An unexpected danger with ISO16000 emission tests

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Species

- Acetic acid
- Formic acid
- Nitric acid
- Hydrogen sulfide
- Carbonyl sulfide
- Dimethyl sulfide
- Formaldehyde
- Acetaldehyde
- Styrene
- Ammonia
- Ethyl acetate
- Ethyl formate
- Ethyl propanate
- Methyl acetate
- Methyl propanate
- Vanillin
- Iso butyl benzol
- Hexanal
- 1,4 diethylbenzene
- Furfural
- Toluene
- 2 pentylfuran
- Diethylamine ethanol
- Octadecylamine
- Peroxyacetyl nitrate
- Chlorides (29% 200 Oddy Cu tests have Cl in corrosion product)
- Mercaptans
- Peroxides
- Fumigants
- Flame retardants

www.hahnpure.de/en/bemma-assessment-scheme/

BEMMA assessment scheme

BEMMA: Assessment of emissions from materials for museum equipment

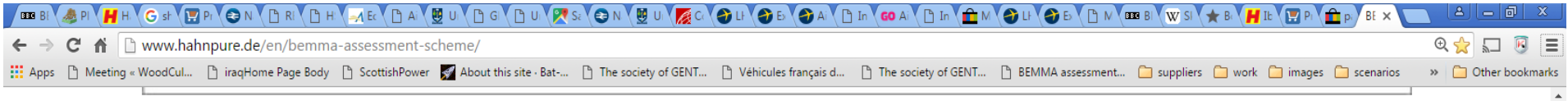
1. Methods of analysis

1. Micro chamber (µ-CTE)
2. DIN ISO 16000-6 (sample taking with Tenax®; VOCs, SVOCs; 0,25 liters withdrawal volume; 10 min)
3. DIN ISO 16000-3 (sample taking with DNPH- cartridges for aldehyde and ketone; VVOCs, VOCs, SVOCs)
4. Formic and acetic acid BAM specific analytic process referring to DIN ISO 16000-3; (derivating, LC-MS; 30 liters withdrawal volume; 20 h)
5. Iso-cyanate (derivatisation, HPLC; 15 liters withdrawal volume; 10 h)
6. Anorganic gases (sensors and optical measuring devices within the scope of 0 to 250 ppm)

2. Criteria

1. Substances with high contamination potential, such as formic acid, acetic acid, formaldehyde, H_2S, SO_2, NH_3; 2,6-TDI, HDI, 2,4-TDI and oxime (s. table 2) must not be detectable
2. Sum emission figures for Σ VVOCs: 100 µg/m³, Σ VOCs: 500 µg/m³ with the exception of sealing materials with Σ VOCs: 2000 µg/m³ due to significantly smaller application surface, for Σ SVOCs: 100 µg/m³ and anorganic gases (planned)

BEMMA SCHEME



Emission figures (< detection limit) for substances with high contamination potential

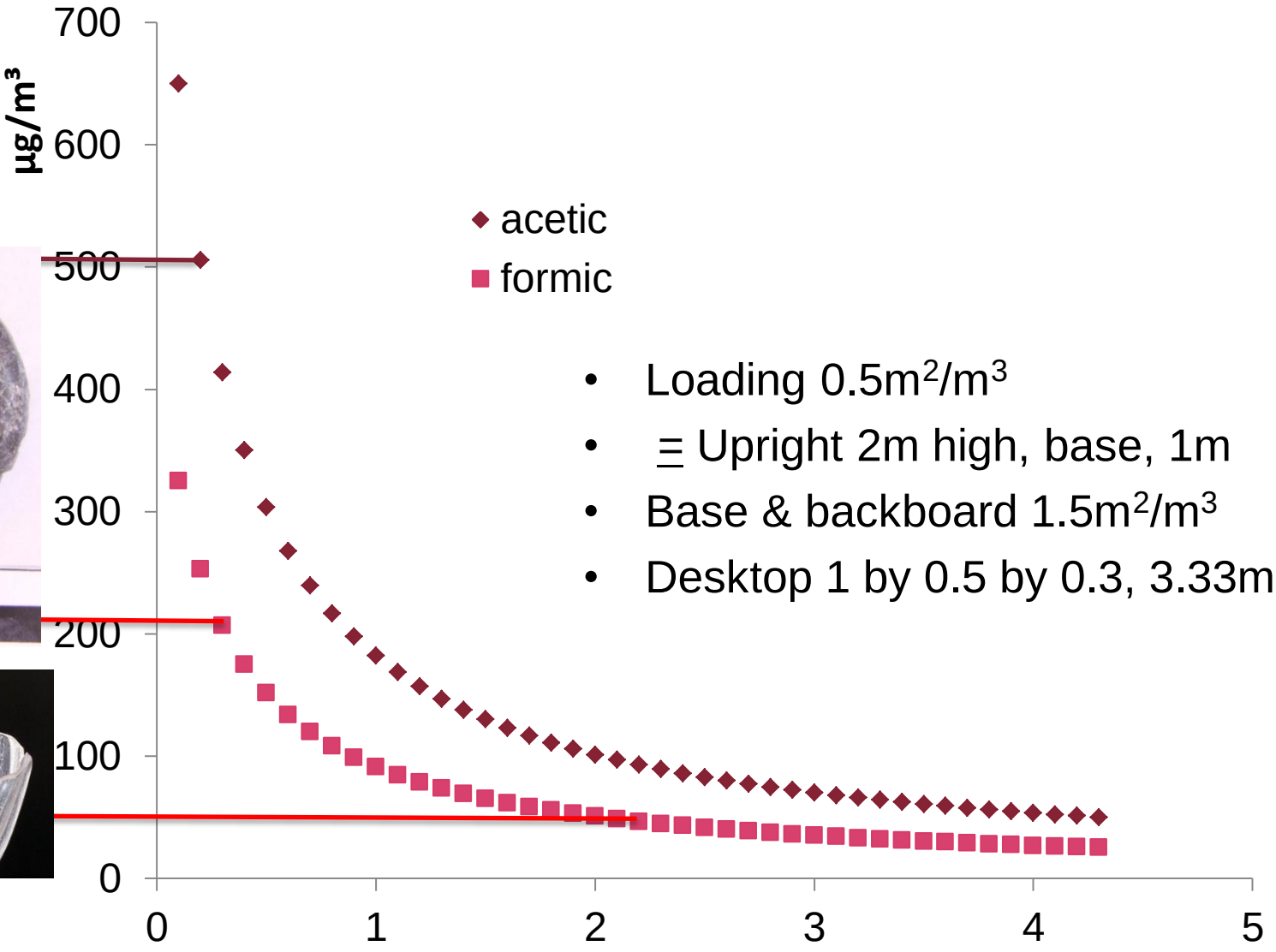
Substances:	Detection limit in µg/m³:	Analytic process
Formic acid	25	BAM specific process, referring to DIN ISO 16000-3
Acetic acid	50	BAM specific process, referring to DIN ISO 16000-3
Formaldehyde	2	DIN ISO 16000-3
2,6-TDI	2	OSHA² method number 42 for DIISOCYANATES
HDI	2	OSHA² method number 42 for DIISOCYANATES
2,4-TDI	1	OSHA² method number 42 for DIISOCYANATES
Oxime	5 (Toluene equivalent)	DIN ISO 16000-6

Neither TDI nor MDI is generally **corrosive** towards **metals** (except aluminium).

Parameters

• BEMMA	Oddy
• Volume $1m^3$	0.00005
• Air exchange rate 0.18 h^{-1} = 4.32 d^{-1}	0.034 d^{-1}
• Loading $0.5m^2/m^3$	72
• Measured after 144h (20h BEMMA)	28 days
• Detection Limits	
• 50µg/m³ acetic	2µg/m³
• 25µg/m³ formic	1µg/m³

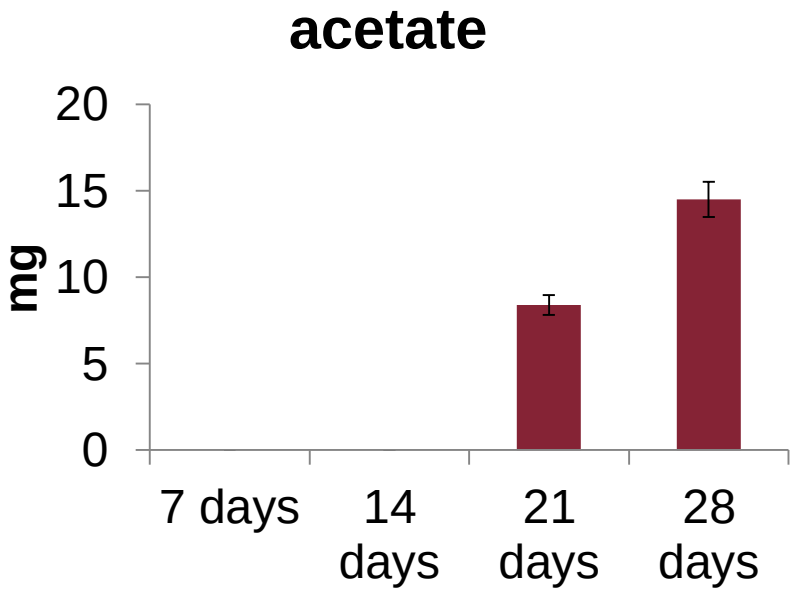
Meyer and Havermanns

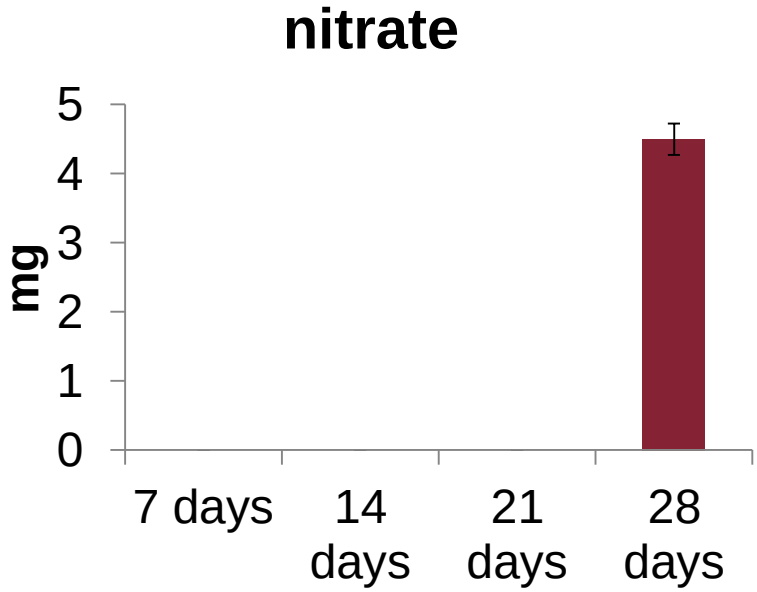


- Loading 0.5m²/m³
- ⩵ Upright 2m high, base, 1m
- Base & backboard 1.5m²/m³
- Desktop 1 by 0.5 by 0.3, 3.33m²/m³

Necessity of Accelerated Aging

- 28 days always an issue, but species are degradation products
- Oddy tests weekly check, over 400, about 4%, late fails, 2% in last week of test
- Gas analysis

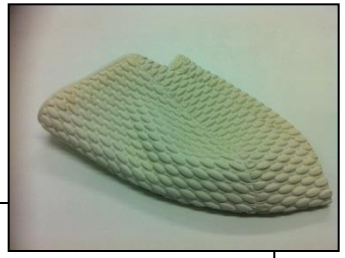




DL 0.005mg

DL 0.001mg

Degradation time
(80 ° C/60%RH)

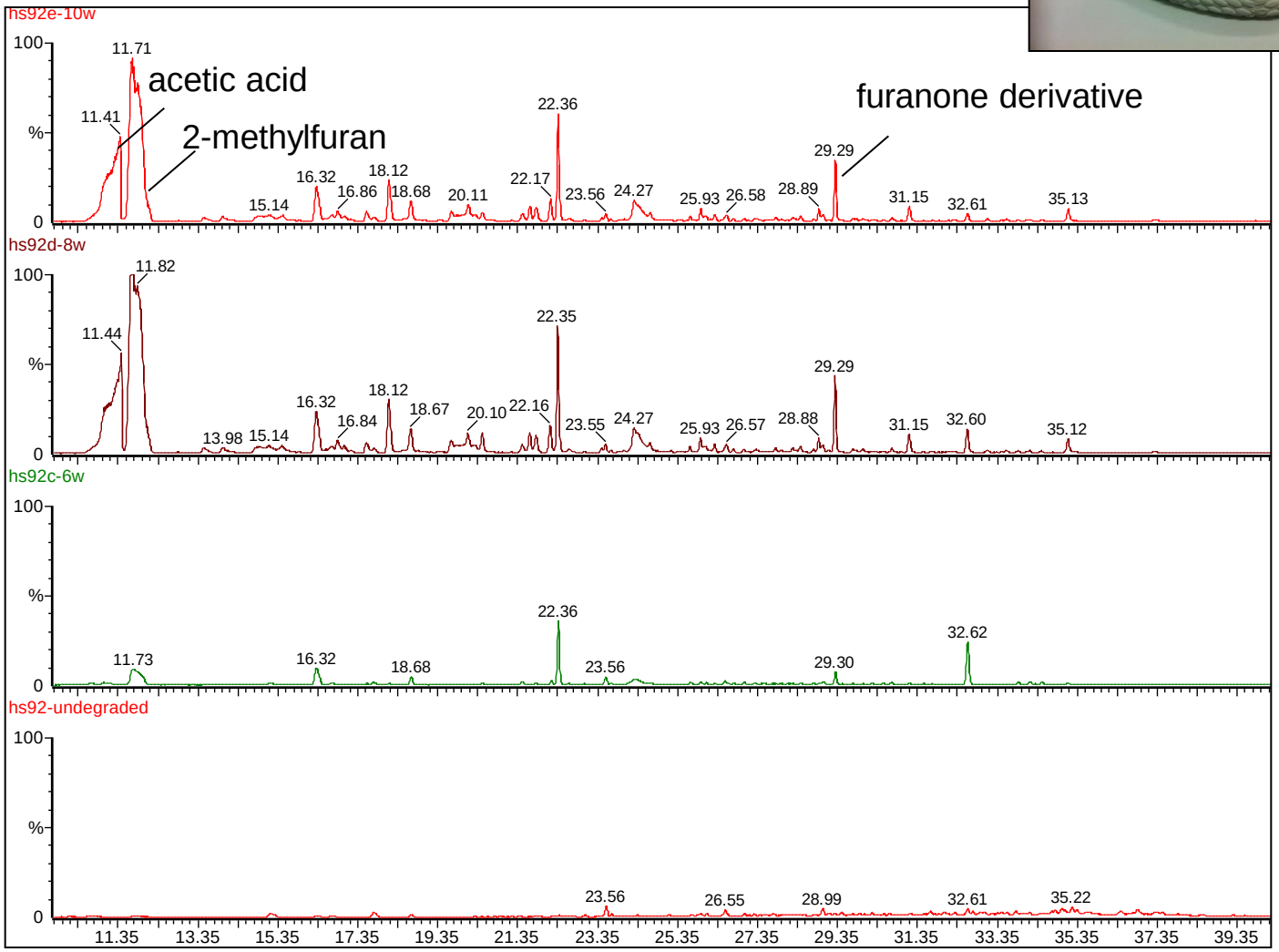


10 weeks

8 weeks

6 weeks

none



Degradation time
(80 ° C/60%RH)

10 weeks

8 weeks

6 weeks

none

ODDY ISSUES

- IF follow method, accelerated corrosion tests can have low reproducibility
  - Two main areas;
    - Metal surface preparation
    - Assessment of coupons at end of test
- But overcome by other industries, ISO9223, 11844, electronics, silver coins/silverware
- ONLY metals, (Ag, Cu, Pb Fe, Zn, Sn, Cd, Al)
  - Extended to paper and silk,
  - working on bone and ivory

METAL PREPARATION

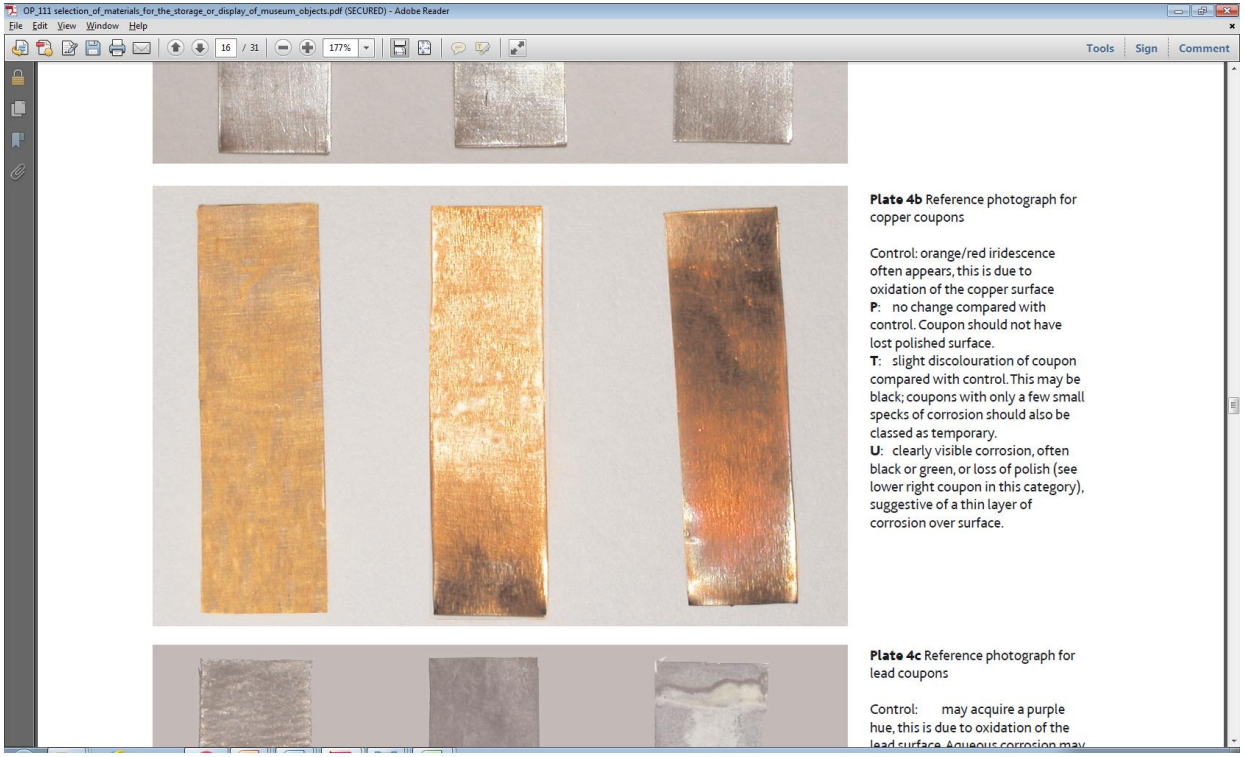
- Oddy (Robinet 2003)
  - GBBrush, Spectrosol acetone 1min, damp tissue
- ISO 9223, ISO 11844,

ISA S.71.04-1985, ASTM G1-90: 1999

- Recent British Museum
  - Micromesh, alumina, Chromanorm acetone, Cl free tissue

ASSESSMENT - VISUAL

- Published guide photographs and descriptions



- Methods low tech dust kit, Regis Berthalon thesis

Adapt images and systemise

Dust_ATLAS.pdf - Adobe Reader

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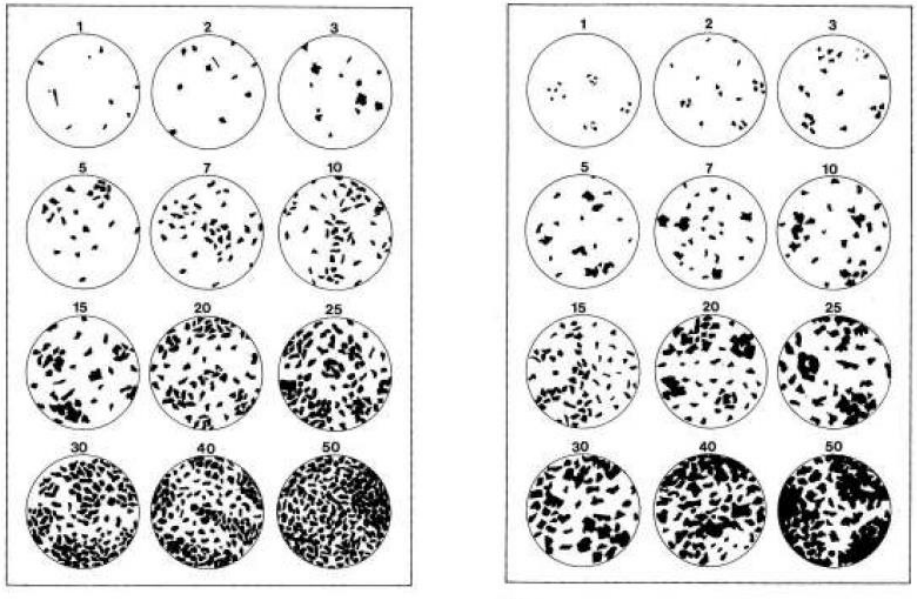
42 / 43 101% Tools Sign Comm

Covering: percentage

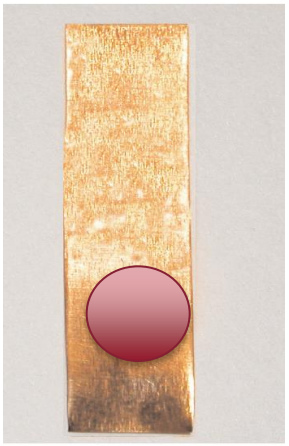


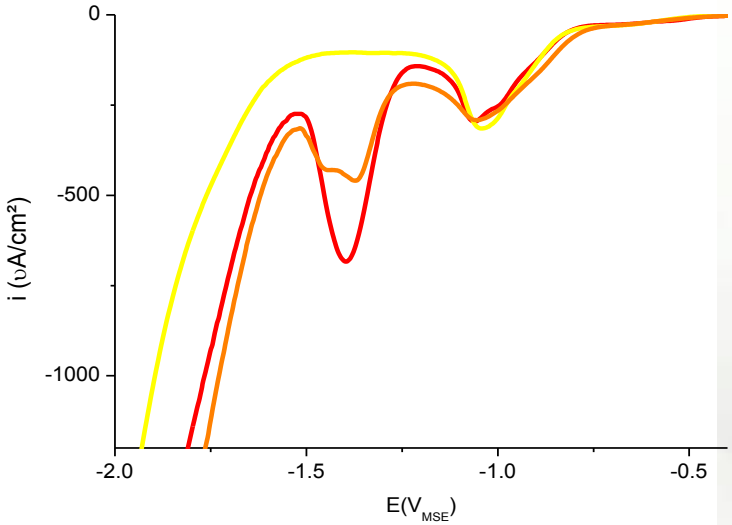
If the coverage is to be estimated, you could use a chart like those used in microscopic examination to estimate the percentage of grains or minerals.

Reference: Castro Dorado, 1989. Petrografía basica. Texturas, clasificación y nomenclatura de rocas. Paraninfo, Madrid

ASSESSMENT – LOWER COST

- Colorimetry (Tetreault)
- Image analysis (Wang et al),
  - Image J, % and colour
  - Challenging for temporary
- Mass Gain
- Mass Loss (stripping)
- Electrochemical stripping





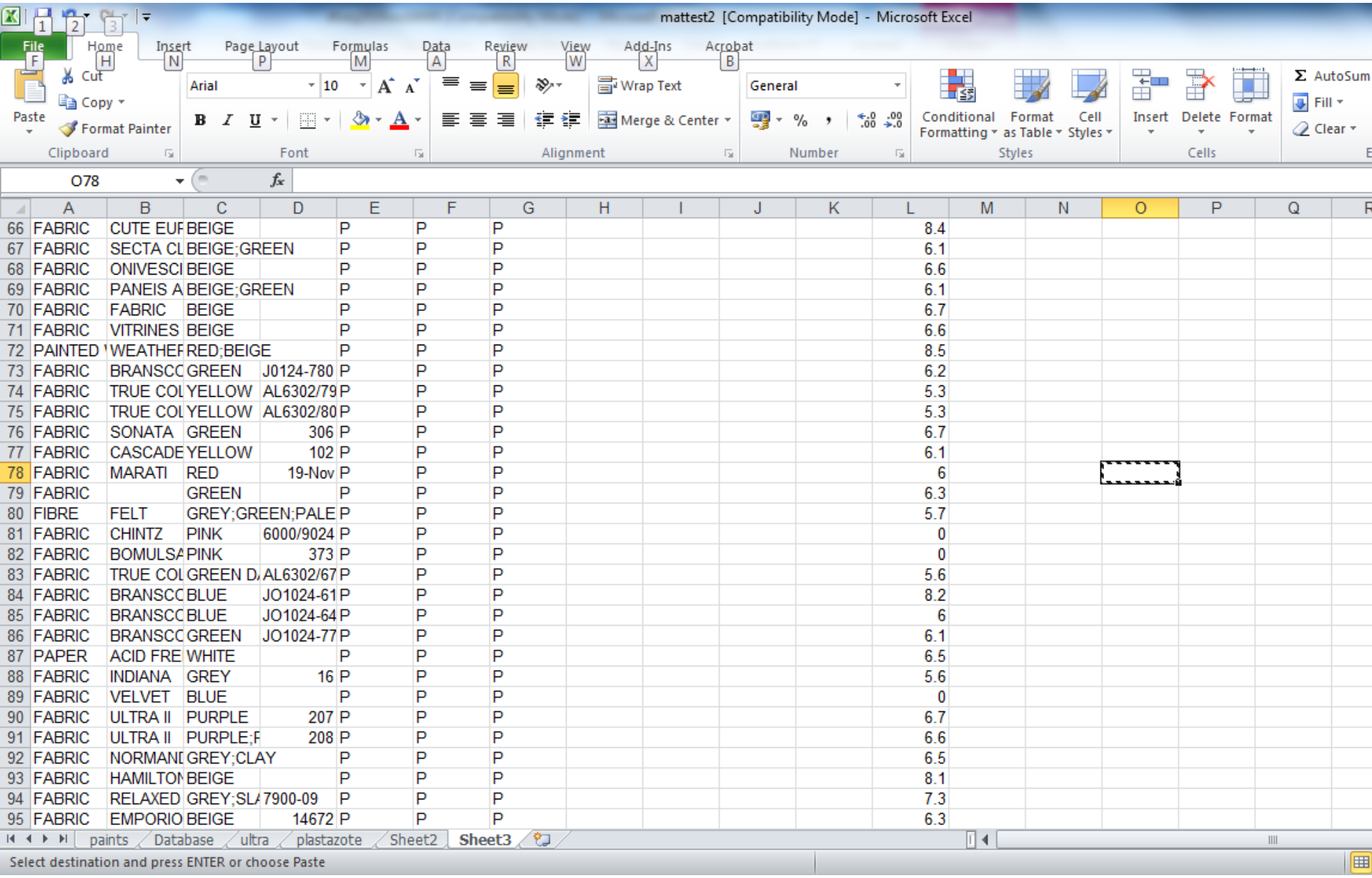
ASSESSMENT INSTRUMENTAL

- LEAD
  - XRD
  - FTIR
- COPPER
  - XRD
  - FTIR
  - SEM-EDAX
- SILVER
  - Grazing angle XRD
  - FTIR (sulfates, oxides)
  - SEM-EDAX
  - XRF
  - XPS
  - Static SIMS
  - Dynamic SIMS
- PAPER
  - Viscometry (DP)
  - NIR
  - FTIR
  - Ion chromatography (low MW sugars)

1000+ instances of corrosion investigated

material	corrosion	tested	new test		enviro data				
				T/RH	acetic/for	SO, NO,	O3	other	
Cu alloy	copper hydroxide	no	fail copper	han 156				ammonia	
			pass						
			fail lead						
			pass						
marble	calcium formate	no	fail lead	ACR 345	yes	yes	no	no	
	calcium acetate								
Cu alloy	sodium copper actetae carbonate 1	no	fail lead	ACR 120	yes	no	no	no	
	sodium formate		fail lead						
	sodium copper actetae carbonate 2								
lead	lead formate	fail lead	6 months fail lead						
glass	sodium formate	no	fail lead	han 12	yes	no	no	form, meth,eth	
			fail lead						
glass	sodium formate	no	fail lead	han 13				form, meth,eth	
			fail lead						
glass	sodium sulfate	no	fail lead, copper	han 57	yes	no	no	no	
enamel	sodiu formate	no	fail lead	after ACR184	yes	no	no	no	
			fail lead						
			fail lead						
			fail lead						


'...WILLINGLY AND DESERVEDLY FULFILLED HIS VOW' – THE LIFE OF THE SPIRIT
The gods governed every aspect of life, sometimes appearing in dreams and visions with instructions. The relationship was a contract, and requests made to gods included the promise of an offering if the prayer was answered. This explains the formula '...willingly and deservedly fulfilled his vow' often ending altar inscriptions.
Religion permeated every activity, whether an offering at the household shrine, attendance at a large sacrifice outside a temple, or taking part in the more intimate rituals of a temple to Mithras or Mars Thincsus. For protection, amulets were worn to ward off evil; and special offerings of miniature items, symbolising a particular need, could be made to a god.
Finally, at the last, standard formulae on tombstones conveyed the soul into the afterlife, and grave goods were provided for the use of the departed; until in the third century the rites became specifically Christian.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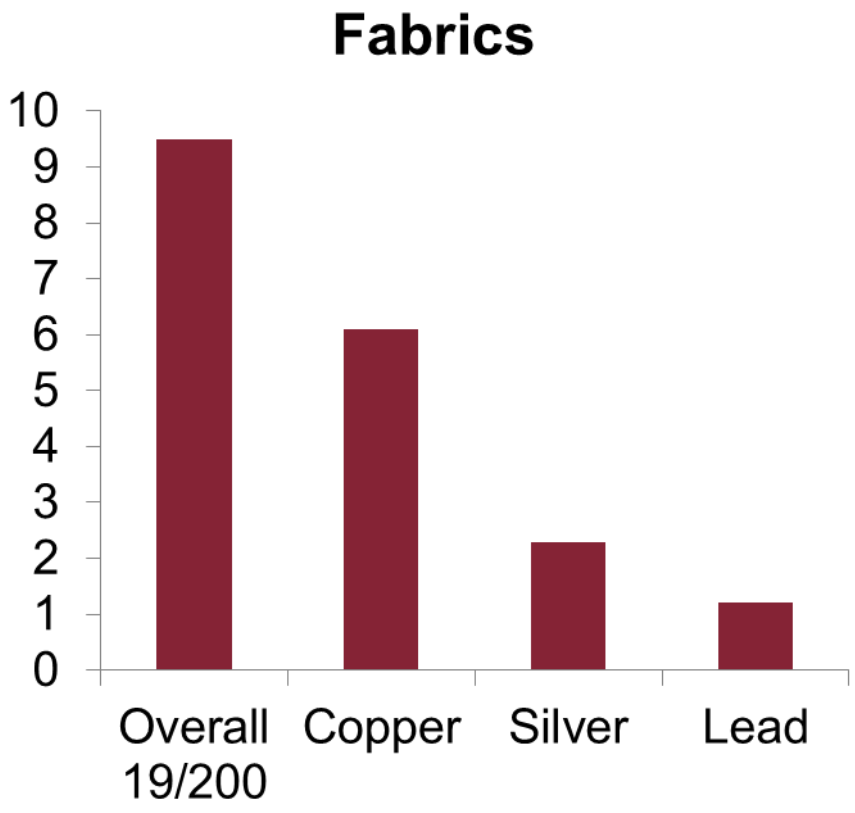
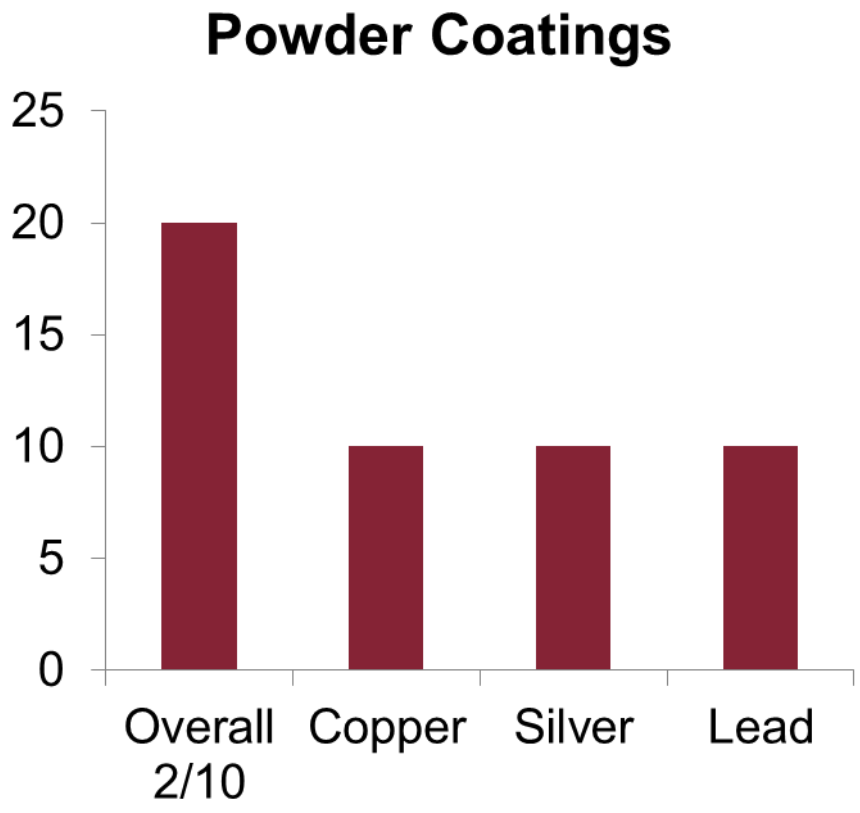
A B C D E F G H I J K L M N O P Q R
66 FABRIC CUTE EUF BEIGE P P P 8.4
67 FABRIC SECTA CL BEIGE;GREEN P P P 6.1
68 FABRIC ONIVESCI BEIGE P P P 6.6
69 FABRIC PANEIS A BEIGE;GREEN P P P 6.1
70 FABRIC FABRIC BEIGE P P P 6.7
71 FABRIC VITRINES BEIGE P P P 6.6
72 PAINTED WEATHEF RED;BEIGE P P P 8.5
73 FABRIC BRANSCC GREEN J0124-780 P P P 6.2
74 FABRIC TRUE COL YELLOW AL6302/79 P P P 5.3
75 FABRIC TRUE COL YELLOW AL6302/80 P P P 5.3
76 FABRIC SONATA GREEN 306 P P P 6.7
77 FABRIC CASCADE YELLOW 102 P P P 6.1
78 FABRIC MARATI RED 19-Nov P P P 6
79 FABRIC GREEN P P P 6.3
80 FIBRE FELT GREY;GREEN;PALE P P P 5.7
81 FABRIC CHINTZ PINK 6000/9024 P P P 0
82 FABRIC BOMULSA PINK 373 P P P 0
83 FABRIC TRUE COL GREEN D/ AL6302/67 P P P 5.6
84 FABRIC BRANSCC BLUE JO1024-61 P P P 8.2
85 FABRIC BRANSCC BLUE JO1024-64 P P P 6
86 FABRIC BRANSCC GREEN JO1024-77 P P P 6.1
87 PAPER ACID FRE WHITE P P P 6.5
88 FABRIC INDIANA GREY 16 P P P 5.6
89 FABRIC VELVET BLUE P P P 0
90 FABRIC ULTRA II PURPLE 207 P P P 6.7
91 FABRIC ULTRA II PURPLE;F 208 P P P 6.6
92 FABRIC NORMANI GREY;CLAY P P P 6.5
93 FABRIC HAMILTON BEIGE P P P 8.1
94 FABRIC RELAXED GREY;SL/ 7900-09 P P P 7.3
95 FABRIC EMPORIO BEIGE 14672 P P P 6.3
paints
Database
ultra
plastazote
Sheet2
Sheet3
Select destination and press ENTER or choose Paste

Direct contact extra risk



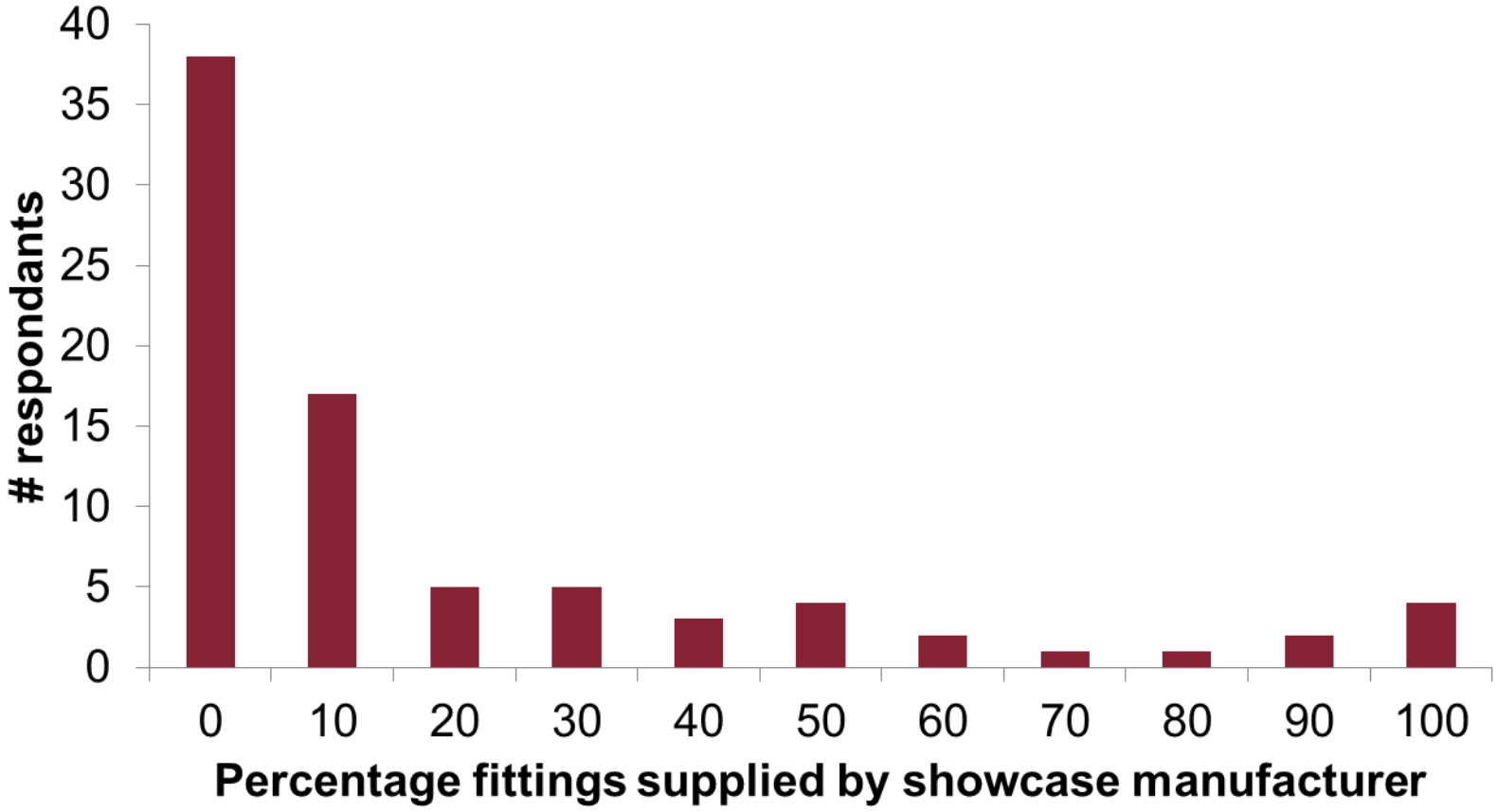


New materials

- Paper, (Strlic et al 2011)
  - Viscometry, fiddly
  - NIR (Surv NIR) possible
  - FTIR calibration as widely available in museum and science labs
- Silk, (Luxford 2009)
  - NIR
  - FTIR methods published
- Differential for organic materials less, need decide acceptable
  - At 50%RH, 20C, 1000µg/m³ acetic
    - lead no corrosion to 4g/m²
    - Paper DP half life decreases by approx 10%


COUNTY OF WILTS
PRECAUTIONARY MEASURES
RAIDS BY AIRCRAFT.
FRAGMENTS FROM FRANCE
Living in the Camps
'A great change is going to take place in our life, our quiet village is to be inundated and we are to have a camp of 4,000 soldiers settled down on Sandhill. Sleepy hollow we shall be no longer. We are going to learn the lesson of our lives.'
For the soldiers who came to the camps, life was often hard and monotonous. Army routine and discipline meant a lack of freedom and privacy.
At first many recruits were poorly equipped, lacking uniforms or even their own eating utensils. When Canadian troops arrived they had to live in tents because there were too few huts. But in the early years of the war those who had volunteered to do their bit were more willing to put up with basic conditions.
For local people the camps were both a blessing and a curse. Although they boosted the local economy there were fears of drunkenness, crime and vice.

SURVEY RESULTS – James Crawford



CONCLUSIONS

- As profession need to decide way forward
  - ISO 16000, species, unknown species, late emission of degradation products
    - levels, conditions
  - Oddy, need tighten up and develop method
  - Probably a method that's less accessible
  - Oddy has degree of flexibility, new materials, direct contact

Acknowledgements

- Kathryn Curran, UCL institute for Sustainable Heritage
- James Crawford, University of Warwick
- Virginia Costa, Federal University, Porto Alegre, Brazil
- Naomi Luxford, English Heritage
- Ana Marques, University of Porto/English Heritage
- Matija Strlic, UCL institute for Sustainable Heritage
- Michel Dubois, CNRS
- David McPhail, Imperial College

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