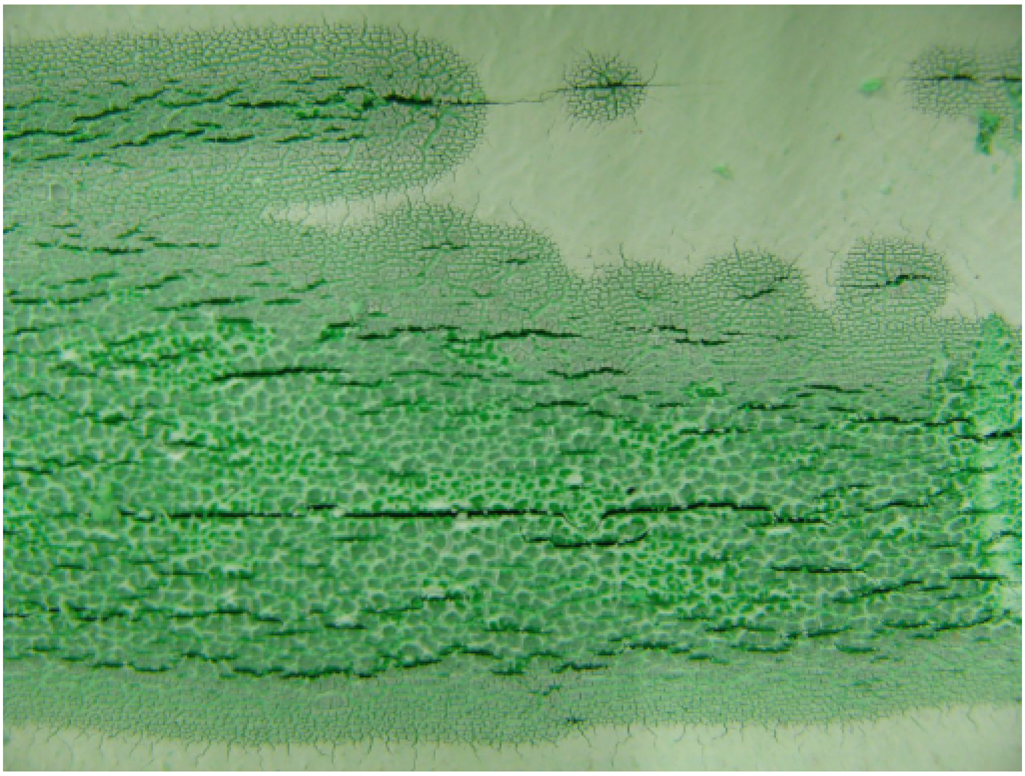
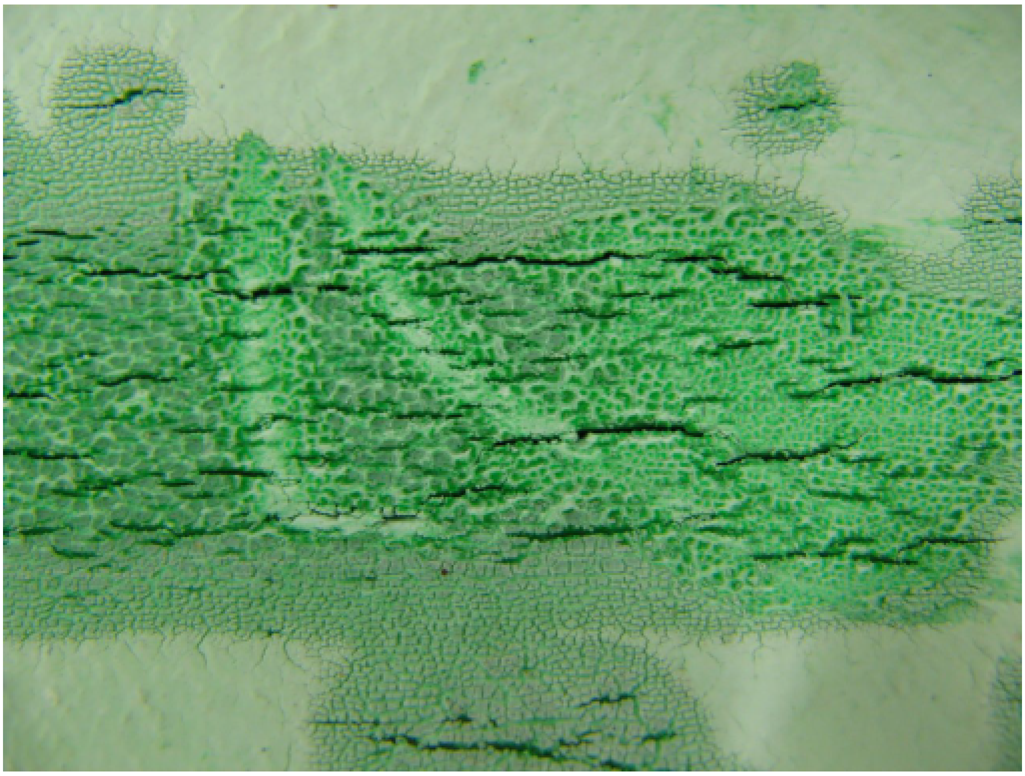
40-50

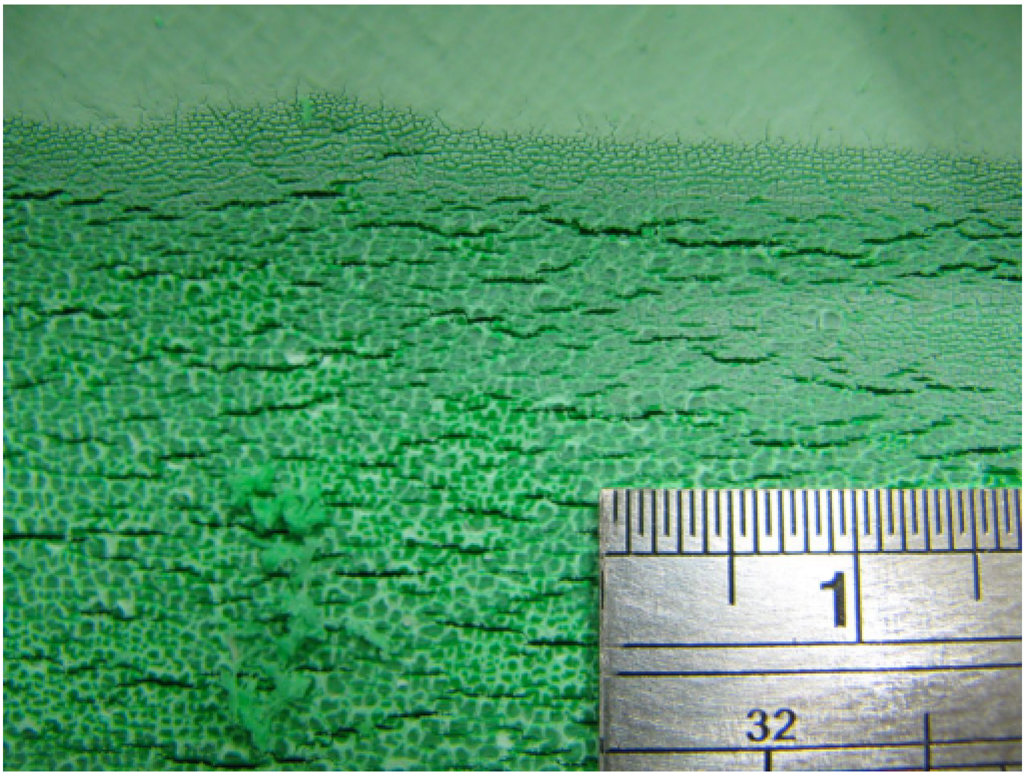
Reinforced polypropylene – Water pipes

Title	Analysis of PP-R Green Pipe
Date	2013
Objective	To analyse a sample of PP-R green pipe to determine the cause of cracking failure
Photo	

Figure 1. Position of leak on outside of pipe



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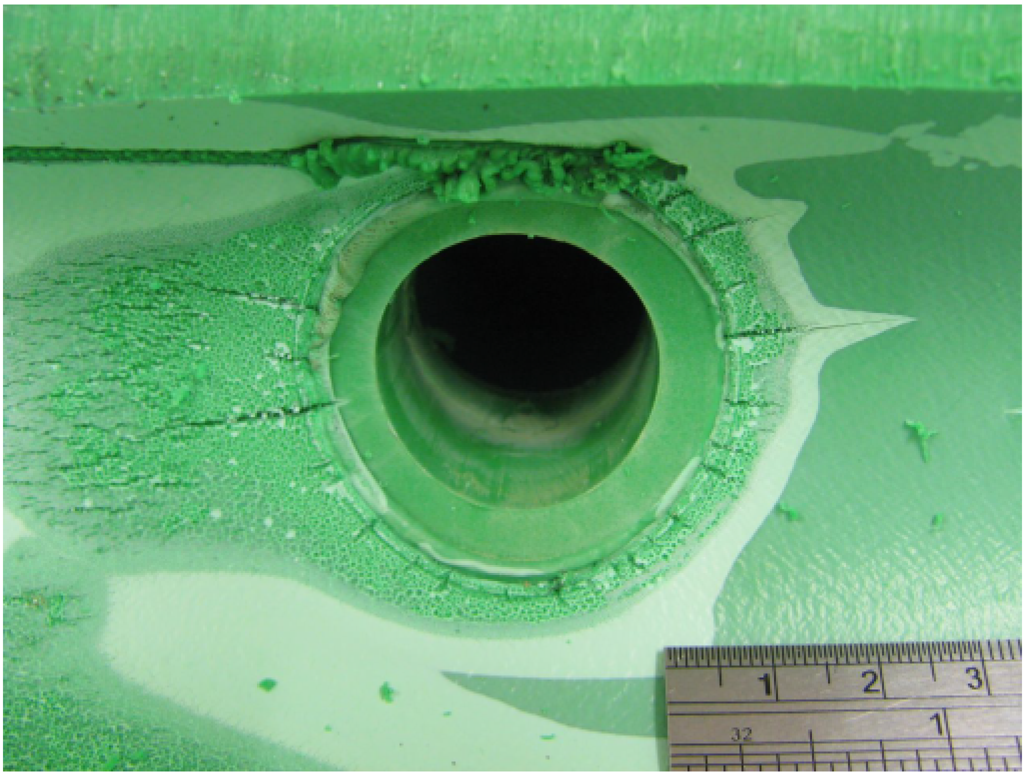
1
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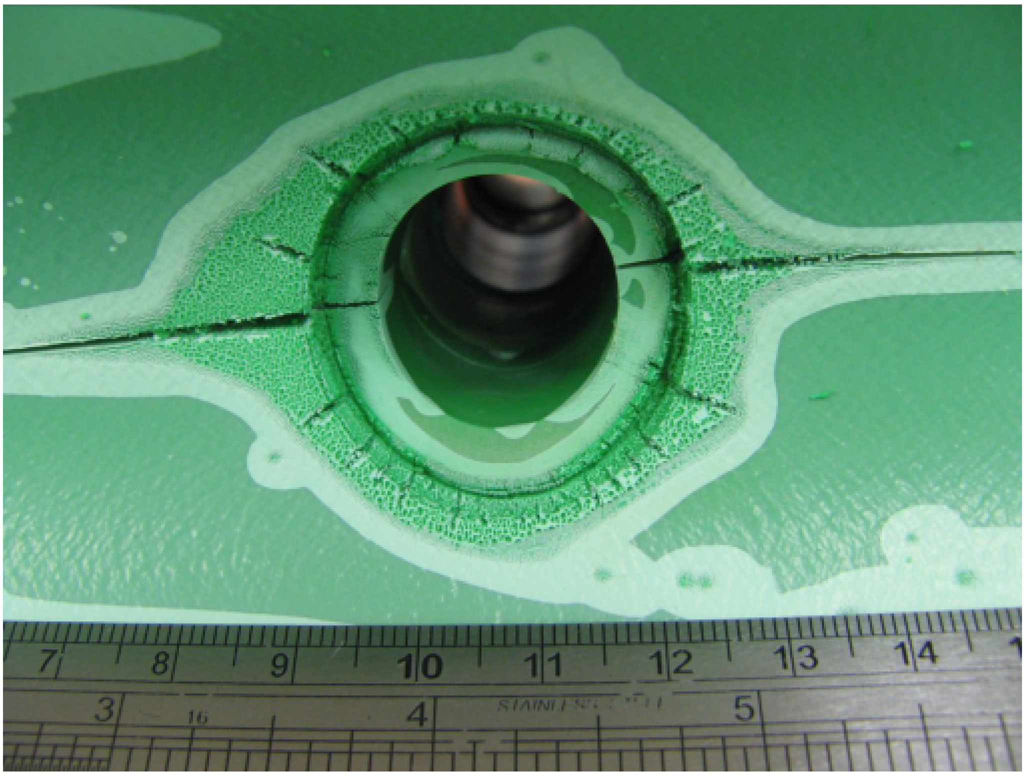
	 Figure 2a, 2b, 2c, 2d, 2e. Photomicroscopy of inside of pipe
Testing Undertaken	OIT as per ASTM D3895 Digital microscopy FTIR as per ASTM F2102 NMR spectroscopy
Failure Analysis	Antioxidants in the pipe were almost totally depleted (only Irganox 1010 and Irfagos168 were present), thus the pipe was not fit for service. The severe oxidative cracking of the pipe was due to a combination of thermal oxidation and stresses associated with thermal expansion and contraction

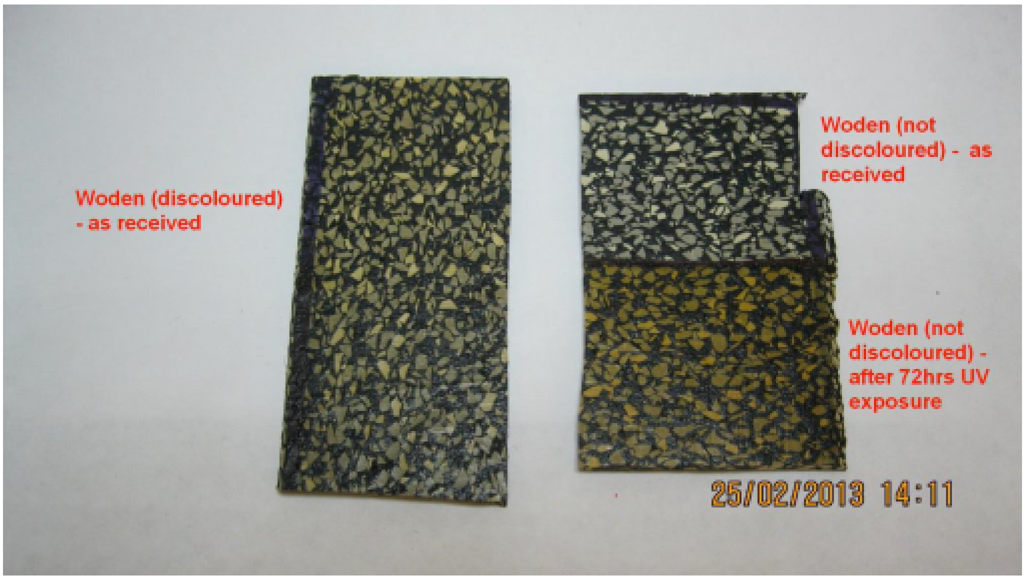
Rubber – Bellows

Title	FAILURE ANALYSIS OF RUBBER BELLOWS
Date	2012
Objective	To investigate the cause of cracking of rubber bellows.
Photo	

	Figure 1a and 1b. Photomicroscopy showing crack in fold of bellows
Testing Undertaken	Photomicroscopy IR-Spec
Failure Analysis	The rubber bellows failed by cracking due to ingress of lithium ions into the nitrile rubber molecular structure.

Rubber – Floorings

Title	DISCOLORATION OF RUBBER FLOORING
Date	2013
Objective	To investigate the discoloration of rubber flooring and in particular to determine the mechanism of yellowing and the root cause of the yellowing.

	The flooring was installed in various shops.
Photo	 Figure 1. Sample comparison after UV exposure to non-discoloured sample.
Testing Undertaken	IR Spec analysis (ASTM E1252 – 98) on the exposed surface of the rubber flooring Accelerated UV exposure testing (QUV) (ASTM D7238 – 06)
Failure Analysis	Yellowing is due to photodegradation of the urethane, which containedchromophores (most likely from the isocyanate precursor) which interact with the UV light leading to poor light stability and photoyellowing. Using chromophore-free isocyanates and/or including UV absorbers would prevent yellowing.

Rubber – Mouldings

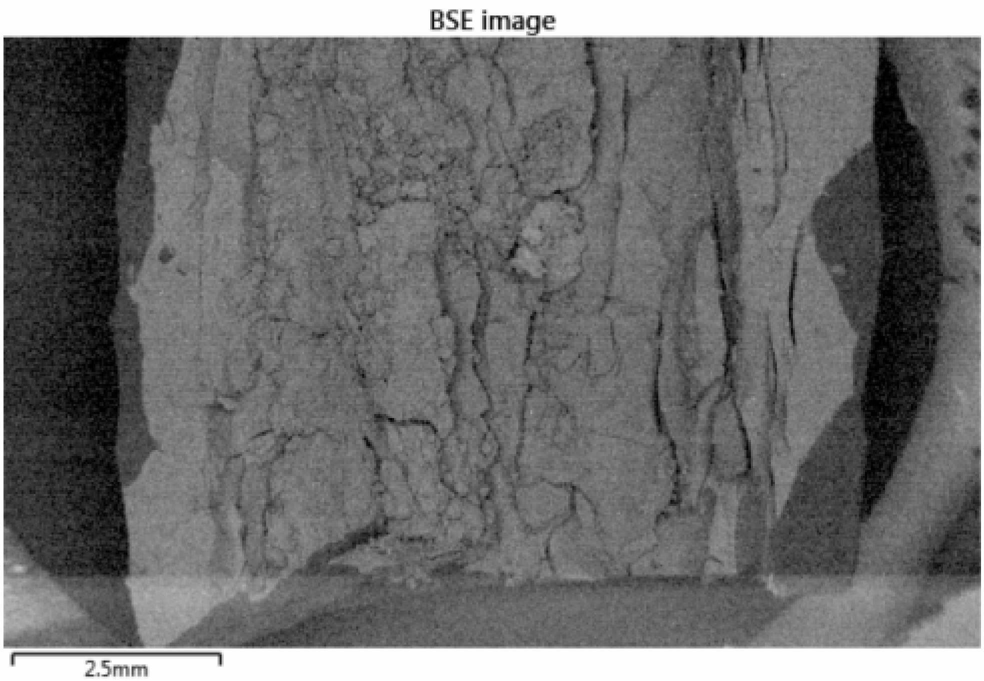
Title	IDENTIFICATION OF A BLACK MOULDED ITEM
Date	2013
Objective	To identify the material from which black item was moulded
Testing Undertaken	Fourier Transform Infrared (FT-IR) according to ASTM E 573, using an Alpha Measurement Module

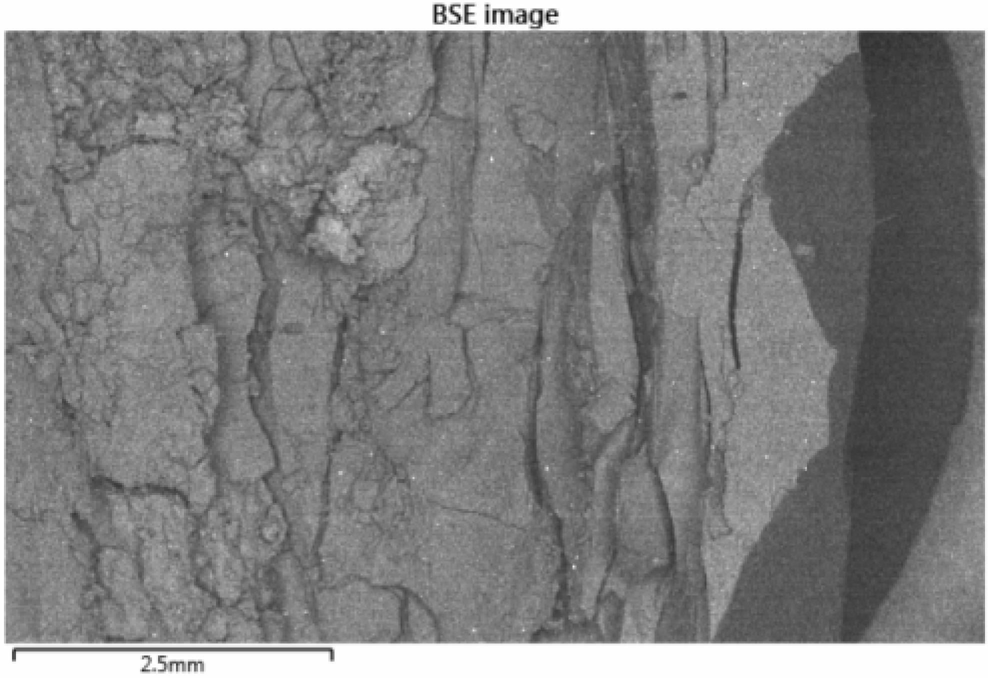
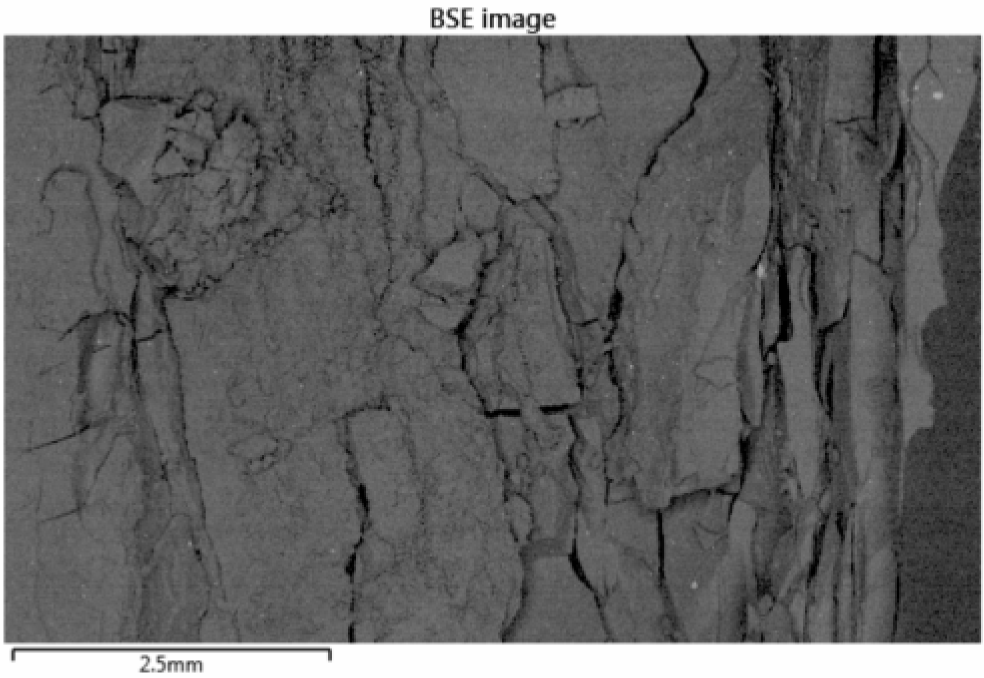
	Digital Scanning Calorimetry (DSC) according to ASTM D 3418, using a DSC Q20 by TA instruments
Conclusion	Material was most likely a thermoplastic elastomer such as Santoprene (co-polymer of polypropylene and EPDM), as the IR spectrum indicated a polypropylene, EPDM and talc mixture, and the DSC scan showed no crystalline melting point behaviour. IR also showed some unidentifiable absorption peaks.

Rubber – O-rings

Title	IDENTIFICATION OF RUBBER O-RINGS AND RELEASE AGENTS
Date	2013
Objective	To identify the material in Rubber O-Rings and their release agents.
Testing Undertaken	The O-rings were washed in chloroform to dissolve the release agents from the O-ring surface. An ATR FTIR spectrometer was then used to measure the IR spectrum of the chloroform wash residue and the washed O-rings.
Conclusion	The IR spectra of the release agents matched Vaseline. The IR spectra of three of the four O-rings matched butyl rubber. The fourth sample (analysed by Pyrolysis IR spectroscopy) matched an inorganic silicate filled ethylene propylene rubber.

Silicone – Electrical cables

Title	FAILURE ANALYSIS OF SILICONE INSULATED ELECTRICAL CABLE
Date	2014
Objective	To conduct a failure analysis on the cracked silicone insulated cable to determine the root causes for the herniating of the cables from a materials perspective. The cables were part of a 75kW electric motor that drives a jet fan in a highway tunnel.
Photo	 Figure 1. Faulty silicone sample 

	  Figures 2a, 2b, 2c. BSE images of failed silicone samples
Testing Undertaken	Ashing at 600°C Elemental Analysis by EDAX SEM Thermogravimetric analysis from RT to 700 °C
Failure Mode	Silicone insulation failed by embrittlement due to thermal degradation. The cable is apparently rated for 300 °C but turned brittle at lower temperatures ('good' silicone sample turned brittle after just 97 hours at 240 °C). The thermogravimetric scans showed that both silicone samples began to degrade at 250 °C, thus the silicone is not properly heat stable and was likely exposed to high conductor temperatures.

	The observed degradation of the film also suggested the cables were exposed to excessive temperatures around 300 °C

Silicone rubber – Seals

Title	FAILURE ANALYSIS OF A SEAL ON A GLASS CONTAINER
Date	2012
Objective	To investigate the cause of a silicone rubber seal sticking to glass and undergoing damage on removal.
Photo	 Figure 1. Failed seal showing loss of material at failure site 

	Figure 2. Seal showing areas of cohesive failure  Figure 3. Difference in gloss levels between good (dull) and bad (glossy) samples
Testing Undertaken	IR-Spec Microscopy
Failure Analysis	The glossy surface of the 'bad' silicone rubber has led to 'auto-adhesion' on the glass and this in turn has led to cohesive failure of the silicone. Use of a less glossy silicone, or one containing an anti-block additive (such as silica), or a grade of silicone with a higher tear strength value is recommended.

Teflon – Flakes

Title	IDENTIFICATION OF WHITE FLAKES
Date	2013
Objective	To identify the composition of white flakes
Testing Undertaken	IR spectroscopy DSC

Failure Mode	Both tests indicated the white flakes consist of Teflon

Thermoplastic – Mouldings

Title	ANALYSIS OF BLOOMING ON A THERMOPLASTIC DASHBOARD MOULDING
Date	2013
Objective	To investigate the chemical nature of the blooming species on the surface of thermoplastic dashboard mouldings (which are allegedly causing respiratory issues to users of the vehicles)
Testing Undertaken	Surface ATR-FTIR Spectroscopy Surface solvent swap followed by NMR ToF-SIMS
Conclusion	The blooming residue on the surface of the mouldings was composed of glycerolmonostearate (GMS) and related glycerol monooleate (GMO). Both are safe additives which pose no toxicity issues or chemical respiratory symptoms.

Thermoplastic polyurethane – Layflat hoses

Title	IMMERSION TESTING OF TPU LAYFLAT HOSE SAMPLES
Date	2012
Objective	To investigate the cause of observed cracking of layflat hose carrying potable water in the field and to investigate the susceptibility to cracking of various layflat hose samples in aqueous chlorine solutions whilst under stress.

Photo	 Figure 1. Used 1.0% free chlorine. Note extensive microcracking
Testing Undertaken	Chlorine Exposure Testing (under bending stress) Digital Microscopy (50x)
Failure Analysis	The hose failed due to oxidative stress cracking in part caused by chlorine exposure and in part by stress.

Toner and acrylic paint – Recyclings

Title	CHEMICAL ANALYSIS OF TONER MIXED WITH ACRYLIC PAINT
Date	2013
Objective	To characterise the composition of waste toner mixed with acrylic paint.
Photo	

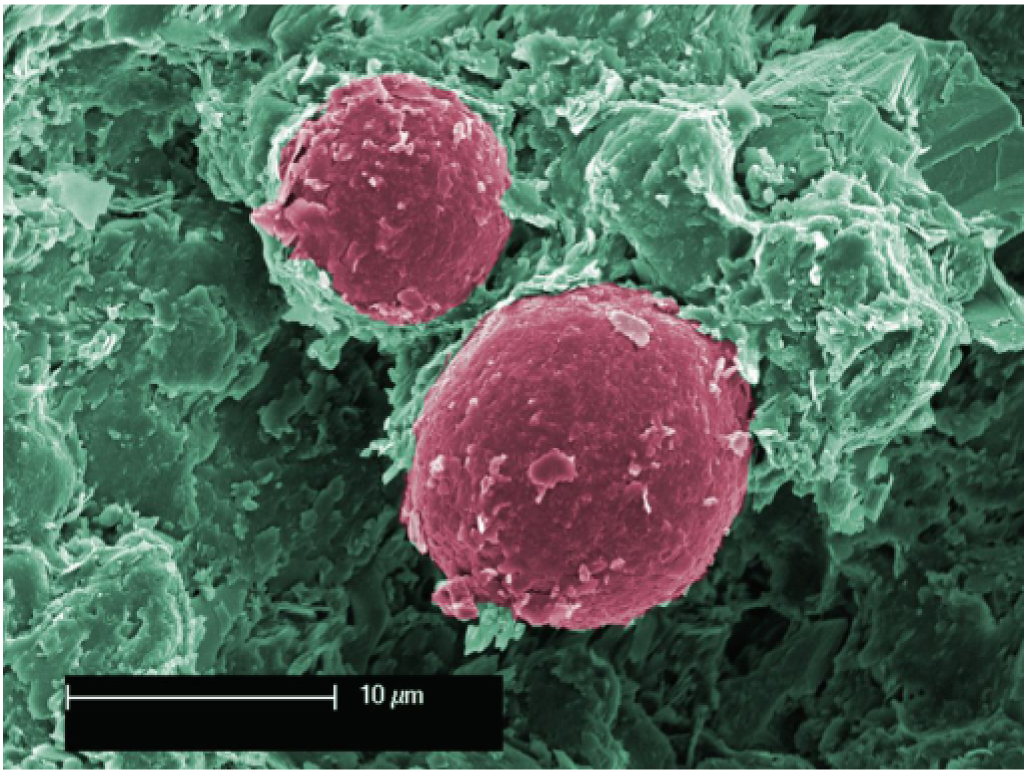


Figure 1. EM photo showing good adhesion by Toner particles (red colour)

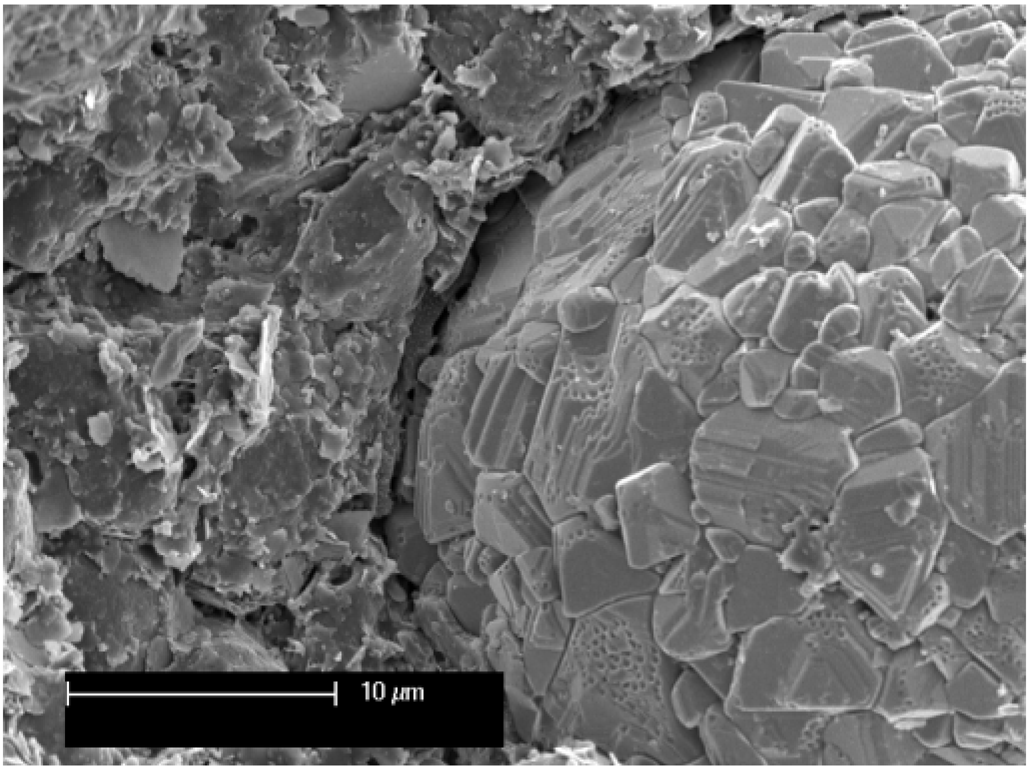


Figure 2. EM photo showing poor adhesion by ferrite particle

	 Figure 3. Flexural Testing of Compression Moulded Sample (4 mm displacement & break)
Testing Undertaken	Thermal Analysis by DSC Electron Microscopy Compression Moulding followed by flexural testing Re-emulsification testing
Conclusion	Good adhesion between toner phase and acrylic binder is evidence of mutual compatibility and miscibility. Mechanical testing indicated the toner is capable of moderate flexing, however it exhibits brittle behaviour. It is recommended a rubber modifier be added to reduce brittleness.

Accreditation

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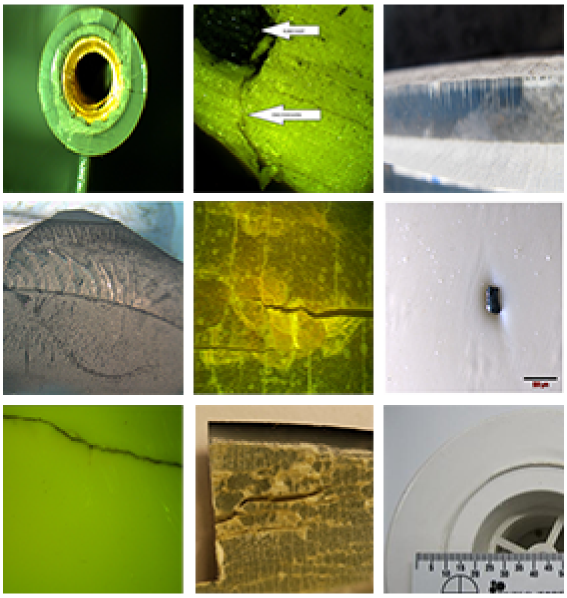
ACCREDITATION

Gallery



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