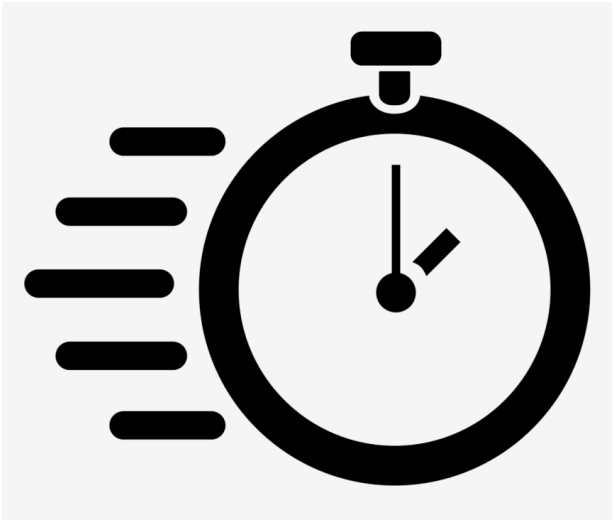
ExcelPlas Independent Materials Testing

Lifetime Assessment of PVC-EIA Liners



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MONITORING TOOLS

	OIT	CARBONYL	180° BEND	CRIT	TENSILES	MELT FLOW RATE
HDPE	✔	✔	✔	✘	✔	✔
LLDPE	✔	✔	✔	✘	✔	✔
FPP	✔	✔	✔	✘	✔	✔
PVC	✘	✘	✔	✔	✔	✘
EIA	✘	✘	✔	✔	✔	✘
CSPE	✘	✘	✔ LT	✘	✔	✘
EPDM	✘	✔	✔ LT	✘	✔	✘

OIT = S-OIT & HP-OIT
CRIT = CONGO RED INDUCTION TIME
LT = LOW TEMPERATURE

Testing Regime for Lifetime Assessment of PVC-EIA Liners

The residual lifetime of PVC-EIA liners can be determined from the following 5 tests:

- Type and Level of Extractable Plasticizers
- Congo-Red Induction Time (CR-IT) to determine retained levels of heat stabilizers
- Number of Flex Cycles to Failure (new samples achieve > 400,000 cycles)
- 180 degree Bending Test and surface microscopy of strained area for degree of microcracking.
- Infra-red analysis (FTIR) for detection of degradation products

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RETAINED PROPERTIES

- The ACTUAL VALUES OF THE TESTS ARE NOT CRITICAL RATHER IT IS THE % RETAINED PROPERTIES THAT ARE IMPORTANT FOR LONG-TERM MONITORING.

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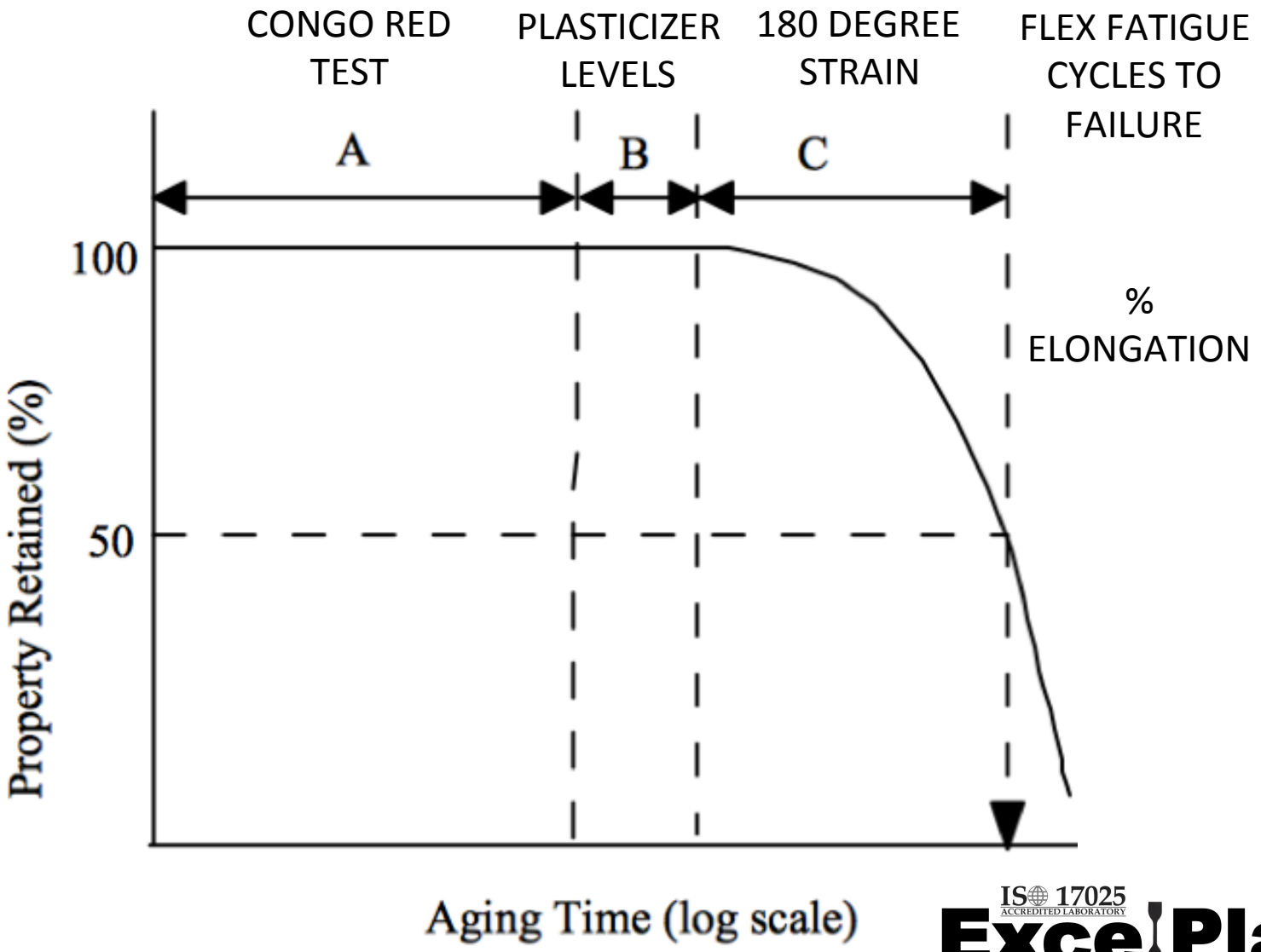
LIFETIME CURVE FOR PVC-BASED LINERS



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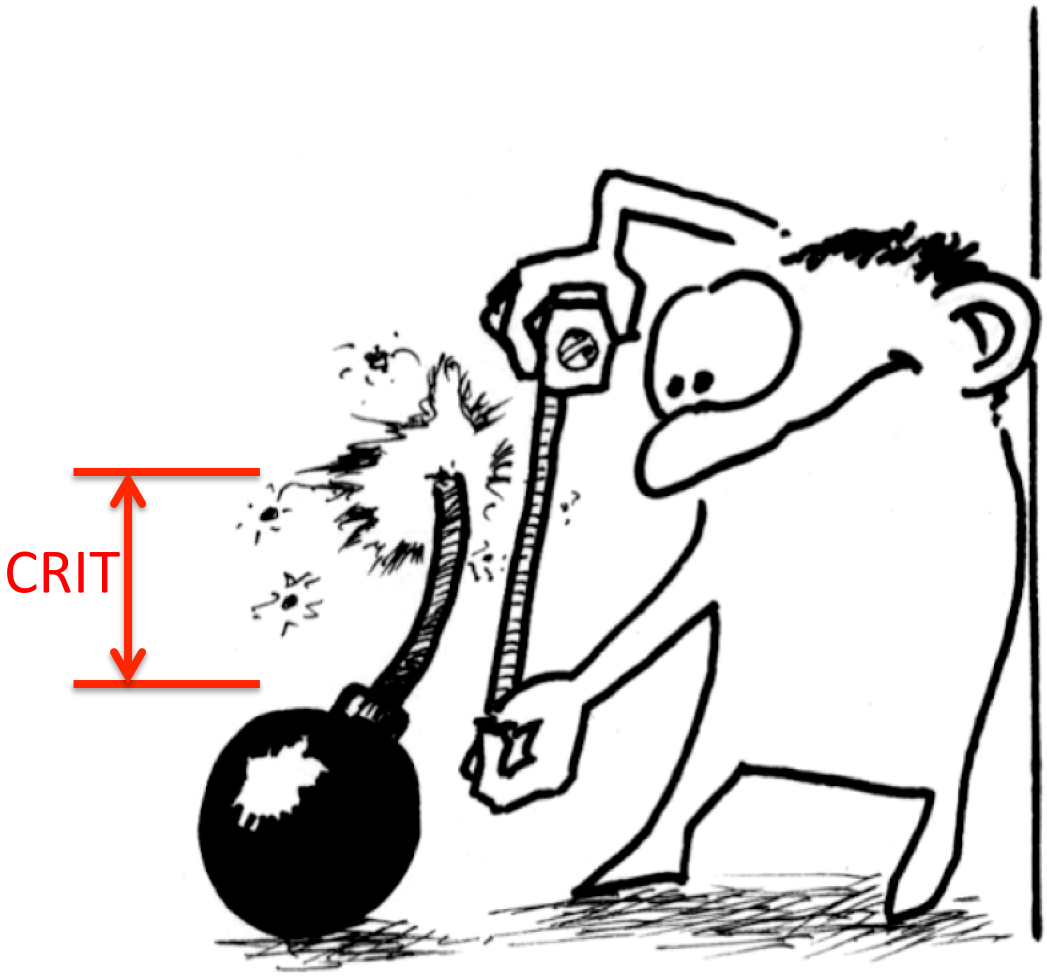
Measuring Durability of PVC-EIA using CRIT Values

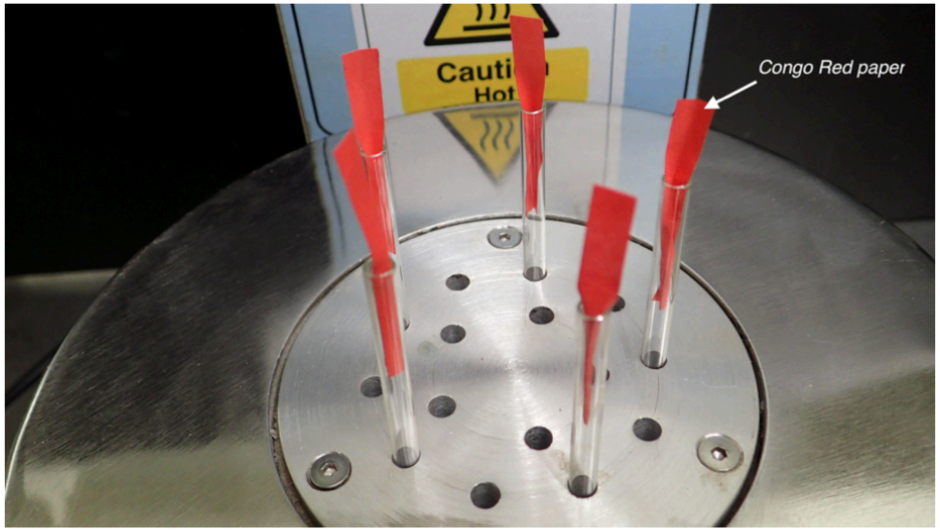


CONGO RED THERMAL STABILITY TESTING OF PVC LINERS

ISO 182-1:1990

Plastics -- Determination of the tendency of compounds and products based on vinyl chloride homopolymers and copolymers to evolve hydrogen chloride and any other acidic products at elevated temperatures -- Part 1: Congo red method.

Intended primarily as a simple and rapid quality-control test during the manufacture and conversion of PVC compounds. Suitable for coloured compounds. The determination is carried out on a sample of the PVC compound which is maintained at an agreed temperature such as 180 or 185 deg.C in still air in an aluminium block heater until the colour of a Congo red paper held above it changes from red to blue.



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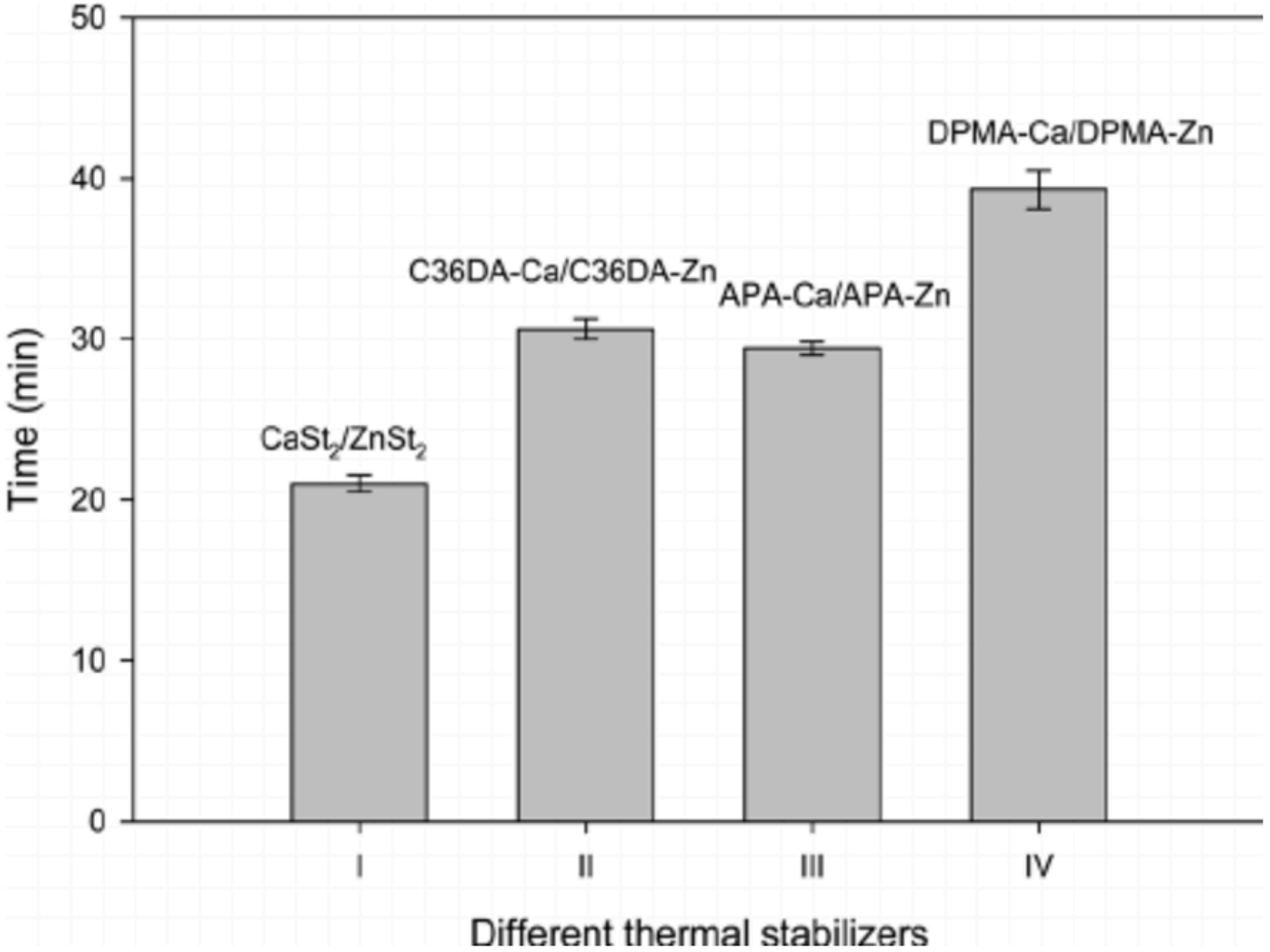
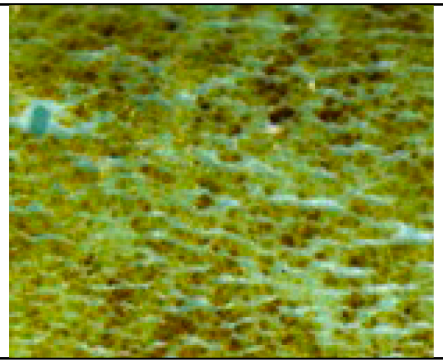
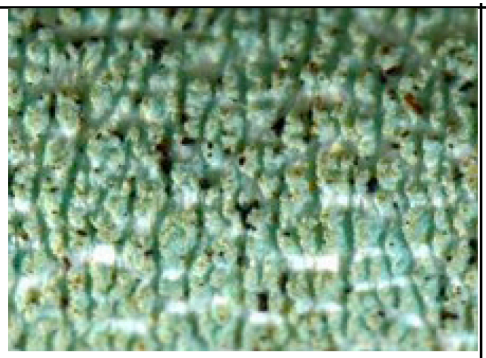
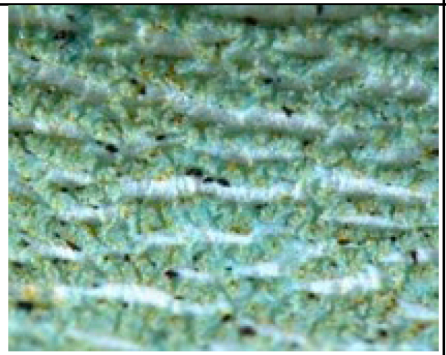
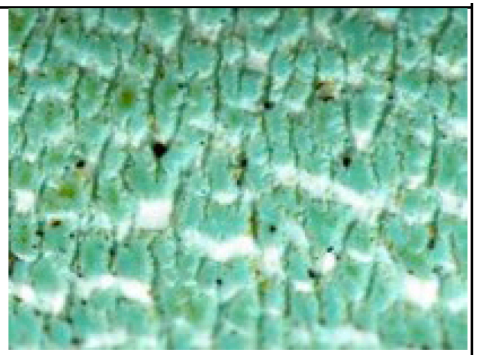
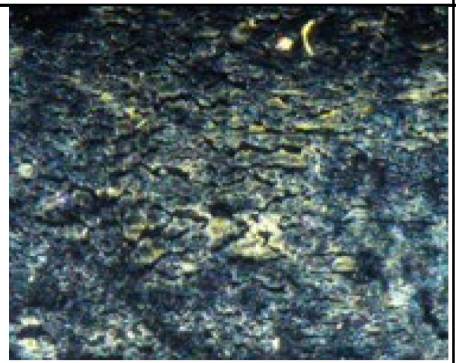
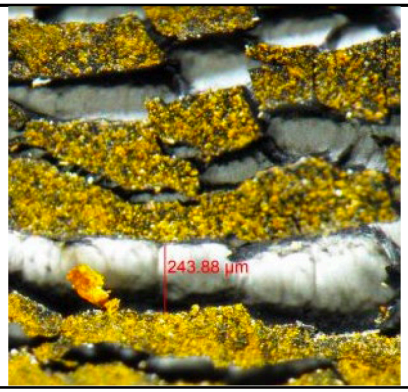
Here are some typical heat stability results for PVC using the Congo Red method for different heat stabilisers in PVC:



The thermal stability time (Ts time) or TST were measured by the Congo red testing. The figure above shows the effects of different stabilizers on Ts of the PVC compounds at 185 C. The results indicate that DPMA-Ca/DPMA-Zn exhibited signifcantly higher long-term heat stability than other stabilizers. The Ts values of different formulations followed the order of DPMA-Ca/DPMA-Zn (48 min) > C36DA-Ca/C36DA-Zn (31 min) > APA-Ca/APA-Zn (29 min 25 s) > CaSt 2 /ZnSt 2 (20 min 55 s).

Examples of Microcracking of Aged PVC-EIA Liners on 180 degree Bend Back

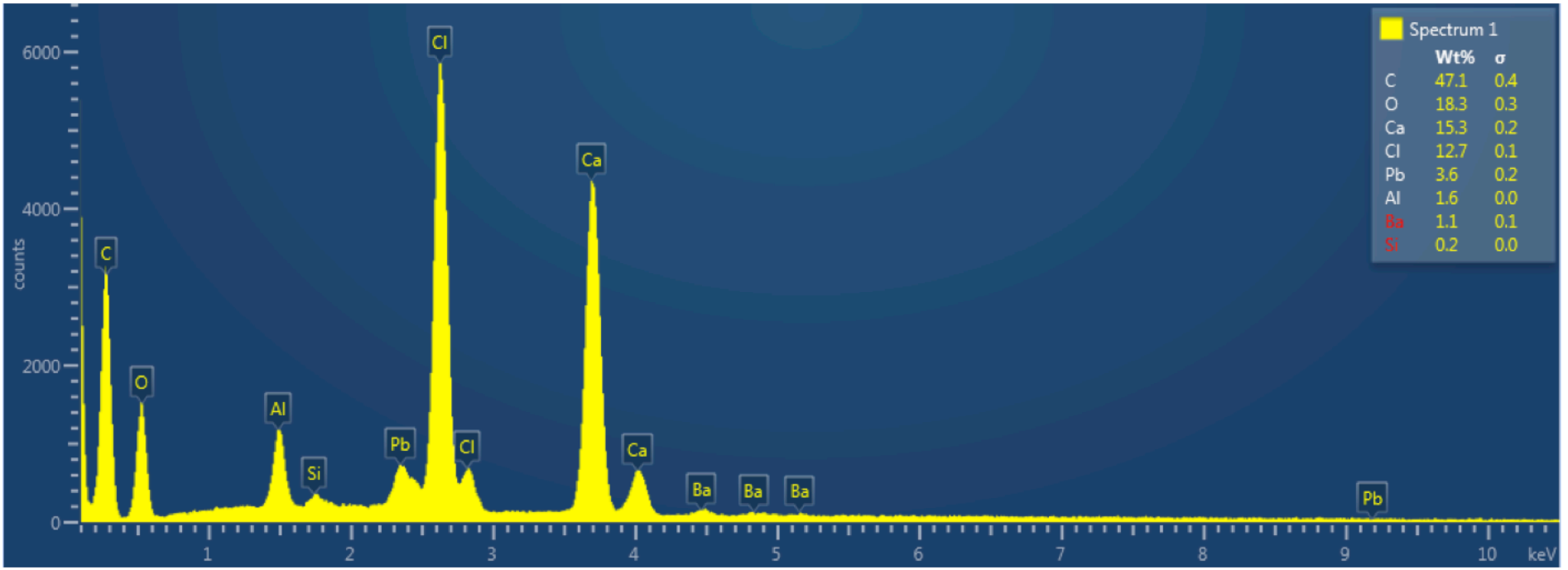


Microcrack Detection by 180 Degree Bend Back Test (BBT)

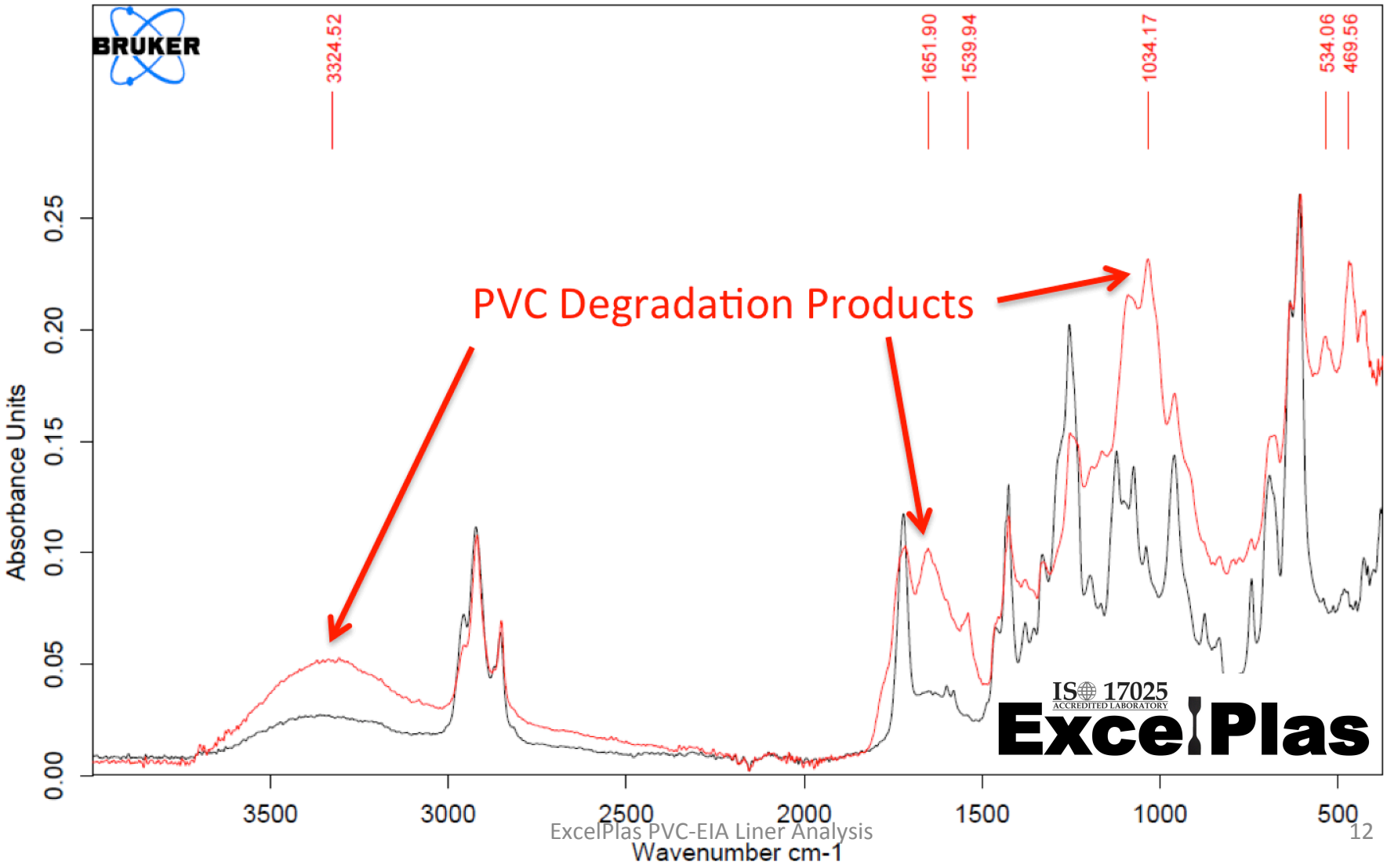
- Bend-back test. The bend-back test evaluates the inside pipe surface for brittleness. The evaluation is made by careful visual inspection of the inside surface of an arc section of the pipe that has been highly strained by bending against the curvature of the pipe wall. The presence of surface cracking or crazing signals that this surface may have become thermally degraded by excessive extrusion temperatures.

" extracted from PE Pipe Design & Installation (M55) by by American Water Works Association"

Elemental Analysis of Aged PVC-EIA Sample



FTIR Spectra



Flex Crack Testing

- Flex cracking resistance of liners by **AS 4878.9-2001** 'Determination of resistance to damage by flexing' (also ASTM D6182)
- The number of flex cycles before cracking is measured.

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ExcelPlas Flex Cracking Tester

Recommended Testing Regime for Determining Residual Life of PVC-EIA Liners

Name Of Test	Test Method/s	Purpose of Test
Plasticizer Analysis (PA)	ASTM D8133	To determine the retained level of extractable plasticizers
Congo Red Induction Time (CR-IT)	ISO 182-1 DIN 53381	To determine the retained level of heat stabilizers
180 Degree Bend Back Test (BBT)	AWWA M55	To determine extent of embrittlement and microcracking
Flex Testing	ASTM D6182 AS 4878.9	To determine retained flexibility by recording number of flex cycles to onset of cracking
Infra-red Analysis (FTIR)	ASTM E168	To determine the presence/evolution of infra-red absorption of PVC-EIA degradation products

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