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Evaluation of the corrosivity of plastics for metals in scientific and technical collections

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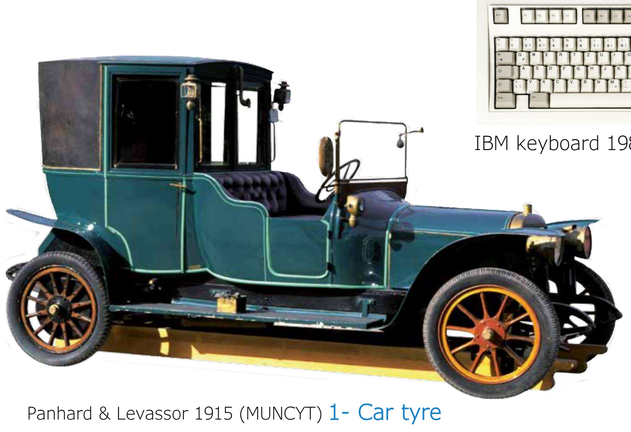
Introduction

The conservation of scientific and technological collections presents great challenges. A really significant one is the coexistence in the same object of potentially incompatible materials such as metals and plastics, two materials that are widely represented in these collections. This work studies the cross-corrosivity of materials composing the heritage artifacts and evaluates the impact on metals produced by plastic materials due to emissions of volatile organic compounds (VOCs). The objective is to correlate chemical composition, ageing changes and corrosion by combining Oddy test (OT) and Fourier transform infrared spectroscopy in external reflection mode (FTIR-ER).

Methodology

Samples selection and identification

13 samples of plastic materials from scientific and technological objects belonging to the National Museum of Science and Technology (MUNCYT) and private collections suspected of emitting VOCs.



Panhard & Levassor 1915 (MUNCYT) 1- Car tyre

IBM keyboard 1985 (CENIM) 6-IBM Key

TEM Tesla-1963 (MUNCYT) 2- Rubber band

Identification of polymer:
FTIR-ER, Bruker Alpha II.
Portable & contactless

Oddy test (OT): Accelerated ageing

Image of the Oddy Test setup

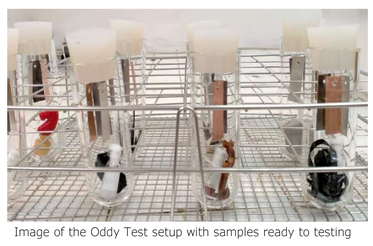


Image of the Oddy Test setup with samples ready to testing

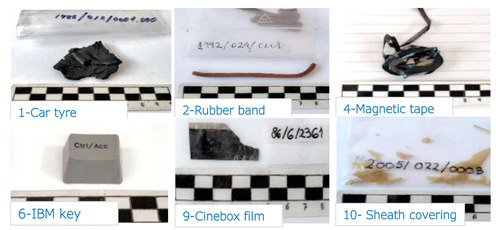


Image Oddy Test Samples

Conditions: 28 days/ 60 ºC/ 100% RH
Sample: 2 g
Coupons: Lead, Silver, Copper.

Goal: Assess the corrosivity of VOCs emitted by the plastic samples.
Evaluation: Visual and qualitative evaluation of the three metal coupons for each material against a blank. This is carried out in blind way by four persons to reduce subjectivity. Materials are ranked as suitable for "**P**ermanent" use, "**T**emporary" use or "**U**nsuitable"

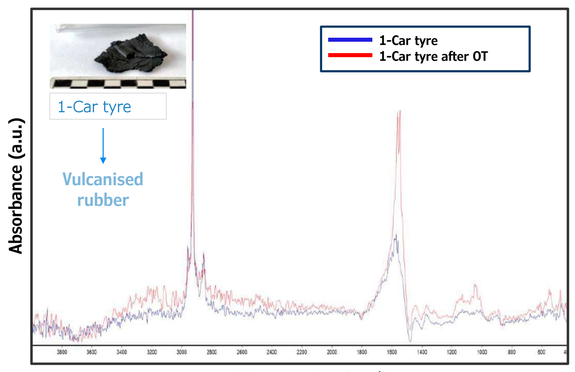
Characterization of aged samples and corrosion products

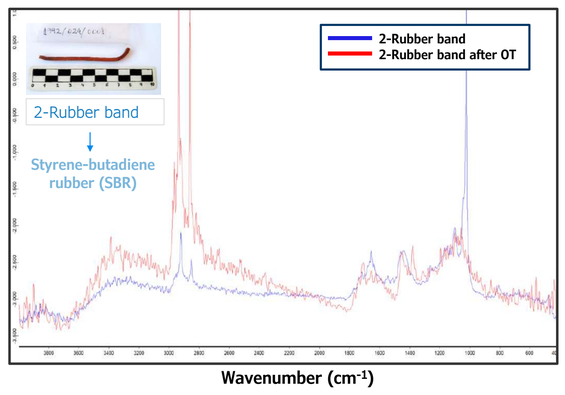
FTIR-ER, Bruker Alpha II/ Raman custom portable B&W TEK /Optical microscopy.

Results & Discussion

FTIR-external reflection/Raman

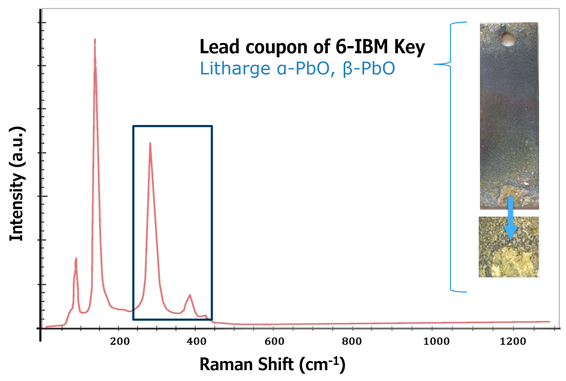
Samples: After OT, chemical changes have been observed in FTIR-ER spectra: Increases in the intensity of absorption bands carbonyl group 1700 cm^{-1} and range OH/NH/CH 3600-3100 cm^{-1}. Loss of absorbance peak (possibly additives).





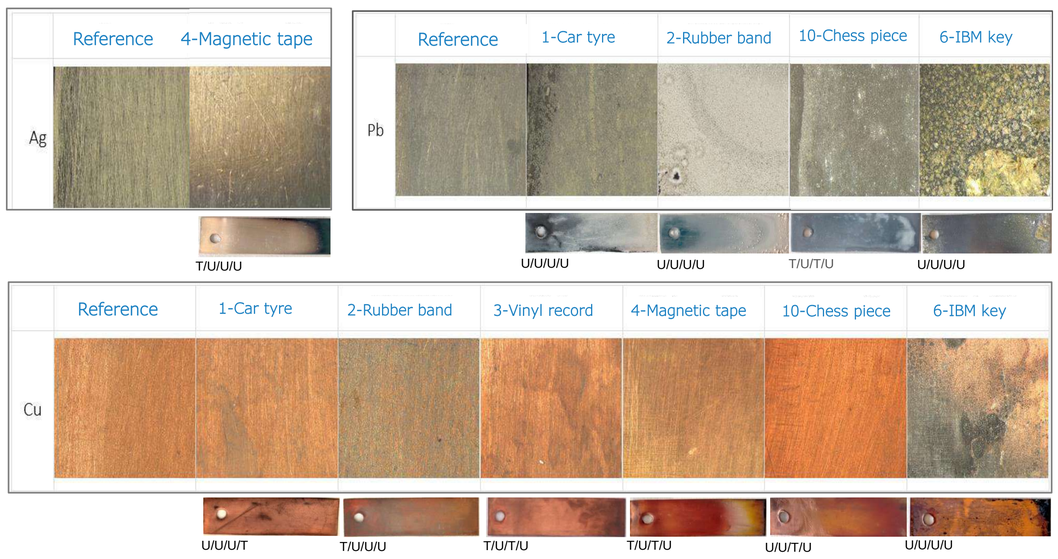
Coupons: After OT, the following corrosion products have been identified by Raman spectroscopy:

Pb	Cu	Ag
Cerussite Hydrocerussite Lead sulphates Litharge	Calcosine Cuprite	Sulphides



Oddy test

Coupons: After OT, lead proved to be the most sensitive metal, with thick layers of corrosion products due to the organic acids emitted. Cu was moderately affected mainly by the magnetic tape and the IBM key. Silver only experimented tarnishing by the magnetic tape sample due to the presence of sulphides, probably originated by the polymer additives.



Images and optical micrographs of the most affected coupons after ageing

ODDY TEST Assessment
U=Unsuitable=High corrosion
T=Temporary= Light corrosion
P=Permanent=No/spot corrosion

Conclusions

- ✓ The proposed methodology, combining Oddy test and FTIR-ER, makes it possible to easily and accurately identify dangerous plastic polymers whose emissions may affect metals in scientific and technical collections, to forecast scenarios and to avoid or limit future risks.
- ✓ The results indicate the potential threat of plastics to metallic elements and the heterogeneity of their emissive behavior, even in similar matrices.
- ✓ After ageing, all samples have changed chemically, mostly without visible alterations. It is therefore necessary to carry out these analyses on a preventive and regular basis.

Acknowledgments

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