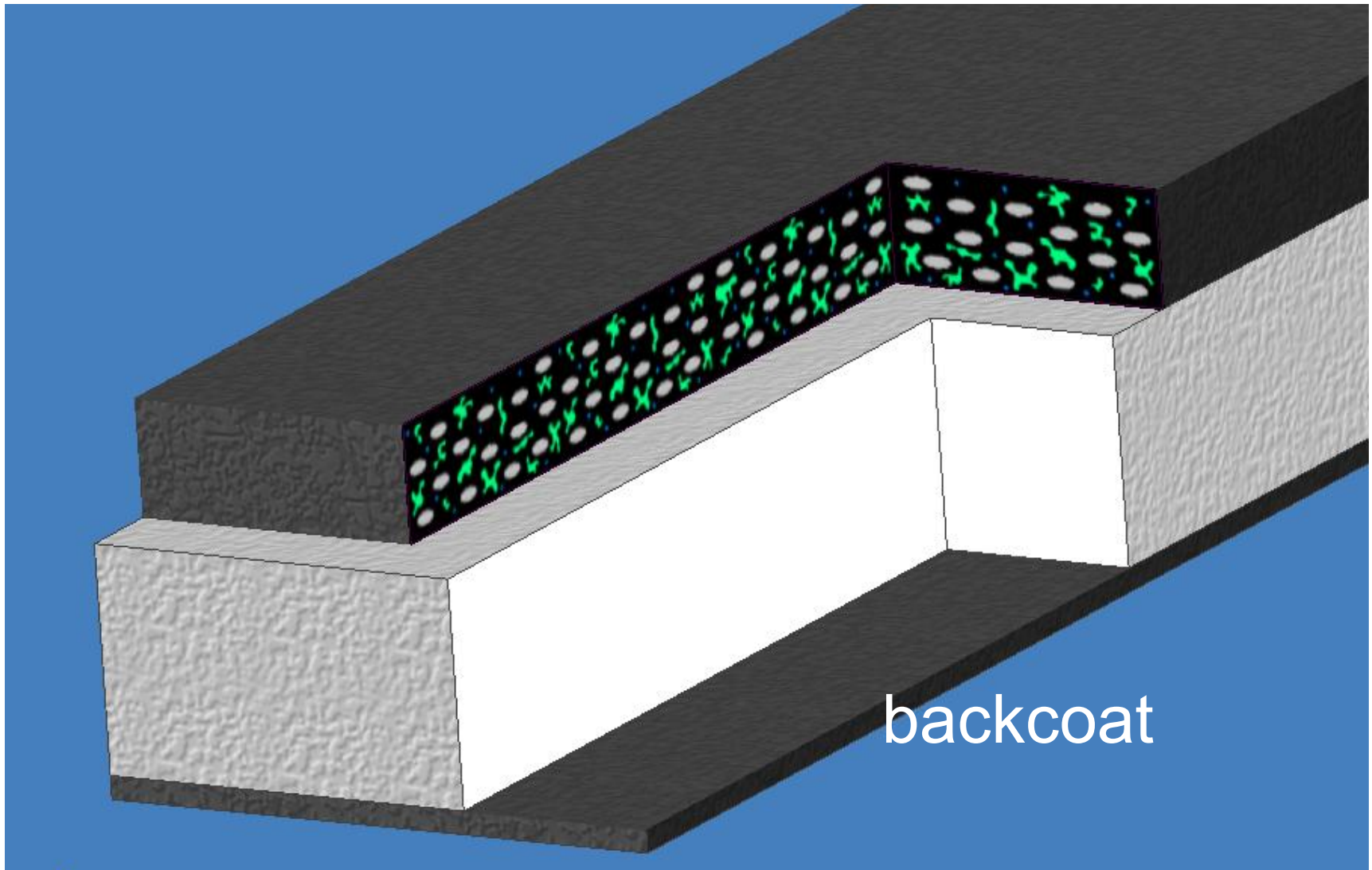


## Soft blocks :

- Flexibility
- Hydrolytic weak point



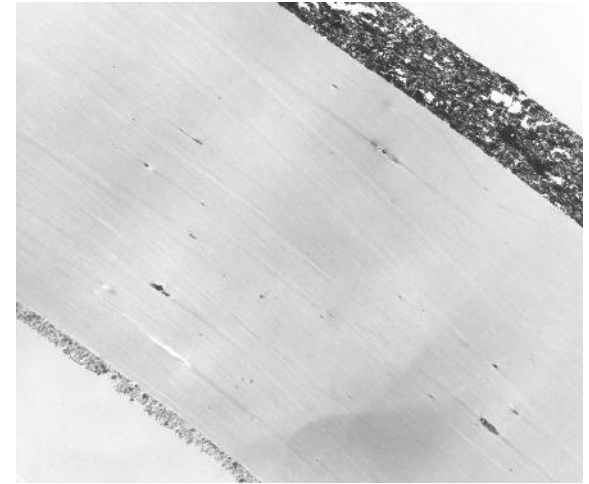
with an optional backcoat





# U-Matic : a model for study

- Tape Composition
- Tape-transport technology
- Preservation issues reporting



U-matic tape structure (0.5-1  $\mu\text{m}$ , TEM x 2000)

## 2. Deterioration Symptoms

- Symptoms that are connected to the recording playback (access)
- - Symptoms related to the preservation of the recorded information
- - Symptoms not related so far to the information preservation or access.

# Access related Symptoms

| Origin                      | Parameters involved   | Examples of symptoms  |
|-----------------------------|---|---|
| Tape player and/or operator | <ul style="list-style-type: none"> <li>→ reading machine settings</li> <li>→ tape mishandling</li> <li>→ highly frequent tape reading (wear, lubricant consumption)</li> <li>→ environmental conditions (RH, T, dust..) while tape playing.</li> </ul>  | <ul style="list-style-type: none"> <li>→ tape-transport instability</li> <li>→ no tape-transport</li> </ul> |
| Tape packaging              | <ul style="list-style-type: none"> <li>→ integrity of cassette/cartridge/hubs parts.</li> </ul>   | <ul style="list-style-type: none"> <li>→ many dropouts</li> </ul>   |
| Magnetic recording          | <ul style="list-style-type: none"> <li>→ initial quality of the recording</li> <li>→ signal processing options</li> </ul>   | <ul style="list-style-type: none"> <li>→ signal strength decrease</li> </ul>                                |
| Magnetic tape               | <ul style="list-style-type: none"> <li>→ alteration of dimensional properties</li> <li>→ alteration of tribological properties</li> <li>→ lubricant evaporation/conversion</li> <li>→ alteration of the head to tape gap</li> </ul> <p>deterioration products or deposited materials (mould, dust etc)</p> <ul style="list-style-type: none"> <li>→ head-clogging by deterioration products.</li> <li>→ alteration of particle magnetic properties</li> </ul> | <ul style="list-style-type: none"> <li>→ loss of signal</li> </ul>  |

# Recording preservation symptoms

| origin                                       | Parameters  | Examples of symptoms   |
|--|---|--|
| Structural integrity of the magnetic coating | <ul style="list-style-type: none"> <li>➔ wear</li> <li>➔ mishandling or storage disaster</li> <li>➔ Important playback stress</li> <li>➔➔ deterioration of the physical and chemical properties upon ageing (environmental conditions)</li> </ul> | <ul style="list-style-type: none"> <li>➔ particles shedding</li> <li>➔ base film breakage</li> <li>➔ magnetization loss</li> </ul> |
| Base Film                                    | <ul style="list-style-type: none"> <li>➔ mishandling</li> <li>➔ important playback stress</li> <li>➔ deterioration of the physical and chemical properties upon ageing under some environmental conditions</li> </ul>                             |  |
| Magnetic Properties                          | <ul style="list-style-type: none"> <li>➔ demagnetization (external field, T, etc)</li> <li>➔ deterioration of the physical and chemical properties of the particles upon ageing under some environmental conditions</li> </ul>                    |  |

# Other Symptoms

| Origin                             | Parameters  | Examples of symptoms  |
|------------------------------------|---|---|
| Chemical formulation (manufacture) | <ul style="list-style-type: none"><li>→ Storage conditions</li><li>→ Tape storage in open air</li></ul> | <ul style="list-style-type: none"><li>→ Evaporation of manufacture residual products (solvents, un-reacted products)</li><li>→ Consumption and conversion of stabilizers (antioxidants, anti-hydrolysis agents)</li></ul> |
| unknown                            | unknown   | <ul style="list-style-type: none"><li>→ odours</li></ul>  |

# 3. Scope of Symptoms Study

- Study limited to the 3 preservation Issues
  - Tribological behaviour
  - Head clogging
  - Cohesion Loss of the Magnetic coating
- Study limited to the magnetic layer

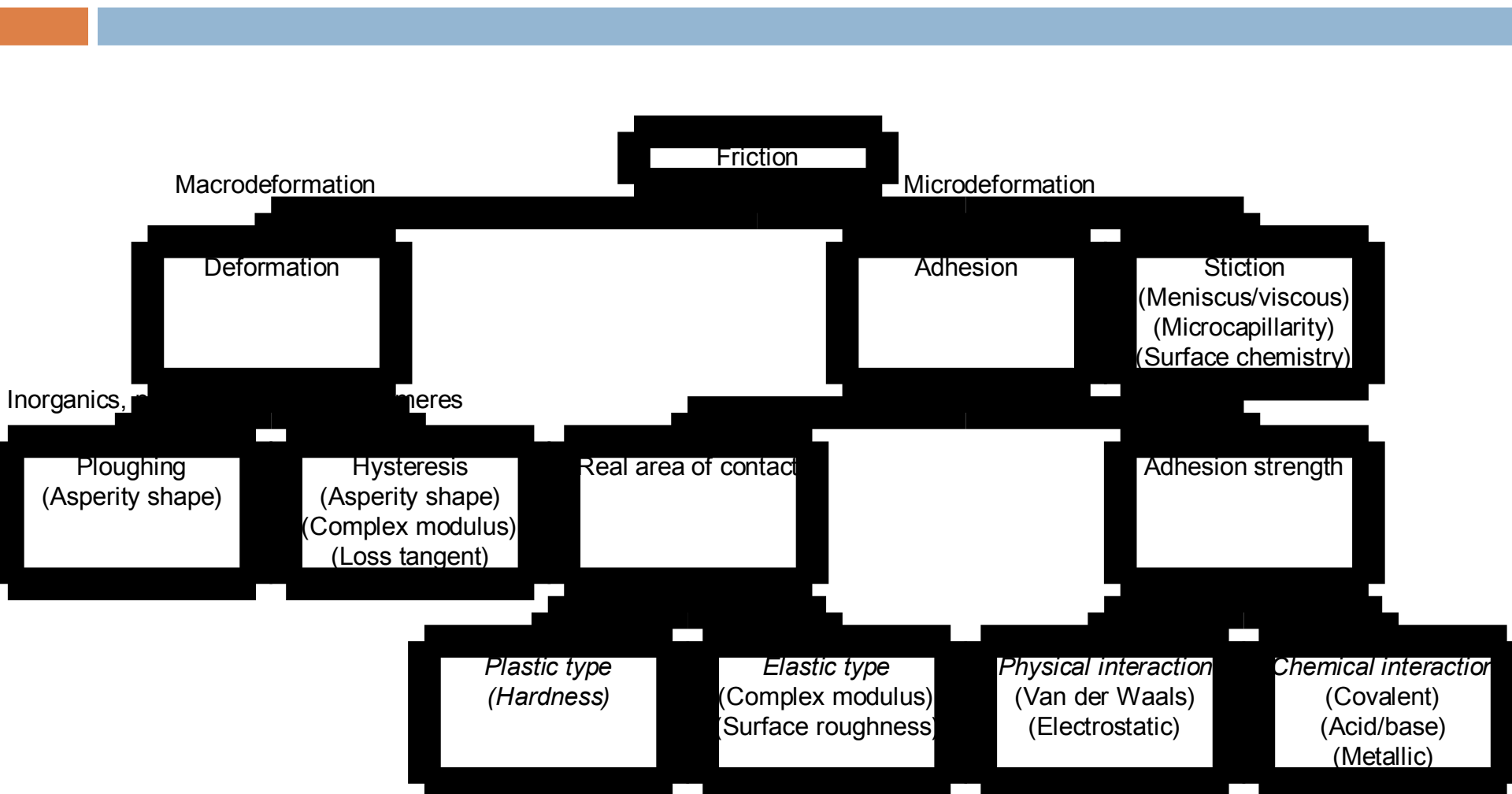
# 4. Testing Tools

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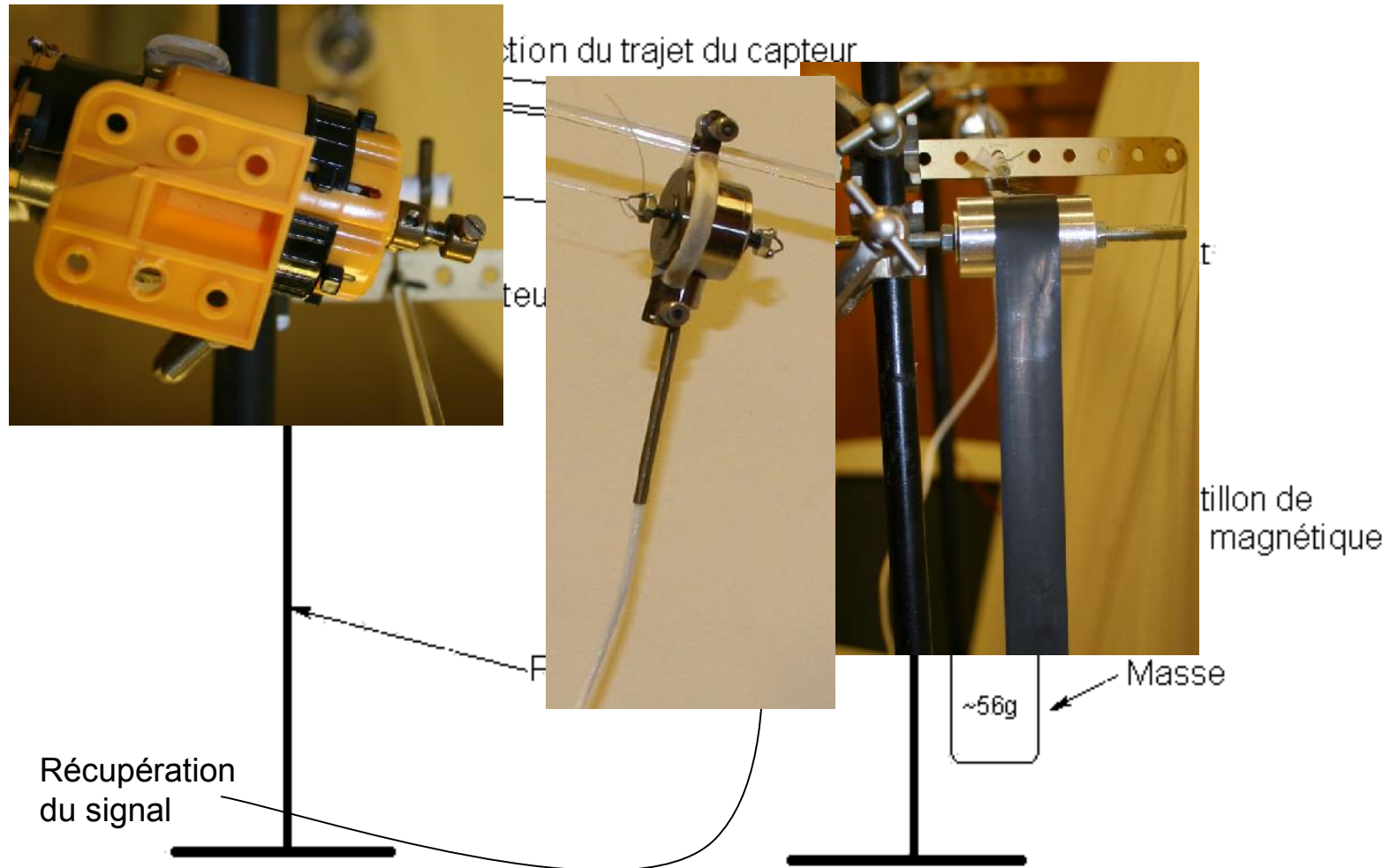
- Change in Magnetic coating tribology (friction)
- Change in Magnetic Coating Cohesion (wear)
- Head-clogging (high-speed reading photo)



# Schematic of sources of polymer friction



# 4.1 Friction and Wear tester



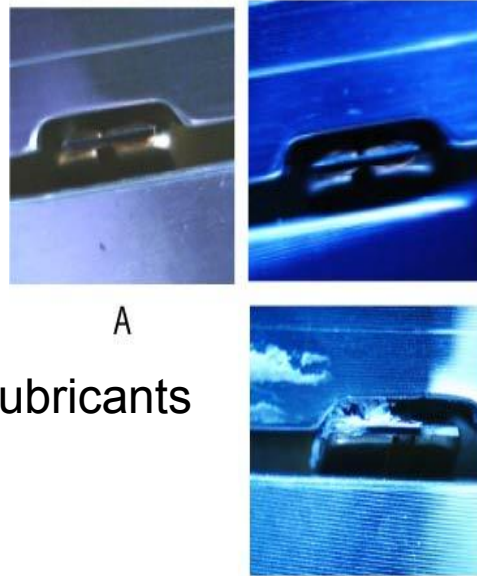
# 4.2 Head-clogging imaging

Rotary drum

**Magnetic head**

Stationary drum

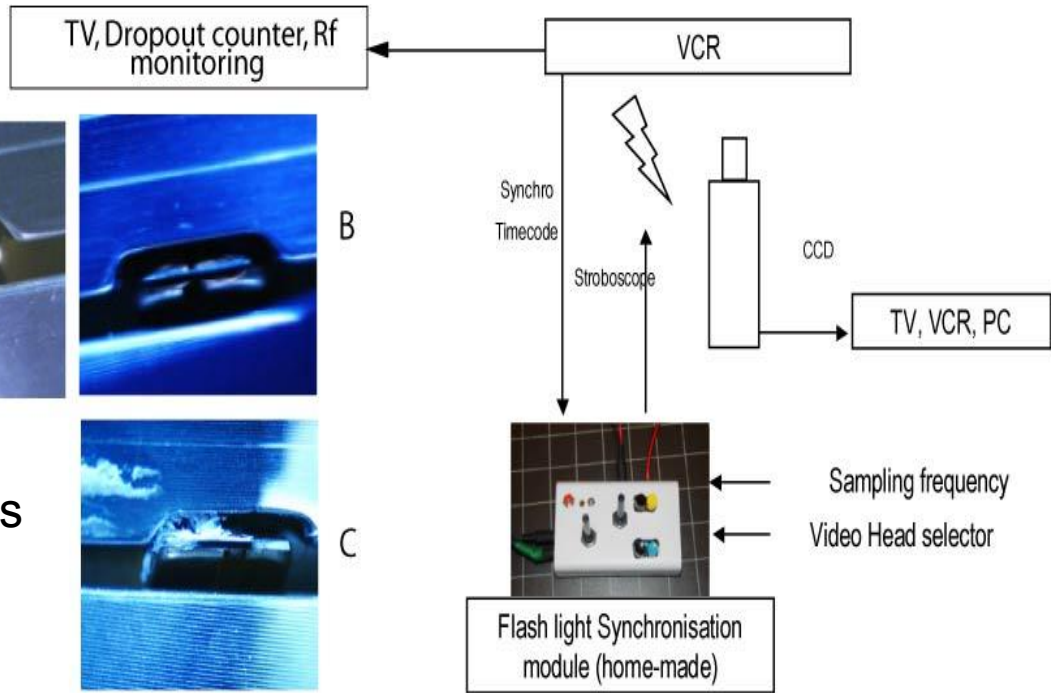
Pilled up lubricants



A

B

C



Modified BVU tape player for high speed imaging of reading head

- A : Clean head, stop position drum
- B : Clean head while playing a tape
- C : Heavily clogged head by tape lubricant, stop position

**Figure 4** Schematic diagram of the experimental apparatus



# 2

## Markers of Degradation



**Deterioration Mechanisms**

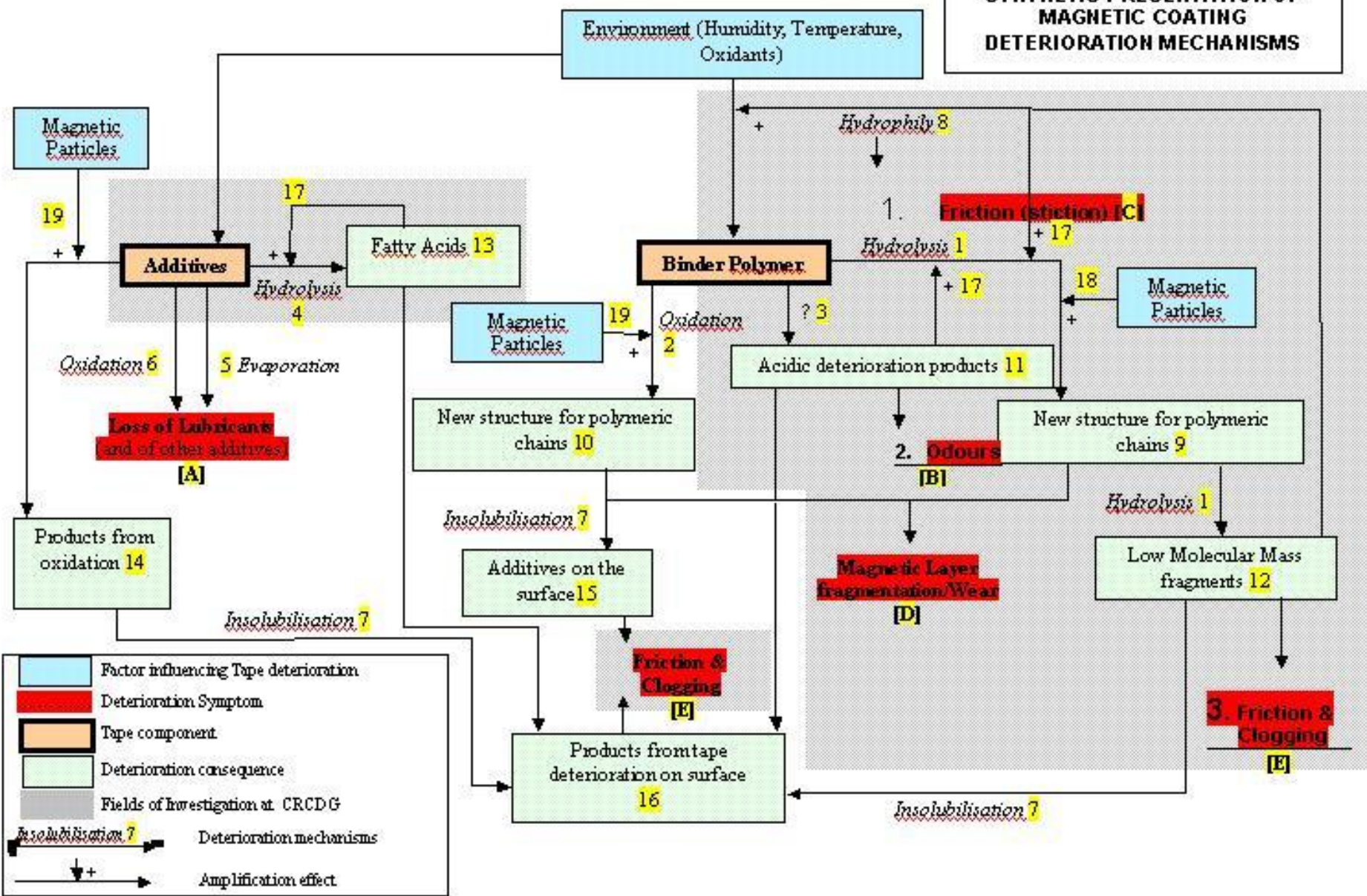
**Potential Degradation Markers**

**Chemical Markers**

**Physical Markers**



# SYNTHETIC PRESENTATION OF MAGNETIC COATING DETERIORATION MECHANISMS



# What is a deterioration marker

- **Monotonic evolution**
- **Consistent with deterioration symptoms time-scale**
- **Related only to deterioration**
- **Initial / Final state known or threshold levels known**

# Potential Markers

- Chemical Markers

- 嬪 Polymeric Binder Molecular weight

- 嬪 Solvent Extractables

- 嬪 Surface Tension

- 嬪 Loss of Additives from Tape

- 嬪 Products from chemical degradation

- Mechanical Markers

- 嬪 Loss of Cohesion / Embrittlement

- 嬪 Friction and Adhesivity



# Analytical Fingerprints [gc-fid]

- acetone extracts from magnetic coating
- mainly tape additives are extracted by acetone
- => « tape technological families »

# Solvent extractables

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- Weighting method
- Size Exclusion Chromatography

# VOC

[spme-gc-ms]

- Some naturally aged tapes give off strong odours
- Volatile Organic Compounds odoring ?
- Hydrolytic artificial ageing tests accelerate and emphasize the release of volatile degradation products
- Carboxylic acids and lactones released

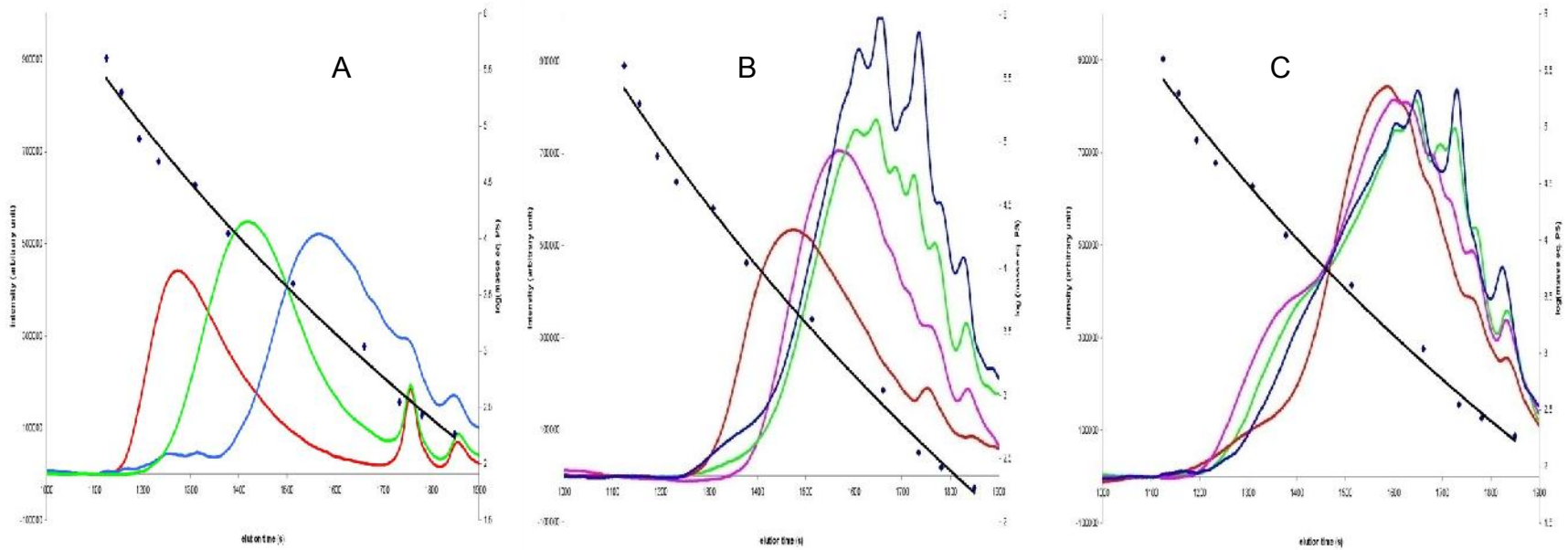
# Binder Molecule Size



- Size Exclusion Chromatography (SEC)
- THF extractable

# Hydrolytic Stability

[sec]



**SEC Chromatogram evolution; ageing at 100%RH, 75°C ; shape A, shape B, shape C  
after 0 day (red), 14 days (pink ), 25 days (green ), 49 days (blue )**

# Adipic Acid Formation

[sec]

- Ampex U-matic tape (1981)
- 100%RH, 75°C, 100 days
- in hermetically closed vial
- Agfa U-matic tape (1980)
- 90%RH, 50°C, > 1 year
- environmental chamber



# Conclusion

- need for magnetic tape deterioration markers
- investigation by conservation scientists
- tools & methods developed successfully for the study of mag tape
- better knowledge of tape composition and tape deterioration
- but no marker clearly identified (until now)

## ONGOING WORK :

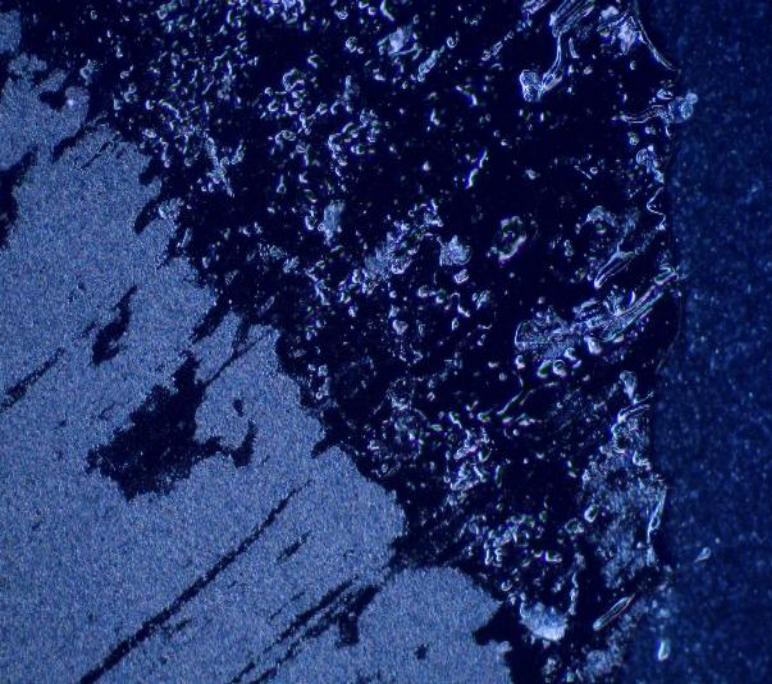
- statistical tool to be developed with other partners (Ina, IT-innovation) based on the tape knowledge base
- polyurethane identification,



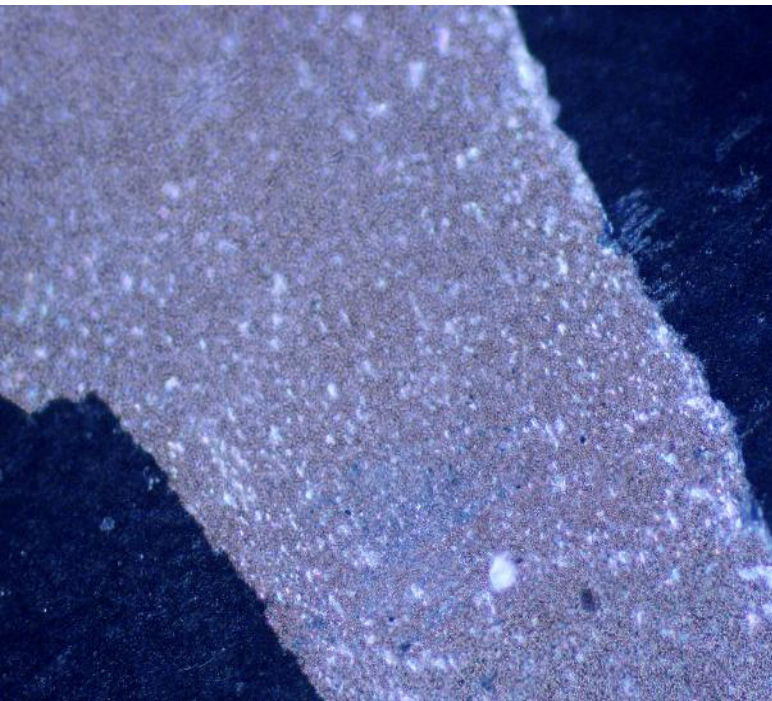
# Les tests du dispositif de pollution

- Tester le





Sticky shed on the backcoat



Magnetic coating scratch from the base film



